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Physico–Chemical and Microbiological Evaluation of Toma–Pep Ketch–up Prepared from Two Local Varieties (Ronita and UTC) of Fresh Tomato (*Lycopersicum esculentum Mill*)

Mohammed Sirajo Funtua[1,*] Cavus Osman[2], Haruna Iya Sule[3]

[1] Department of Food Science & Technology, The Federal Polytechnic, PMB 1012, Kaura–Namoda, Zamfara state, Nigeria.

[2] Department of Gastronomy and Culinary Arts, Faculty of Tourism, Abant Izzet Baysal University, 14840–Mengen, Bolu, Turkey.

[3] Department of Food Science & Technology, The Federal Polytechnic, PMB 35, Mubi, Adamawa state, Nigeria.

Research Article

***Corresponding author**

Mohammed Sirajo Funtua, Department of Food Science & Technology, The Federal Polytechnic, PMB 1012, Kaura–Namoda, Zamfara state, Nigeria,
Email: sirajfuntua.fst@fedponam.edu.ng, smfuntua@gmail.com.

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Abstract

This study focused on the development and quality evaluation of Toma–Pep Ketch–Up (TPK) prepared from two local species of fresh Tomato fruits (Ronita and UTC); all the samples including the control sample (commercially available Tomato Ketch–up) (TK) were subjected to physico–chemical, sensory and microbial analyses. The physico–chemical properties results of the TPK and TK were the pH of the samples of Tomato ketchup ranges from 4.5–4.3 for samples 215 (Ronita TPK), 217 (UTC TPK) and 204 (TK) respectively. The Brix content of the samples of the TPK and TK were 23.8%, 23.05%, and 23.6% for samples 215, 217, and 204 respectively. The total titratable acidity (TTA) recorded for the three samples were 1.58, 1.89, and 1.01 respectively for samples 215, 217, and 204; while the viscosity values of the three samples were, 21,340 mpas with a rotation of A06 RPM for sample 215 and concentration of 107% and 21,120 mpa with rotation of A06 RPM for sample 217 and concentration of 106% while sample 204 (TK) having a viscosity of 30,290 and a rotation of A03 RPM and concentration of 76%. The microbial cells counts of all the three samples of TPK and TK fall within the satisfactory limit for RTE foods. The study suggests that the production of Toma–Pep Ketch–up was achieved using local varieties of Tomato Ronita and UTC, respectively, although results of the physico–chemical parameters indicated sample 215 (Ronita TPK) was better than samples 217 (UTC TPK) and 204 (TK).

Keywords: Ronita; UTC; Development; Quality, Evaluation; Physico–chemical and Microbial

Introduction and Background of Study

The intention to develop Toma–Pep Ketch–up from two local varieties of Tomato fruits namely 'Ronita' and 'UTC' mixed with sweet pepper and other ingredients prompted this research. Tomato is botanically known as *Lycopersicon esculentum Mill*; it belongs to the family *Solanaceae*; it is classified as both fruit and vegetable and it is regarded as an important horticultural crop of great interest owing to the fact that it is widely consumed by many people; and for several centuries ago fresh Tomato is called fresh Plum Fruits in the Europe [1]. Tomato is regarded as one of the most important vegetables worldwide; and its production in 2001 was about 105 million tons from an estimated 3.9 Million; as it is a relatively short duration crop and gives a high yield, it is economically attractive and the area under cultivation is increasing daily [2]. The Red colour in Tomato is due to Lycopene, a carotenoid compound which is biosynthesized from isoprene, which in turn comes from acetate which is a basic biosynthetic block [3–5].

Common Names and Local Varieties of Tomato Fruits in Nigeria

In Nigeria, fresh Tomato fruit is called 'Tumatiri' among the Northerners coined from the Arabic word ''Tamatim''; while the South–Western people call it by its English Name Tomato; and this clearly shows that Tomato fruits maintains specific names for its recognition in the world. However, there are several local varieties of Tomato fruits available in Nigeria including 'Chibili', 'Rukuta', Dan–Baga, Dan–Syria,'UTC', 'Tandino', Roma VFN,Teema,

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'Suzana' and 'Ronita'; the 'Ronita' is also called 'Dan–Eka' among the farmers and Business men involved in buying and selling fresh Tomato fruits; also they opined that some varieties of Tomato fruit have more flesh and durable than the others; for instance 'Tandino' and 'UTC' have extra flesh than the 'Ronita' [6,7]. Ugonna, Jolaoso and Onwualu [8] and Nigerian Seed Portal Initiative (2020) reported [9] and documented that Ronita variety of Tomato, known as SAMTOM–12 was developed and released for use in 1980 and registered in 1991, with a national code (NLGE 19–12), by the Institute of Agriculture Research, Ahmadu Bello University, Zaria; and it has been described as Plum–shaped high quality and firm fruit; it has high yield and good paste quality as readily established by some studies. While UTC has been described as a variety of Tomato fruit that has stripped–reddish and yellow identity [7]. However, the major problem with fresh Tomato fruit in Nigeria is high perishability; and the need to preserve and/or convert it to products that will gain the appeal and confidence of potential consumers [8].This study intends to use Ronita and UTC and fresh sweet pepper for the development of Toma–Pep Ketch–Up.

Plate 1: 'UTC' variety of fresh Tomato fruit.

Plate 2: 'Ronita' variety of fresh Tomato fruit.

Global Ranking, Estimated Production and Annual Loss of Fresh Tomatoes in Nigeria

Nigeria is ranked the 14th largest producer of fresh Tomatoes in the world; in the African Continent, it has been ranked the 2nd after Egypt, worth about 1.8 Million Metric Tons, which it produces annually [10]. Also, according to the FAO (2010) report [11], Nigeria was ranked as the largest producer of fresh Tomatoes in West Africa and 16th in the world; but unfortunately more than 750,000 to 1,350,000 metric tons (41.67–75%) of fresh Tomatoes produced and harvested in Nigeria is estimated as annual postharvest loss due to poor food supply chain, perishability, price instability as a result of seasonal fluctuations in production and the supply preference of growers and middle business men that supply to urban markets and the few processors due to low Farm Gate Price [10,11]. Nonetheless, the national need for fresh Tomatoes as at 2018 in Nigeria was estimated at 2.45 metric tons [10]. According to the study of Ugonna et al., [8] it has been established that fresh Tomato is produced in large quantities in the northern part of Nigeria and the leading in the production of fresh Tomatoes includes Bauchi, Gombe, Jigawa, Kaduna, Kano, Katsina, Sokoto, Taraba and Zamfara; nonetheless, Kano state is the most successful when it comes to the production of fresh Tomato fruits in the northern Nigeria [10,12]. The highest yield of fresh Tomatoes in the history of Nigeria was recorded in 2010 worth of #247, 539, 6000, 000; still it could not satisfy the Nigeria's consumption need; this is owing to the fact that the annual national demand for fresh Tomatoes in Nigeria is approximately 2–3 Million tons [10,12]. In 2016, the fresh Tomato sector in Nigeria was severely hit by the *Tuta absoluta* pest leading to the unavailability of fresh Tomatoes in the Market; and importers lobbied the FGN to allow the massive importation of Tomato paste (TP) and Tomato paste concentrates (TPC) by making foreign exchange available to them [10]. But, unfortunately, most of fresh Tomatoes is lost to inability to process them by companies into paste and other Tomato products; even though only a few of the fresh Tomato varieties in Nigeria are suitable for industrial processing. Nonetheless, is has been suggested by Ugonna et al., [8] that the Federal Government of Nigeria (FGN) should ban the importation of Tomato Products into Nigeria and ensure there is a new Policy of backward integration in the fresh Tomatoes production sector. This is because the value chain approach could be employed to improve the production of fresh Tomatoes through an improved process technology for the purpose of reducing the losses arising as a result of perishable nature of freshly harvested Tomatoes [8].

Problems and Prospects of Fresh Tomatoes Production and Processing in Nigeria

There are several problems facing the production of fresh Tomatoes in Nigeria including Poor Agricultural Practices (GAP), Poor Post–harvest Practices (PPP), Poor Transportation System (PTS), Poor Storage System (PSS), lack of availability of Policy of government that will ensure quality production and supply chain value (SCV) and funding of research grants to ensure that quality and safe fresh Tomatoes production and processing in Nigeria [8, 10–12]. This can be achieved if the FGN can provide agricultural loans that is interest–free to the grass root farmers that are already in the business of the production of fresh Tomatoes; this is to enable the peasant farmers of fresh Tomatoes to start their Small Farm Business (SFB) so that they can make available fresh Tomatoes, year–in–year–out, for industrial processing [8,

10–12]. Although, when sold fresh, good quality stable Tomato in good conditions usually yield the highest profits especially early in the season; at the peak of the season, however, supply may exceed demand which causes prices to drop [2,8]. Lack of storage capacity, the surplus Tomato fruits rot, unless well preserved and/or adequately processed, such as paste and/or concentrates and Ketch–up, can be kept for up to a year or more depending on processing techniques, packaging and storage conditions [2,13].

Qualities of Tomato Ketch–up

Tomato Ketch–up is a product made of the concentrated paste of healthy and ripe Tomato pulp seasoned by essential food grade additives such spices, colourant, stabilizers, sugar and Vinegar [14]. Good quality Ketch–up is judged by colour, consistency, flavour and uniformity [15]. The main factor in Tomato Ketch–up colour is the lycopene that is available in Tomato which is the Carotenoid pigment including twelve (12) double conjugated bonds formed while Tomato ripened and chlorophyll decayed. Among other factors that influence the colour quality of Ketch–up, include Tomato variety, the amount of salt and sugar used in its formulation [15]. A lot of different brands and types of imported Tomato Ketch–up are available in the Nigerian market. Hence, in view of the fact Tomato Ketch–up brands are always imported into our country from the foreign countries despite the availability of several varieties of Tomatoes in the Nigeria; hence this study intends to exploit the possibility of using two selected varieties of Tomato fruits in the preparation of good quality Toma–Pep Ketch–up mixed with processed puree of fresh sweet pepper in order to create special variety for the Nigerian market owing to the fact that many Nigerians use Tomato Ketch–up in eating fried Irish Potato, Yam, Egg, Plantain and other fried food products. Nonetheless, the sensory attributes such as the aroma, texture and cooking characteristics of fresh Tomato depends on several factors including local environment, growing method, variety, post harvesting handling and methods of processing used on the fresh Tomato [1,16]. Hence, the two major processing methods includes Cold–break (CBP) and Hot–break (HBP) processing, respectively [16]. The differences between the two major Tomato Fruits processing methods is that HBP involves a processing temperature of 90°C or higher resulting in viscous Tomato fruit products; while the CBP is a processing temperature of 77°C or lower leading to low viscous Tomato fruit products, but having better sensory (i.e. aroma and red colour) attributes [13,17–20]. Nonetheless, there is viscous and sensory difference between the Tomato products that are processed by either processes, which has been attributed to the inactivation of Pectin *Methylesterase* and *Endopolygalacturonase* involving in the breakdown of Pectin at an elevated temperature [17,19]. Moreover, in CBP, pectin is loss due to enzymatic breakdown, while in HBP, pectin is loss by non–enzymatic thermal breakdown; however, in fresh Tomato fruit juice, pectins are susceptible to breakdown by acid hydrolysis and β–elimination at higher temperatures; while another study indicates similar opinion [13,18].This implies that in a HBP, *Polymethylestrase* (PME), *Poly–galacturonase* (PG) and Lipoxygenase (LG) are deactivated thereby inhibiting the breakdown of pectin and producing better viscosity; while in a CBP, these enzymes are neither deactivated or neutralized, thus ensuring the breakdown of pectin, but produces a Tomato product with lower viscosity, but excellent Tomato aroma [13,21]. Pectin and related molecules are complex polymers of sugars acids found in the middle lamella of Tomato fruits' cells; and they can be soluble or insoluble in water; the class of pectin in Tomato fruit is homogalacturonan consisting of linear chains of α–1, 4 linked–d–galacturonic acid with some carboxyl groups in form of methyl ester [22,23]. This study uses the Hot–break method for the processing of fresh Tomato fruits [20].s

Nonetheless, since the Market for Ketch–up looks promising in Nigeria, the need to use the locally available fresh Tomato fruits for its preparation becomes imperative. Therefore, what variety of fresh Tomato fruits, Ronita or UTC, would be suitable for the production of Toma–Pep Ketch–up?

Materials and Methods

Materials and their Sources

The raw materials and ingredients used for developing Toma–Pep Ketch–up (TPK) includes two varieties of fresh Tomato fruits namely 'Ronita' and 'UTC', fresh red sweet Pepper, fresh Onion, vinegar, sugar, salt, and potable water. The materials with the exception of potable water for this study were bought from the Tudun Wada market, Gusau town; the Tomato products were developed in the Food Processing workshop of the department of Food Science and Technology, Federal Polytechnic, Kaura–Namoda.

Apparatus/Equipment/Utensils/Package used for this Research

The equipment and utensils used for this study includes; electronic compact weighing balance (Model KD–BV, China), Blender (Model BD0021DA–1031D, China), stainless knife, stainless bowl, blancher, stainless pot, sieves, pH meter (Model GMbH, Metler–Toledo, Switzerland), Digital Hand–held Pocket Refractometer (Model PAL–1 Q3810–E04, USA) Tripod–stand, measuring cylinder, Pipette, Burette, Glass funnel, Spatula and Conical flask (200 ml capacity).

Experimental Design for This Research

Two varieties of fresh Tomato fruits, 'Ronita' and 'UTC', were used in the production of Tomato paste by Hot–Break Rupture Process; the preparation of samples of TPK was done under a hygienic condition using modified methods [17,20,24]. There was a comparison between the both Toma–Pep Ketch–up developed; also the control sample was used as the basis for comparison; and Physico–chemical and sensory evaluations were conducted on all the Tomato products including the Control sample (i.e. commercially available Tomato Ketch–up in the market). And t–Test (two–tail), ANOVA, Least Significant Difference (LSD) test for multiple comparisons among the three samples of Tomato products, Profiling and Ranking were used for statistical analysis of all the data ($P < 0.05$) to compare the relationship between the variables [24,25,26]. All data were recorded in duplicates and results were presented in Tables [25,28]. Also, selected microbiological analyses were conducted on the samples of Toma–Pep Ketch–up (TPK) samples developed and data obtained after determination of Total viable count, Coliform count and Yeasts/Moulds cells Count were converted to $\log_{10}$cfu g^{-1} for all the samples using FEPTU 557 $\log_{10}$ conversion Table [29,30]. Also, t–Test (two–tail) was used for statistical analysis of all the data ($P < 0.05$) to compare the relationship between the variables [24,25].

Recipe Formulations for the Production of Toma–Pep Ketch–up (TKP)

To have a control over the production of samples of TPK, an ingredients formulation was established after three trial productions (Table 1). And all the ingredients were accurately measure with the aid of the electronic compact weighing balance (Model KD–BV, China).

Table 1 presents the ingredients formulation of all raw materials and additives used in the preparation of both samples of TPK prepared from both the Ronita and UTC varieties of fresh Tomato fruits.

Table 1: Recipe formulation for the Production of TPK.

Ingredients	Amount (g/ml)	Amount (%)
Fresh Tomato Paste	1500g	86.21
Fresh Onion Paste	50g	2.87
Fresh Red pepper Paste	50g	2.87
Salt	5g	0.29
Sugar	100g	5.75
Natural Vinegar (White Type)	35ml	2.01

Production of Samples of Toma–Pep Ketch–up (TPK)

Fresh Tomato fruits were sorted and graded to select the healthy, ripe and firm fruits from the whole; after sorting and grading of the Tomato and they were thoroughly washed, hot–water–blanched for 15 mins and then de–skinned by peeling manually while still hot; while fresh red Pepper and Onions were steam–blanched for exactly six (6) mins; the blanched and peeled Tomato, Red pepper and Onions were allowed to cool and blended with the aid of an electric blender (Model BD0021DA–1031D, China). The pulp obtained was strained with the aid of a sieve of 0.5 µm diameter to obtain a fine pulp by removing seeds, skin and unblended pieces of the Tomato followed by holding for 3–5 mins during which the enzymes are liberated to breakdown pectin. The pulp was concentrated by heating at 85°C for 90 mins (i.e. Hot Break Process) in a stainless pot with continuous stirring to obtain concentrated pulp; in addition, sweet pepper paste, Onion paste, sugar, salt and natural white Vinegar were added to the concentrated Toma–Pep pulp and heating continued for 60 mins at 85°C; the developed TPK was filled into a pre–sterilized bottle at 700C; the caps were closed and samples of the developed TPK were further pasteurized at 85°C for 5 minutes. The mildly heated TPK samples were cooled and stored away (Figure 1) for microbiological and physico–chemical analyses, respectively.

The above Process Flow Diagram (Figure 1) represents the methods and unit operations adopted and employed in the production of Toma–Pep Ketch–up (TPK) samples developed in this study.

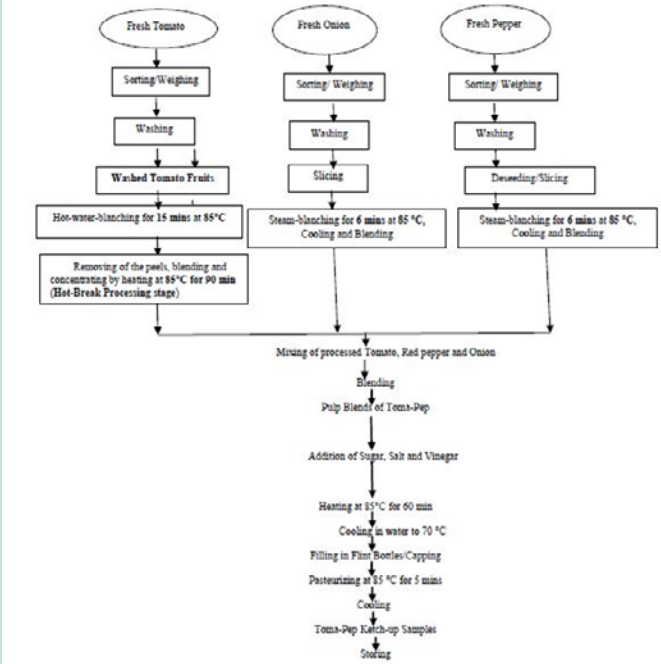

Figure 1: Process Flow Diagram for the Production of Toma-Pep Ketch-up.

Physico–chemical Analysis

Analysis of pH Value

Accurately 10 g of the samples were weighed and dissolved in 25 ml distilled water and thoroughly stirred with a glass stirrer. A pH meter (Model GMbH, Metler–Toledo, Switzerland) was used to determine the pH values of the samples. Initially, the pH meter was properly standardized by dipping the electrode of the meter into a buffers solutions of 4 and 7 pH values, respectively and then it was dipped in the dissolved solutions of the samples to obtain their various values. The pH values of the samples were determined two consecutive times (i.e. duplicates) and the average was taken as the accurate pH values for all the samples [20,31].

Total Titratable Acidity (TTA) Test (% as Citric acid)

Accurately 10g of the samples were weighed and dissolved in distilled water 10 ml and the mixtures were thoroughly stirred. Then 5 ml of the dissolved samples were collected in a conical flask and 1ml of phenolphthalein was added to the solutions. These were then titrated with 0.1N NaOH solution until the end point was obtained with a pink colour. The volume of NaOH solution used before the colour change were noted and used to calculate the total titratable acidity of the samples by multiplying the volume of the NaOH solutions used by a factor 0.15 [31].

Hence, TTA of the samples = volume of 0.1N NaOH ×100

Determination of Total Soluble Solids (TSS) Expressed as the Brix and Viscosity and Concentration

In the determination of TSS, viscosity and concentration of samples of Toma–Pep Ketch–up and commercially available Tomato Ketch–up was conducted using a Digital Hand–held Pocket Refractometer (Model PAL–1 Q3810–E04, USA) and Digital Rotary Viscometer (Model NDJ–5S, England). TSS were determined by thoroughly mixing the samples of the Toma–Pep Ketch–up to obtain homogenous mixture; then a drop was placed on the Prism of the Refractometer and direct readings were taken by reading the scale in °Brix. This is equivalent to the total quantity of soluble solid contents. Between each sample determination, the Prism of Refractometer was washed with distilled water and dried with the aid of cotton wool before use; also the Refractometer was standardized against distilled water before use. All determinations were performed at 20°C after filtration through hydrophilic cotton [31]. All the determinations were conducted two times consecutively and an average was taken.

Viscosity and concentrations were determined by weighing 10 ml of all the samples of the developed Toma–Pep Ketch–up and the Control (commercial Tomato Ketch–up) into a clean Viscometer beaker and mixed with potable of 5 ml and analyzed using the digital Rotary Viscometer and readings taken in centipoise (cp) using spindle number 5 at a shear rate of 6 Revolutions Per Minute (RPM) [31]. All the determinations were conducted two times consecutively and an average was taken.

Determination of Microbiological status of samples of Toma–Pep Ketch–up

Preparation of Samples and Culture Media

Samples of Toma–Pep developed and commercial Tomato Ketch–up were blended in a Stomacher bag using a Stomacher (400 laboratory blender Type BA, 7021 Model, England, UK.). Serial dilutions were prepared, inoculated on selective media and incubated at 37°C for 24 to 48 hr. After incubation colonies were counted using the method [32]. Also, all the culture media (i.e. Agar) used in this study was prepared according to the instructions of the respective Manufacturers.

Microbiological Analysis of samples of Toma–Pep Ketch–up

Ten (10) grams of each samples of Toma–Pep Ketch–up was homogenized with 90ml sterile buffer peptone water. Further ten–fold serial dilutions of the resultant homogenates were made to obtain 10^{-2}, 10^{-3}, 10^{-4} and 10^{-5} respectively [33,34]. From the appropriate dilutions, 0.1ml was plated in replicate onto different media using pour plate technique. At the end of the incubation periods, colonies were counted using illuminated colony counter (Gallenkamp, England). The counts for each plate were expressed as colony forming unit per ml of sample homogenate (cfu/ml) [32,33].

Viable Bacterial Cell Count

After overnight incubation, growth on the PCA showing viable cells colonies of 30 to 300 was counted. And the bacterial count was expressed as the number of colonies multiplied by the dilution factor [32,35].

Results and Discussions

Results

This part of the study presents and discusses the results obtained from the analyzed data generated from the physico–chemical and microbial analyses conducted on all the samples of Toma–Pep Ketch–up (TPK) developed from the species of fresh Tomato fruits 'Ronita' (coded sample 215) and 'UTC' (coded sample 217) and the Control (i.e. Commercially available Ketch–up) (coded sample 204) (Table 2–5).

Table 2: Results of Physico-chemical Properties of TPK and the Control.

Sample Code	pH	Brix (%)	TTA
215e	4.5 (±0.01)a	23.80 (±0.04)a	1.38 (±0.01)a
217	4.3 (±0.01)a	23.05 (±0.04)a	1.89 (±0.17)c
204	4.3 (±0.01)a	23.60 (±0.04)a	1.01 (±0.15)b
Values are Mean of triplicate determinations ±SD values within a row with the same letter are not significantly different and those with different superscript along the row are significantly different ($P < 0.05$).			

Table 3 presents the results of viscous nature for all the three samples of Ketch–up. Moreover, the abbreviations are Mpas (Mile Pascal Second) and RPM (Rotations Per Minute).

Table 3: Results of Viscosity and Concentration Two Samples of TPK and the Control.

Sample Code	Viscosity(Mpas)	Rotation (RPM)	Concentration (%)
215	21,340 (±0.01)a	A 06	107
217	21,120 (±0.01)a	A 06	106
204	30,290 (±0.01)b	A 06	152
Values are Mean of triplicate determinations ±SD values within a row with the same letter are not significantly different and those with different superscript along the row are significantly different ($P < 0.05$).			

Table 4 presents the results of the microbiological status conducted on samples of TPK developed from 'Ronita' (Sample 215) and 'UTC' (Sample 217) varieties of fresh Tomato fruits and the Control (Commercially Available Tomato Ketch–up in the Market).

Table 4: Results of the Total Plate Count of the Samples of Developed TPK and the Control.

Samples Code	Microbial cell loads (cfu/g)	Converted Value ($log_{10}cfu^{-g}$)
215	$< 1.0 \times 10^1$	1.00 (±0.01)^a
217	$< 1.0 \times 10^1$	1.00 (±0.01)^a
204	$< 1.0 \times 10^1$	1.00 (±0.01)^a
Values are Mean of triplicate determinations ±SD values within a row with the same letter are not significantly different ($P < 0.05$).		

Table 5 presents the results of the Moulds and Yeasts' cells counts conducted on samples of TPK developed from 'Ronita' (Sample 215) and 'UTC' (Sample 217) varieties of fresh Tomato fruits and the Control (commercially available Tomato Ketch–up in the Market).

Table 5: Results of the Yeasts/Moulds Cells Count of the Samples of Developed TPK and the Control.

Samples Code	Yeasts/Moulds Cells Load (cfu/g)	Converted Value ($log_{10}cfu^{-g}$)
215	1.7×10^3	3.25 (±0.01)^a
217	7.0×10^3	3.85 (±0.02)^b
204	2.1×10^4	4.30 (±0.71)^c
Values are Mean of triplicate determinations ±SD values within a row with the same letter are not significantly different and those with different superscript along the row are significantly different ($P < 0.05$).		

Discussions

Discussion on Results of Physico–Chemical Analysis

In this study, Table 2 showed the result of the physico–chemical properties of Toma–Pep Ketchup; the pH values of the sample were 4.5, 4.3, and 4.3 for the sample 215, 217, and 204 respectively. These values were higher in acidity than the reported value of 5.8, 5.7, and 5.4 by Baloch et al. [36] and Mozunder et al. [37] respectively but is in agreement with the value (pH 4.6) of AOAC 981.32 Standard. The Brix contents of the developed Toma–Pep and Tomato Ketch–up samples from Ronita (sample 251) and

UTC (sample 217) and the Control (sample 204) were 23.80%, 23.05%, and 23.60%, respectively; hence results obtained in this study implies all the Brix contents of the three samples are within the same range; and this could be attributed to the fact that all the three samples under test were prepared with natural sugar. The total titratable acidity of the samples of Toma–Pep Ketch–up prepared Tomato samples from Ronita (sample 215) and UTC (sample 217) and the Control (sample 204) were 1.58, 1.89, and 1.01 respectively; and these value were found to be in agreement with the value of 0.6 to1.0 reported [38]. However, the values are lower than 0.6 to 8.5 reported [37,39]. This study classifies the developed Toma–Pep Ketch–up as a high acidic food that could preserve itself due to high acidic medium, which could be attributed to addition of Vinegar, Salt, Sugar, Citric acid and Benzoic acid into the prepared Toma–Pep paste.

Also, in this study, Table 3 showed the viscosity values of the samples prepared Toma–Pep Ketch–up from Ronita (sample 215) and UTC (sample 217) and the Control (sample 204) were reported to be a viscosity of 21,340 mpas (i.e. milli Pascal second) with a rotation of A06 Rpm (i.e. Rotation per minute) and concentration of 107% and a viscosity of 21120 mpa with rotation of A06 Rpm and concentration of 106% while sample 204 (control) having a viscosity of 30290 and a rotation of A03Rpm and concentration of 76%. These results showed that there is significant difference between sample 204, 217, and 215 this could be as a result of thickener that was added to sample 204 (i.e. the Control).

Discussion on Microbiological Result

In this study, the results of the microbiological analysis (Tables 4 & 5) conducted on the two samples of the developed Toma–Pep and the commercially available Tomato Ketch–up bought on the shelf of a Supermarket; all the samples recorded the microbial cells counts of < 1.0 x 10^1 cfu/g; and as for the moulds/yeasts cells counts, sample 215 recorded 1.7x103cfu/g; sample 217 recorded 7.0x10^3cfu/g while sample 204 recorded 2.1x10^4cfu/g, respectively. This could possibly be attributed to that fact that Tomato Ketch–up are acidic foods that are processed by Hurdle Technology and preserved using Benzoic acid, which is a preservative against ranges of microbes; and Citric acid, an acidic regulator, before being packaged in primary packages for retailing and distribution; and it is in most cases expected that high acidic content RTE foods should not contain pathogens in them with the exception of moulds, yeasts and a few acid–tolerant bacteria that may likely grow and proliferate over period of time [32].Hence, this study established that microbial cells that were detected from the three samples (Tables 4 & 5) were within the satisfactory (10^3cfu/g) and marginal ($10^3$to<10^5cfu/g) microbial limits for RTE foods [33,40].

Conclusion

In summary, two samples of Toma–Pep Ketch–up (TPK) were developed from two local varieties of fresh Tomato fruits namely Ronita (coded 215) and UTC (coded 217); while sample 204 [commercially available Tomato Ketch–up (TK) in the Market] was used as the control; hence, this study reveals that the TPK was successfully developed from the fresh Ronita variety of Tomato mixed with prepared sweet pepper paste and other essential ingredients [41–63].

Acknowledgement/Special Notification

We sincerely appreciate the Management of ALDUSAR Food and Beverages Limited, Katsina, Nigeria for allowing us to use their well–equipped laboratory to conduct Microbiological and Physico–chemical analyses during this study. Also, this developed product (i.e. Toma–Pep Ketch–up) is on the process of patenting; hence no person or group of persons is allowed to use the Process Flow Diagram and/or the Recipes formulation reported in this study.

Limitation of this Study

The limitation of this study is to conduct the Shelf life study of the prepared Tomato products. This can be achieved in the future study.

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