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Quality analysis of turmeric modified tomato powder

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Abstract
Tomato is a very important source of minerals and vitamins to human diet. Its demand is on the increase globally due to the nutritional and economic benefit. Unfortunately, 20-50% of tomato produce does not reach the consumers due to the associated postharvest losses accruing greatly from its perishable nature with untold consequences. Utilization of appropriate knowledge and technologies towards prevention of this wastage is a very crucial way of sustaining tomatoes availability at household level throughout the year. The research was aimed at assessing the organoleptic, nutrient, and phytochemical qualities of turmeric modified tomato powder so as to enhance its availability and use. Tomato and turmeric were purposefully purchased from Wadata market in Makurdi which was prepared and pulverized into powder for compounding of different ranges of the composite powder. The qualities were assessed immediately before and after storage. The 10%: 90% turmeric: tomato powder was the most appreciated for taste, and general acceptability. Whereas, 100% turmeric powder was least appreciated for taste, texture, and general acceptability. The moisture content of the composite powder ranged between 5.8 to 6.5% after storage; while the protein and fat content increased after storage in all samples. The mineral concentration of Zn and Mg decreased while Na and Mn increased after storage. Phytochemicals (lycopene, Beta-carotene, Vitamin C, and curcumin) decreased after storage with lesser proportion observed in the composite samples. The research has shown that turmeric modified tomato powder can enhance nutritive and preservative benefits. Thus, the processing of the tomato into power can increase its use and prevent postharvest losses.

Keywords: quality analysis, turmeric modified, tomato powder

Introduction

Tomato (*Lycopersicon esculentum*) is one prominent perishable vegetable that serves as an important source of minerals and vitamins in human diet (Manzoor, Muhamad, Abid, & Kuinram, 2006) [16]. Tomatoes have been documented to have high levels of Vitamins A, C and E. it also contains lycopene, beta- carotene, fibres and phenolic compound such as flavonoids and phenolic acid (Ugonna, Jolaoso, & Onwaulu, 2015) [26] (Pinheiro, Goncalves, & Silva, 2013) [20] (Parnel, Suslow, & Harris, 2004) [19] (Manuel & Gerre, 2016) [15] (Ukponmwan, 2015) [27] (Mwekaven, Wanen Ikyo, Alye, & Aorkwagh, 2019) [17]. One medium size of tomato contains 22 cal, 0 g fat, 5 g carbohydrate, 1 g dietary fibre, 1 g protein, 6 g of sodium, 552 µg of beta- carotene, and 3,165 µg of lycopene. It also contains high level of P, K, folate, niacin, and vitamin B6 useful in reduction of heart disease (Ugonna *et al*., 2015) [26] (Ukponmwan, 2015) [27] (Mwekaven *et al*., 2019) [17]. Its potential benefit in reduction of cancer and other chronic diseases is as a result of the antioxidant properties of the lycopene and carotene which also aid in building of the immune system (Arah, G.K., Anku, Kuma, & Amaglo, 2016) [2] (Ugonna *et al*., 2015) [26] (Manuel & Gerre, 2016) (Ukponmwan, 2015) [27] (Mwekaven *et al*., 2019) (Bunghez, Raduly, S., Aksahin, & Ion, 2011) (Olaniyi, Bulya, & Husein, 2017) [18]. Studies have revealed that women have a 29% chance of lowering risk of cardiovascular diseases when they consume 7-10 servings of tomato product per week in comparison to those that are consuming less (Ugonna *et al*., 2015) [26] (Ukponmwan, 2015) [27]. Globally, tomato cultivation is now on the increase for its nutritional and economic benefits. Currently, there is progress in production to meet up with demand. However, 20-50% of the produce do not reach the consumers as a result of postharvest losses (Arah *et al*., 2016) [2] (Ugonna *et al*., 2015) [26]. This could be accountable for by the perishable nature of the crop; making tomato transportation, storage, and packaging challenging. Hence, the high quantum losses are incurred up to 50% between harvesting, transportation, and consumption as reported in some countries such as Bangladesh (Sarker, Hannan, Quamruzzaman, & Khatun, 2014) [23]. Although postharvest losses and wastages are prevalent worldwide but the extent is greater in developing countries like Nigeria where there is inadequate storage infrastructure (Ugonna *et al*., 2015) [26]. Several methods have been adopted for tomato preservation; these include freezing of tomatoes and dehydrating or drying tomatoes (Parnel *et al*., 2004) [19] (Bhat, Alias, & Paliath, 2012) [9] etc. Drying is a preservation method where by water is removed from the food product to achieve a level of water activity where thriving of the spoilage microbes is not supported. The duration it takes to achieve sufficient drying is a function of the tomato variety, thickness of the slices and the air's humidity during the process of drying. The optimum temperature for the drying process is 57.2℃ to 60℃. The technique involved include natural drying using the sun or use of stimulated heat under controlled temperature (Sharif, Mustapha, Jai, N. Moh., & Zaki, 2017) [24]. The moisture content is then removed to 10-15% where growth of microbes is inhibited.

Turmeric has been in use for over 4000 years as a spice in different parts of the world. It is a rhizome belonging to the ginger family with about 133 species identified and in use for foodstuff spice, colouring agent, cosmetic, and medicinal purposes (Jayashree & Zachariah, 2016) [13]. The main bioactive component is the volatile oil that contains natural antioxidants (turmerone and curcuminoids) as well as sesquiterpenes and polysacharride-ukonans (Prasad, Kavita, Chandrashekhar, & Manohar, 2018) [21]. A 100 g of turmeric contains 390 kcal, 10 g fat, 3 g saturated fat, 0 cholesterol, 0.2 g Ca, 0.26 g P, 10 g Na, 2500 mg K, 47.5 mg Fe, 0.9 mg thiamine, 0.19 mg riboflavin, 4.8 mg niacin, 50 mg ascorbic acid, 69.9 mg total carbohydrate, 21 mg dietary fibre, 3 g sugar, and 8 g protein. It is also a good source of omega 3 fatty acid and linolenic acid. In addition, health wise it is known to have carminative, anticancer, antioxidant, anti-parasitic, anti-mutagenic, anti- inflammatory, anti-protease, immune-modulatory and apoptosis inducing properties (Krishna & Lakshmanan., 2018) [14] (Prasad *et al*., 2018) [21]. These properties are known to enhance the healing of wounds, reduction in risk of arteriosclerosis is also said to be associated with its antioxidant effect (Zdrojewicz, Szyca, Popowicz, Michalik, & B., 2017) [28]. Combination of turmeric with tomato to produce a composite powder is therefore quite strategic to reap the synergistic benefit from their individual nutritive and bioactive properties, consequently imparting preservative effect in modified tomato powder. Additionally, the use of a plant source preservative has an added advantage of preserving the organoleptic properties and enhancing quality of (Campelo, Medeiros, & Silva, 2019) [11]. Food preservation methods that have been in practice have engage the use of several synthetic or chemical preservatives such as benzoic acid, nitrates, nitrites, sorbate, sulphites, sulphur dioxide and butyl hydroxyl anisole (BHA). There has been however an improved awareness of their short- and long-term health and environmental consequences. These include their association with the development of cancer and cardiovascular diseases (Campelo *et al*., 2019) [11]. As such, it has led to the high consumer demand for food products with natural preservatives (Campelo *et al*., 2019) [11] (Sharif *et al*., 2017) [24]. This is also in line with the principles of Green Chemistry; where emphasis are focussed on consumption of safer, biodegradable, and renewable chemicals (Asemave, 2016) [3] (Asemave & Anure, 2019) [6] (Asemave, 2018) [4] (Asemave & Asemave, 2015) [7] (Asemave, Abakpa, & Ligom, 2020) [5] (Asemave, Hunt, & Farmer, 2009) [8].

Utilization of appropriate knowledge and technologies towards prevention of food wastages is a very crucial and important means of sustaining food at the household level. This can bring about food security, food availability even during off seasons, and economic benefit to all stakeholders (Ugonna *et al*., 2015) [26]. In Nigeria food insecurity is prevalent which is majorly accounted for by poor preservation and postharvest handling of surpluses. This presents epileptic availability of food products especially during the out of season periods; more so that the technology for wholesome storage of fresh tomato is not available in our communities (Adekalu, 2014) [1]. Unavailability of food can cause hunger and malnutrition leading to loss of productivity, illness, and death. Therefore, this paper looks at organoleptic, nutritional, and phytochemical assessment of turmeric modified tomato powder in order to enhance tomato use.

Materials and Methods

Materials

Tomato crates, bowls, plates, water, knife, colander, trays, sieve, foil, paper, tomatoes, turmeric, nitric acid, hydrochloric acid, Na_2SO_4, ethanol, petroleum ether, distilled water. Atomic Absorption spectrometer (Pg990 model), UV Spectrophotometer, grinder, Adam weighing machine, beakers, crucibles, oven, desiccator, petri dish, volumetric flask, separating funnel, electric shaker, pipette.

Methods

Sample Collection

Tomatoes and turmeric were purposely purchased from the Wadata market. This is a hub for fruits and vegetables located within Makurdi the state capital of Benue State.

Pre-treatment of the sample

With the aid of tomato crates and bowls, sorting out of the tomatoes was carried out to select ripe and firm tomatoes while the spoilt ones were discarded. The selected tomatoes were washed in salted clean tap water to reduce the microbial load. It was then sliced into 5 mm sizes and blanched in preparation for drying. The turmeric rhizomes were also sorted out, good quality ones were selected, washed and cleaned for use in the processing.

Processing of the tomato powder

The cut tomatoes were placed cut side up at ½ to 1 inch apart in single layer for drying in the sun. The choice of the sun for drying was due to the prevailing harmattan season thereby allowing the product to dry within a shorter duration of time to become cripsy and easy to pulverize. For the moisture content to be removed to the level that would inhibit thriving of microbes, the sun drying process took up to 5-7 days. The well dried tomato was pulverized into powder and separated into appropriate portions in duplicate for compounding with the turmeric powder.

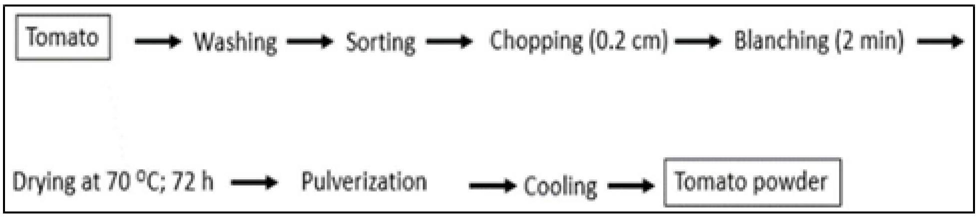

Fig 1: Flow chart for production of powdered tomato

Curing and turmeric powder processing

Curing of turmeric was performed before drying. This was achieved through parboiling of the prepared turmeric in boiling water for 40-60 min. Curing was carried out to remove the raw odour, gelatinize its starch, and bring about uniform colour of the product (D., Bukvick, Prasad, & Tyagi, 2016) [12]. Thereafter, it was sun dried for up to 5-7 days. The dried product was then pulverized into powder. This was well mixed at different proportions with the tomato powder to form the composite turmeric-tomato powder of different ratio ranges of 10: 90, 20: 80 and 30: 70 as shown in Table 1

Table 1: Ratio of the blends prepared

S/N	Tomato (g)	Turmeric (g)	Code
1	100	0	A1, A11
2	0	100	B1, B11
3	90	10	C1, C11
4	80	20	D1, D11
5	70	30	E1, E11

Note: AI; AII - 100% tomato powder before and after storage; BI; BII- 100% turmeric powder before and after storage; CI; CII-10:90 composite turmeric-tomato powder before and after storage; DI; DII-20:80 composite turmeric-tomato powder before and after storage; EI; EII-30:70 composite turmeric-tomato powder before and after storage

Fig 2: The turmeric modified tomato powder

Organoleptic analysis

The organoleptic qualities assessed were colour, taste, aroma and overall general acceptability by a pre-trained panel comprising of pharmacists, nurses and other healthcare workers using the 5- point Hedonic scale (5- Very good, 4-good, 3-fair, 2-poor, and 1-bad) (S. & Kulshreshtha, 2013) [22].

Proximate analysis
The official method of the Association of Analytical Chemist (AOAC) was used to determine the moisture, protein, fat, and total ash content (Zdrojewicz *et al*., 2017) [28].

Minerals analysis
Assessment of some mineral content was done using Atomic Absorption spectrometer (AAS) the PG990 model.

Phytochemicals analysis
Determination of B-carotene, curcumin, and lycopene contents were performed by the Ranganna method while vitamin C content was estimated with the xylene extraction method (S. & Kulshreshtha, 2013) [22].

B-Carotene
B-Carotene was determined by ethanol and petroleum ether extraction. With the aid of Sodium tetra oxo-sulphate six ($Na_2SO_{4)}$ and ethanol, the sample was extracted and a separating funnel was used to separate ethanol and petroleum ether from the layers in series. The optical density of the final petroleum ether extract was determined at the wave length of 450 nm with spectrophotometer using petroleum ether as blank.

Curcumin
Curcumin was also determined using ethanol. 10.10 g of sample was dissolved in 25 mL of ethanol, filtered and the volume measured up to 100 mL and diluted. The absorbance was measured at 425 nm. The % curcumin was then determined using the absorbance (a), path length (L) and absorptivity (A).

Lycopene (%)
Lycopene content was determined using distilled water where 1 g of sample was taken and filled up to 100 mL with distilled water in a 100 mL volumetric flask. This was shaken up properly and 10 mL from it mixed with 40 mL of distilled water in a separating funnel. 25 mL of petroleum ether was added to it after properly shaking vigorously with electric shaker. The upper layer of the petroleum ether was pipetted and its absorbance determined at 550 nm using spectrophotometer.

Ascorbic acid
Ascorbic acid content was determined using the xylene extraction method. The concentration of the analyte was assessed using the amount from the calibration curve, the dilution factor of 50 mL, the sample weight (10 g) and the pack size of sample (5 g).

Results and Discussion
Organoleptic assessment
The organoleptic evaluation carried out by panellist revealed that the 100% turmeric (B) was mostly appreciated for colour and aroma; while 100% tomato (A) was least appreciated for its colour and aroma. The 90%:10% (C) blend was the most appreciated for taste and general acceptability; while 100% turmeric was least appreciated for taste, texture, and general acceptability as shown in Table 2.

Table 2: Organoleptic evaluation of the turmeric modified tomato powder

	A1	A11	B1	B11	C1	C11	D1	D11	E1	E11
Colour	3.7	2.5	4.7	4.6	4.6	3.0	4.2	3.2	4.3	3.5
Aroma	3.7	3.2	4.1	3.7	4.0	3.5	3.9	3.3	4.0	3.1
Taste	3.9	3.2	3.3	3.4	4.3	3.3	4.2	3.5	4.0	2.8
Texture	3.7	2.8	3.8	4.2	4.3	3.4	4.1	3.3	3.8	3.1
Acceptability	3.9	3.6	3.9	3.8	4.4	3.5	4.3	3.8	4.1	3.4

It has remained a great challenge on how to sustainably preserve fruits and vegetables in order to make it available and accessible to consumers all year round with minimal wastages. This study aimed at harvesting the bio-preservative benefits of turmeric thereby producing a blend of turmeric modified tomato powder. The work has revealed that production of composite powder with tomato and turmeric is possible with different blend ranges that gained different sensory acceptability by the panellist made up of different cadres of Health workers. From the organoleptic assessment, it was evident from the panellist rating that the varying ranges of the turmeric modified tomato powder gained advantage over the 100% tomato or turmeric powder in terms of general acceptability of the product. A study carried out in Edo where dry tomato was compared to the fresh one, the panellists could hardly differentiate the two in terms of taste of the stewed products (Sarker *et al*., 2014) [23] (Ukponmwan, 2015) [27].
This is a pointer to the fact that the dried tomato product may not be apparently different from the fresh one. Although it's been documented that after one year of storage of dried tomatoes, there is deterioration in colour, aroma, flavour and nutritive value (Parnel *et al*., 2004) [19].

Proximate analysis

The results also revealed that the 100% turmeric powder had the highest moisture content of 15%, this was however reduced in the composite samples (C, D and E) and became much lower to a level ranging between 5.8 to 6.5% after twelve months of storage (see Table 3).

Table 3: Proximate analysis of samples

	A1	A11	B1	B11	C1	C11	D1	D11	E1	E11
Moisture (%)	7.8	6.0	15.0	7.9	8.5	5.8	8.3	6.5	7.8	6.4
Ash (%)	21.3	10.4	13.5	8.2	20.8	10.7	18.3	9.8	20.3	9.9
Protein (%)	1.3	5.6	1.6	5.4	1.9	4.4	2.0	5.6	2.3	5.7
Fat (%)	0.2	1.7	0.4	2.1	0.5	1.5	0.6	1.5	1.1	1.6
Crude fibre (%)	0.01	0.02	0.01	0.03	0.02	0.02	0.01	0.02	0.02	0.02
Carbohydrate (%)	69.39	76.28	69.46	73.37	68.28	76.58	70.79	76.58	68.48	76.38

The moisture content of the freshly prepared 100% tomato powder was 7.8%, this finding is similar and comparable to the study conducted in Dinajpur where the moisture content was 8.12% (Sarker *et al*., 2014) [23]. The 100% turmeric powder had a higher moisture content of 15% while the blended samples had moisture range of 7.8 to 8.5% (Sarker *et al*., 2014) [23]. After a storage duration of twelve months the moisture content was seen to have decreased in this study whereas in the Dinajpur study it rather increased (Sarker *et al*., 2014) [23]. This could be due to storage package or environmental factor differences. After the storage period it was observed that the moisture content in the composite sample were lower than the 100% tomato and 100% turmeric powder. These values are however not far from the recommended range of (4-8%) for commercial tomato powder (Surrendar, Shere, & Shere, 2018) [25].

The protein content of the composite samples was higher than the individual tomato or turmeric samples, this double by over 100% after storage. The protein content in this study was 1.3% as against the Dinajpur and India study where the values were 14.3% and 13.96%, respectively (Sarker *et al*., 2014) [23] (Surrendar *et al*., 2018) [25]; although the value increased to 5.6% after storage in the 100% tomato powder, it is still comparatively lower. This may be accountable by the variety of tomato, drying technique or the processing technology (Manuel & Gerre, 2016) [15]. Heat processing and storage is documented to be associated with degradation of mineral or phytochemical components of tomato products. Similarly, the fat contents of the composite samples were higher compared with the pure tomato and turmeric powders. These values increased after twelve months of storage as seen in Table 3. Meanwhile, the ash content of these samples decreased in all cases after storage. It was also seen that the 100% powder of tomato had higher ash than its counterpart, turmeric. Furthermore, the research found that the carbohydrate and crude fibre contents were relatively same both in the standards and the blends.

Mineral Analysis

The concentration of the minerals in the stored samples were seen to have decreased after twelve (12) months of storage for zinc (Zn) and Magnesium (Mg). On the other hand, the concentration of sodium (Na) and manganese (Mn) increased after the storage period as seen in Table 4.

Table 4: Mineral analysis

Parameter(mg/100g)	A1	A11	B1	B11	C1	C11	D1	D11	E1	E11
Sodium (Na)	90.00	156.31	86.00	24.93	37.55	25.58	70.10	10.55	63.62	9.39
Zinc (Zn)	1.82	0.20	1.60	0.54	1.30	0.49	1.39	0.51	1.20	0.66
Magnesium (Mg)	23.52	24..78	24.72	23.63	23.36	21.09	22.68	21.63	22.19	18.58
Potassium (K)	8.82	BD	9.17	BD	9.13	BD	8.92	BD	8.98	BD
Manganese (Mn)	0.74	4.28	0.55	13.11	1.42	2.57	0.42	1.61	0.38	12.15
Copper (Cu)	BD	0.54	BD	0.30	BD	0.36	BD	0.43	BD	0.42
Phosphorus (P)	0.14	BD	0.12	BD	0.09	BD	0.15	BD	0.10	BD

Phytochemical analysis

The concentration of all the phytochemicals assessed were seen to have reduced after two months of storage. The lycopene level was remarkably higher in the blended powder of 90: 10 and 80:20 tomato turmeric ratio as compare with their 100% single powder. The beta carotene concentration was higher in the 70:30 ratio blend, this was reduced after two months of storage but however maintained as the highest. The blend of 80:20 ratio of the powder gave the highest concentration of ascorbic acid, although the concentration reduced after two months of storage, it still remained the highest even over the 100% tomato powder. The curcumin level in the 100% turmeric was the highest followed by the 80:20 ratio blend, this was maintained after two months storage duration. The content in the blended composite powder in all the samples were higher than the 100% tomato powder. The single factor ANOVA analysis showed that the mean variation between the samples were statistically significant for lycopene (LSD=0.15), Beta-carotene (LSD=728.27), and curcumin (LDS=0.66); unlike ascorbic acid as shown in Table 5.

Table 5: Phytochemical analysis of the samples

	A	B	C	D	E	LSD
Lycopene, %	0.79	0.30	1.76	1.97	1.32	0.15
B-carotene, µg/100 g	3215.03	4141.24	4305.44	3055.32	4761.51	728.27
Curcumin, %	9.55	13.47	11.62	12.49	10.50	0.66
Vitamin C mg/100 g	59.78	10.60	94.89	98.65	81.26	NA

Tomato is known to have Vitamin A and C; Vitamin C is useful in helping the body against infection and free radicals while Vitamin A in addition to carotene are useful in night vision. Relatively the content of Carotenoid (B carotene and lycopene) and Vitamin C in tomato powder is usually higher than the fresh one. This serves as an added advantage of converting the fresh tomato to dry form (Manuel & Gerre, 2016) [15]. In this study the level of Vitamin C in the composite sample were higher than the control (100% tomato and 100% turmeric) even after storage. This finding is seen to be higher than that documented (35.1 mg/100 g) by the Dinajpur study (Sarker *et al*., 2014) [23]. Vitamin C and Lycopene values in the composite samples in this study are comparable to those documented by Srivastava (125 mg/100 g and 1.41 mg/100 g respectively) in India (Zdrojewicz *et al*., 2017) [28]. The lycopene and B carotene levels in the composite samples were also higher compared to the 100% samples of tomato and turmeric powder. Although the values reduced in all samples after storage, the rate of reduction was lower in the composite samples.

The level of this phytochemical even in small quantities is very useful in the control of degenerative diseases such as prostate cancer, cancer of the skin and breast. The added advantage is seen in the composite powder where even after storage the value seen are comparably higher than in the 100% tomato or turmeric alone. The significant difference of the phytochemicals (Lycopene, B-carotene and Curcumin) between the samples is an indication of the effect of the turmeric presence. Thus, making provision for harvesting of its preservative properties.

100 g of tomato usually contains about 237 mg of potassium and 5 mg of sodium, potassium is useful in the control of heart disease and blood pressure. This study revealed a higher level of sodium with lower level of potassium (90 mg and 8mg respectively). The value of copper was below detectable level in all the samples however after storage the value found (0.5mg/100g) in the 100% tomato powder was comparable to the Indian study where 0.876 mg/100g was documented (Zdrojewicz *et al*., 2017) [28]. Other mineral content values in this study were still lower than the Indian study values. This could be attributed to the tomato variety or processing technology. This brings to the fore the importance of comparison bringing to mind difference in variety and processing technology. It has been previously reported also that tomato in powder may be the best conservation way for the community (Manuel & Gerre, 2016) [15].

Conclusion

Processing tomatoes into powder form is a sustainable way of conserving tomato at the community level. In addition, the blending of tomato powder with turmeric has shown nutritive enhancement, plus, it can ensure preservative benefit due to the presence of turmeric therein.

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References

1. Adekalu OA. Postharvest losses reduction of Tomatoes stores in Natural preservatives. Asian Journal of Agriculture and Food Science,2014:5:1571-2321.
2. Arah IK, GK A, Anku EK, Kuma EK, Amaglo H. Postharvest handling practices and treatment methods for tomato handlers in developing countries. A mini review. Advances in Agriculture, 2016. https://doi.org/10.1155/2016/6436945
3. Asemave K. Biobased Lipophilic Chelating Agents and their Applications in Metals Recovery. University of York, UK, 2016.
4. Asemave K. Greener Chelators for Recovery of Metals and Other Applications. Organic & Medicinal Chemistry International Journal,2018:6(4):001-011. https://doi.org/10.19080/OMCIJ.2018.06.555694
5. Asemave K, Abakpa DO, Ligom TT. Extraction and Antibacterial Studies of Oil from three Mango Kernel obtained from Makurdi - Nigeria. Progress in Chemical and Biochemical Research,2020:3(1):74-80. https://doi.org/10.33945/SAMI/PCBR.2020.1.9
6. Asemave K, Anure TT. The bioactivities of the neem (seeds, leaves and their extracts) against Callosobruchus maculatus on Vigna Subterranean L. Progress in Chemical and Biochemical Research,2019:2(3):92-98. https://doi.org/DOI: 10.33945/SAMI/PCBR.2019.3.2
7. Asemave K, Asemave TA. African Shea Butter as a Staple and Renewable Bioproduct. International Journal of Science and Research,2015:4(12):2133-2135.
8. Asemave K, Hunt AJ, Farmer TJ. Preliminary Cu (II) extraction analysis with biobased lipophilic, 2009, 14. 16-hentricaontanedione. https://doi.org/10.15406/mojboc.2019.03.00093

9. Bhat R, Alias AK, Paliath G. Dehydration of fruits and Vegetables in tropical Regions; In: Progress in Food preservation. Willey- Blackwell Publishers, 2012.
10. Bunghez IR, Raduly MSD, Aksahin I, Ion RM. Lycopene Determination in Tomatoes by different spectral technique. Digest Journal of Nanomaterials and Biostructure,2011:6(3):1359-1356.
11. Campelo MCS, Medeiros JMS, Silva JBA. Natural products in food preservation. International Food Research Journal,2019:26(1):41-46.
12. DG, Bukvick D, Prasad S, Tyagi AK. Beneficial effects of spices in food preservation and safety. Frontiers in Microbiology,2016:7:1394.
13. Jayashree E, Zachariah TJ. Processing of turmeric by different curing methods and its effect of quality. Indian Journal of Agricultural Science,2016:86(5):696.
14. Krishna MR, Lakshmanan. Study of Bio-preservative potential of Tumeric on Tomato. Indo Am J. P Sci,2018:5(5):3818-3829.
15. Manuel D, Gerre S. Tomato Production in Powder: A Tomato Conservation Technology to support the Communities and methodological proposal for chemistry contextualized education. The Eurasia Proceedings of Educational and Social Sciences,2016:4:182-191.
16. Manzoor N, Muhamad I, Abid H, Kuinram NS. Postharvest economic losses of tomato crop grown in Pashawa valley. Sahad Journal of Agric,2006:22:(1).
17. Mwekaven SS, Wanen Ikyo YT, Alye CT, Aorkwagh MT. Identification and Enumeration of Microorganisms associated with postharvest spoilage of Tomatoes Lycopersicum esculentum sold in Gboko metropolis. Journal of Scientific and Engineering Research,2019:6(6):153-158.
18. Olaniyi IJ, Bulya TE, Husein JB. Efffects of drying methods on quality of Tomato and Pepper powder. BAOJ, Food Science and Technology,2017:1(2).
19. Parnel TL, Suslow TV, Harris LJ. Tomatoes: Safe Methods to Store, Preserve and Enjoy, 2004. Retrieved August 16, 2021, from http://anrcatalog.ucdavis.edu
20. Pinheiro J, Goncalves EM, Silva CLM. Alternative technologies for tomato postharvest quality preservation. CAB Reviews, 2013. Retrieved March 31, 2019, from http://www.cabi.org/cabre views
21. Prasad VK, Kavita NY, Chandrashekhar LB, Manohar JP. Standardization and Quantification of curcumin from curcuma longa extract using UV visible spectroscopy and HPLC. Journal of Pharmacognosy and Phytochemistry,2018:7(5):1913-1918.
22. SS, Kulshreshtha K. Nutritional Content and significance of tomato powder. Annals of Arid,2013:52(2):121-124.
23. Sarker M, Hannan MA, Quamruzzaman AMA, Khatun H. Storage of tomato powder in different packaging materials. Journal of Agricultural Technology,2014:10(3):595-605.
24. Sharif ZIM, Mustapha FA, Jai JN, Moh Y, Zaki NAM. Review on methods for preservation and natural preservatives for extending the food longevity. Chemical Engineering Research Bulletin,2017:19:145-153.
25. Surrendar J, Shere DM, Shere PD. Effect of drying on quality characteristics of dried tomato powder. Journal of Pharmacognosy and Phytochemistry,2018:7(2):2690-2694.
26. Ugonna CU, Jolaoso MA, Onwaulu AP. Tomato Value Chain in Nigeria: Issues, Challenges and Strategies. Journal of Scientific Research and Reports,2015:7(7):501-515.
27. Ukponmwan I. Preservation of Tomatoes. 5th International Conference on Biomedical Engineering and Technology,2015:81:15.
28. Zdrojewicz Z, Szyca M, Popowicz E, Michalik T, BS. Tumeric- not only spice. Pol Merkur Lekarski,2017:42(252):227-230