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Research Article

Determination of Phytochemical and Proximate Profiles in Healthy and Spoilt Produce (*Cucurbita argyrosperma*, *Solanum lycopersicum*, and *Capsicum annuum*) from Abaji Market, Nigeria

Fatima Mairami[1] and Samira Abdulmudallib Abdullahi[2]
[1]Department of Biology, Baze University, Abuja, Nigeria.
[2]Department of Biochemistry, Baze University, Abuja, Nigeria
*Corresponding author's Email: Samira.abdullahi@bazeuniversity.edu.ng, doi.org/10.55639/607.020100150

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ABSTRACT

Vegetables contribute significantly to global food security and public health by delivering essential macronutrients, micronutrients, and bioactive secondary metabolites. However, post-harvest spoilage severely limits their dietary and therapeutic potential. This study investigated the qualitative phytochemical profiles and proximate compositions of healthy and spoilt pumpkin (*Cucurbita argyrosperma*), tomato (*Solanum lycopersicum),* and pepper (*Capsicum annuum*) fruits collected from Abaji Market in Abuja, Nigeria. Phytochemical screening was carried out using qualitative colorimetric techniques, whereas proximate composition (moisture, crude fat, crude protein, carbohydrate, ash, and crude fiber) was assessed using AOAC guidelines. Data were analyzed by two-way ANOVA (crop × condition) followed by within-crop Welch t-tests. Healthy pumpkin and tomato samples had a diverse range of phytochemicals, including tannins, phlobatannins, saponins, cardiac glycosides, anthraquinones, flavonoids, and alkaloids, whereas spoilt pumpkin contained only flavonoids and steroids, and spoilt tomato lacked all examined phytochemicals. The healthy pepper had all of the tested components except for phlobatannins, but the spoilt pepper only contained phlobatannins. Proximate analysis showed an increase in moisture content and significant decline ($P \leq 0.05$) in the nutritional parameters of spoilt fruits. Healthy tomatoes had the highest levels of crude protein (4.75 ±0.07%), while healthy peppers had the highest levels of ash (0.92± 0.01%) and carbohydrates (23.79 ±0.14%). Crude protein, crude fat, carbohydrates, ash, and crude fiber, on the other hand, were significantly reduced in spoilt samples of all three species (except crude fat in tomato). These findings show that post-harvest spoilage decreases both the phytochemicals and the core macronutrient value of key market produce, emphasizing the critical need for better post-harvest handling and storage procedures.

Corresponding author: Samira A. Abdullahi, **Email**: Samira.abdullahi@bazeuniversity.edu.ng
Department of Biology, Baze University, Abuja, Nigeria, Nigeria

1.0 INTRODUCTION

Vegetables perform a crucial role in global food security and nutrition security (Natesh *et al.,* 2017). They are important for human health due to their vitamins, minerals, phytochemical compounds, and dietary fiber content (Ulger *et al*., 2018). Vegetable consumption is influenced by gender, age, income, education, ancestry, and the health status of an individual (Amaechi *et al.,* 2021). Tomato (*Solanum lycopersicum*) is a significant component of the human diet and the second-highest vegetable consumed and produced in West Africa. It offers a plethora of nutritional and medicinal benefits owing to its rich content of essential vitamins, minerals, phytochemicals, and especially lycopene, which helps prevent the development of some cancers. Tomatoes as a major food can be eaten fresh, dried, cooked, or processed into a paste (Ibitomi *et al.,* 2024). Tomato fruits are consumed fresh in salads or cooked in sauces, soups, and meat or fish dishes; the fruit is a fleshy berry, globular to oblate in shape and 2–15 cm in diameter, with immature fruit being green and hairy and ripe fruit ranging from yellow to red (Chime & Aiwansoba, 2023). Tomato is a major vegetable crop that has achieved tremendous popularity over the last century (Akinboye *et al.,* 2024). There are known to be a rich source of water, minerals, vitamin C, folate, vitamin K, potassium, insoluble fibers such as hemicellulose, cellulose, and lignin, and a potent source of lycopene (Ademosun *et al.,* 2024). The production of tomatoes in Nigeria was reported to have increased from 1.8 million metric tonnes to 2.3 million metric tonnes over recent years (Adeoye & Aderibigbe, 2021). It has the capability of improving Nigerian agricultural economic development (Popoola *et al*., 2026). Peppers are significant crops frequently used in cooking or as spices, containing numerous phytochemicals including capsaicinoids, phenolics, and carotenoids (Erol *et al.,* 2024). They have been consumed worldwide for its aroma, hot taste, vibrant color, and richness in capsaicin and carotenoids, which offer protective attributes against rheumatism, joint pain, bronchitis, and cancer (Kalauni et al., 2024). Peppers are beneficial for health since they contain phytonutrients with anti-inflammatory and antioxidant qualities (Oloruntola *et al.,* 2023).

A versatile and popular cucurbitaceous vegetable, pumpkin (*Cucurbita* genus) has gained attention because of its variety of phytochemicals and health advantages; it is a vital food for subsistence farmers and urban consumers (Gavril *et al*., 2024). It is a multifunctional ingredient in the diet whose fruit flesh, seed, and peel are rich sources of primary and secondary metabolites, including proteins, carbohydrates, fatty acids, carotenoids, tocopherols, and tryptophan (Batool *et al*., 2022). Pumpkin fruits are consumed as vegetables or dessert pies, while seeds are roasted as snacks or processed for oil extraction (Chatepa *et al.,* 2022).

Bioactive phytochemicals provided by fruits and vegetables reduce the risk of chronic diseases (Haruna, 2020). These plant food groups provide vitamins, minerals, dietary fiber, and phytochemicals that act as anti-inflammatories, antioxidants, and phytoestrogens (Uyang *et al*., 2025). The antioxidant and anti-inflammatory properties of phytochemicals provide pharmacological benefits useful in treating and preventing diseases (Famojuro *et al*., 2025). The nutritional value of grains, fruits, and vegetables is paramount for public health, particularly in developing countries where these food groups are integral to daily diets (Dike-Iheanyi *et al*., 2024). Studying the nutritional and therapeutic values of plant foods encourages increased intake and provides a balanced nutrient supply (Islary *et al.,* 2016). Phytochemicals are naturally occurring secondary metabolites in various plant parts that provide health benefits beyond basic nutrition, serving diverse functions such as plant defense, pollination attraction, and structural strength (Agatemor *et al.,* 2018).

Carbohydrates formed during photosynthesis represent energy-building plant products consumed as major energy sources (Sadiq *et al.,* 2021). Phytochemicals such as phenolic acids, flavonoids, ascorbic acid, and carotenoids are strong antioxidants with anti-aging,

antidiabetic, and anti-inflammatory functions (Hasan *et al.,* 2022). Phytonutrients are classified according to their chemical structures and functional properties (Sha'a *et al.,* 2019). It is important to determine the chemical composition of vegetables to establish their health benefits and stimulate cultivation. Proximate analysis measures major biomass constituents, including carbohydrates, moisture, ash, crude fiber, crude protein, and lipids (Sadiq *et al*., 2021). However, there has been a lack of scientific data regarding the nutritional quality and phytochemical composition of vegetables sold in Abaji Market, Abuja. Although fresh and spoilt tomatoes from markets in Benin City have been compared (Chime & Aiwansoba, 2023),

To our knowledge, comparable data for pumpkin, tomato and pepper for the market in the federal capital territory are lacking. Therefore, this study aimed to determine and compare the qualitative phytochemical profiles and proximate compositions of healthy and spoilt pumpkin, tomato and pepper fruits sold in Abaji Market, Abuja, in order to describe the nutritional consequences of post-harvest spoilage.

2.0 MATERIALS AND METHODS

2.1 Sample Collection and Preparation

Fresh, healthy fruits and visibly spoilt fruits of pumpkin (*Cucurbita argyrosperma*), tomato (*Solanum lycopersicum*), and pepper (*Capsicum annuum*) were randomly purchased from vendors at Abaji Market in the Abaji Local Government Area, Federal Capital Territory (FCT), Abuja, Nigeria. The samples were transported immediately in sterile polythene bags to the Biology and Biochemistry Laboratories at Baze University, Abuja

2.2 Qualitative Phytochemical Screening

Sub-samples (100 g each) were sliced into small pieces and air-dried at room temperature (25 ± 2 °C) for three weeks until a constant weight was attained. The dried material was ground into a fine powder with a mechanical blender and stored in airtight plastic containers until extraction. For extraction, 10 g of the powdered sample was macerated in 100 mL of 80% aqueous methanol in an Erlenmeyer flask for 48 hours at room temperature, with intermittent agitation. The mixture was then filtered through Whatman No. 1 filter paper, and the filtrate was concentrated under reduced pressure using a rotary evaporator. The resulting extract was stored at 4 °C prior to qualitative phytochemical screening. Qualitative phytochemical evaluations were carried out on the prepared fruit extracts using standard chemical procedures according to Sha'a et al. (2019):

Test for Alkaloids

To 2 mL of plant extract, 2 mL of concentrated hydrochloric acid was added. Mayer's reagent (3 drops) was added. Green or white precipitate suggests the presence of alkaloids.

Test for Saponins

To 1ml of plant extract, add 5-10 ml of distilled water and shake in a graduated cylinder for 15 minutes. The presence of saponins was suggested by the formation of a 1-cm layer of foam.

Test for Cardiac Glycosides

Extract 2 mL was treated with 1mL of glacial acetic acid containing a few drops of $FeCl_3$ solution. Concentrated H_2SO_4(2 mL) was carefully poured down the inner side of the test tube. A reddish-brown ring at the interface and a bluish-green upper layer confirmed the presence of deoxysugars and cardiac glycosides.

Tests for Steroids

To 1 mL of plant extract, an equal volume of chloroform and 3 drops of concentrated H2SO4 were added. The formation of a brown ring suggested the presence of steroids.

Test for Anthraquinones

Powdered extract (0.5 g) was shaken with 5mL of chloroform for 5 minutes and filtered. The filtrate was shaken with an equal volume of 100% ammonia solution. A pink, violet, or red color in the lower ammoniacal layer indicated anthraquinones.

Test for Tannins

To 1 ml of plant extract, 2 ml of 5% ferric chloride was added. Tannins are present when a dark blue or greenish hue forms.

Test for Flavonoids

To 1 ml of plant extract, 1ml of aqueous NaOH solution was applied and the

production of yellow-orange hue was noticed. (ii) Four drops of concentrated H_2SO_4 were added to 2 ml of plant extract, and the production of an orange hue was monitored.

Test for phlobatannins

According to Saio and Syiem (2015), each sample's was cooked with 1% aqueous hydrochloric acid to see if any red precipitate, which is a sign of phlobatannins, would appear.

2.2 Proximate Composition Analysis

2.3.1 Moisture Content Determination

Moisture was measured following American Association of Cereal Chemists (AACC) Method 44–15A. Empty crucibles were first dried for 1 h at 103 °C in a forced-draught oven, left to cool in a desiccator for roughly 10 min, and weighed. A 2 g portion of each sample was then placed in a crucible and dried for 4 h at 103 °C in the same oven. After cooling for 10 min, the crucibles were weighed again, and moisture was calculated as:

Moisture (%) = [(mass of food + tin) − (mass of dry food + tin)] / [(mass of food + tin) − (mass of tin)] × 100

2.3.2 Protein Content Determination

The micro-Kjeldahl procedure of the Association of Official Analytical Chemists (AOAC) was followed. Each 2 g sample was digested in a heating tube with 10 mL of concentrated H_2SO_4 and one selenium catalyst tablet, under a fume cupboard. The digest was quantitatively transferred to a 100 mL volumetric flask and diluted to the mark with distilled water. A 10 mL aliquot was combined with the same volume of 45% NaOH and distilled. Fifty millilitres of distillate was collected in 4% boric acid with three drops of indicator and then titrated. Every sample was run in duplicate, and the mean was used. Nitrogen was calculated from the equation below, and crude protein was obtained by multiplying by 6.25.

Nitrogen (%) = (T × N × 14 × Vf × 100) / (W × Va × 1000)

Where W is the sample weight, N is the normality of the titrant (0.1 N), Vf is the total digest volume (100 mL), T is the titre, and Va is the aliquot volume distilled.

2.3.3 Ash Content Determination

To determine the ash content, which is the substance remaining after oxidative combustion of all the organic matter in food, the American Association of Cereal Chemists (AACC) method 08–01 was used .Crucibles were dried at 100 °C for 5 h, cooled, and weighed. After 2 g of sample was added to each, the contents were charred over a tripod and then incinerated in a muffle furnace at 550 °C for 5 h. The crucibles were cooled to room temperature in a desiccator and weighed, and the ash percentage was calculated as:

Ash (%) = [(mass of ash + crucible) − (mass of crucible)] / [(mass of food + crucible) − (mass of crucible)] × 100

2.3.4 Fat Content Determination

Crude Fat was extracted with petroleum ether in a Soxhlet apparatus according to American Association of Cereal Chemists (AACC) Method 30–25. The solvent was then evaporated from the receiving flask at low temperature, and the remaining fat was oven-dried at 100 °C for 30 min. Fat content was obtained as:

Fat (%) = [(mass of beaker + extracted fat) − (mass of beaker)] / mass of sample × 100

2.3.5 Fiber Content Determination

A filter bag was weighed (W1), and 0.5 g of dried sample (W2), milled to pass a 1 mm sieve, and was placed in it. A blank bag was digested alongside the samples to give the blank correction (C1). Each bag was heat-sealed about 0.5 cm from its edge and loaded onto a bag suspender. The suspender was placed in the vessel of an ANKOM fibre analyser containing about 2000 mL of pre-heated acid detergent solution, the lid was closed, and the run lasted 60 min. The bags were then rinsed with about 2000 mL of hot water under agitation, followed by further rinsing for 3–5 min until the rinse water was neutral. Excess water was squeezed out, and the bags were soaked in acetone for 3 min, pressed, and dried at 105 °C for at least 2 h. Once at ambient temperature, they were reweighed (W3). The result was calculated as:

ADF (%, as-is basis) = [W3 − (W1 × C1)] / W2 × 100

2.3.6 Carbohydrates Determination

Available carbohydrate was estimated by difference:

Carbohydrate (%) = 100 − (% moisture + % ash + % crude protein + % crude fat + % crude fibre)

2.4 Statistical Analysis

Each analytical determination was performed on three independent biological replicates (n = 3). Quantitative proximate data were analysed by two-way analysis of variance (ANOVA) to test the main effects of crop (*Cucurbita argyrosperma*, *Solanum lycopersicum* and *Capsicum annuum*) and condition (healthy or spoilt), together with their interaction (crop × condition). Within each crop, the effect of spoilage was assessed by comparing the healthy and spoilt means with Welch's independent-samples t-test. Differences were considered statistically significant at $P < 0.05$. All analyses were carried out using IBM SPSS Statistics (version 26.0; IBM Corp., Armonk, NY, USA). Results of the qualitative phytochemical screening were recorded as present (+) or absent (−) based on colorimetric observation and are described categorically

3.0 RESULTS

The qualitative phytochemical composition of healthy and spoilt fruits from Abaji Market is presented in Table 1. Healthy pumpkin fruits tested positive for all eight evaluated phytochemicals (tannins, phlobatannins, saponins, cardiac glycosides, anthraquinones, flavonoids, alkaloids, and steroids). In contrast, spoilt pumpkin fruits retained only flavonoids and steroids while lacking all other constituents. Healthy tomato fruits contained all evaluated phytochemicals except steroids, whereas spoilt tomato fruits showed complete depletion across all tested secondary metabolites. Healthy pepper fruits contained all phytochemicals except phlobatannins, while spoilt pepper retained only phlobatannins.

Table 1: Phytochemical Constituents of Healthy and Spoilt Fruits Sourced from Abaji Market

Samples	Tannins	Phlobatannin	Saponins	Cardiac glycosides	Anthraquinones	Flavonoid	Alkaloid	Steroid
PU (H)	+	+	+	+	+	+	+	+
PU (S)	-	-	-	-	-	+	-	+
TO (H)	+	+	+	+	+	+	+	-
TO (S)	-	-	-	-	-	-	-	-
PE (H)	+	-	+	+	+	+	+	+
PE (S)	-	+	-	-	-	-	-	-

Values represent qualitative colorimetric detection carried out in triplicate (n = 3). PU = pumpkin (*Cucurbita argyrosperma*); TO = tomato (*Solanum lycopersicum*); PE = pepper (*Capsicum annuum*); H = healthy fruits; S = spoilt fruits; (+) = present; (−) = absent.

The proximate composition of the healthy and spoilt fruits is presented in Table 2. Two-way ANOVA revealed significant main effects of both crop ($P < 0.001$) and condition ($P < 0.001$) on all six proximate parameters. A significant crop × condition interaction was detected for moisture ($P < 0.001$), crude protein ($P < 0.001$), carbohydrate ($P < 0.001$), ash ($P = 0.005$) and crude fibre ($P = 0.009$), whereas the interaction for crude fat was not significant ($P = 0.30$).

Within each crop, spoilt samples had significantly higher moisture content than their healthy counterparts ($P < 0.01$, Welch's t-test). In contrast, healthy fruits had significantly higher crude protein, carbohydrate, ash and crude fibre contents in all three crops ($P < 0.05$). Crude fat was significantly higher in healthy pumpkin ($P = 0.013$) and pepper ($P = 0.004$). In tomato, however, the difference in crude fat between healthy (0.45 ± 0.05%) and spoilt (0.37 ± 0.03%) fruits was not statistically significant ($P = 0.091$).

Table 2: Proximate Composition of Healthy and Spoilt Fruits Sourced from Abaji Market

Sample	Moisture (%)	Crude fat (%)	Crude Protein (%)	Carbohydrate (%)	Ash (%)	Crude fiber (%)
PU (H)	78.19±0.03[b]	0.47±0.00[a]	3.39±0.22[a]	18.29±0.23[a]	0.59±0.02[a]	1.91±0.01[a]
PU (S)	82.64±0.49[a]	0.42±0.01[b]	2.69±0.03[b]	13.15±0.28[b]	0.39±0.01[b]	1.10±0.03[b]
TO (H)	79.52±0.36[b]	0.45±0.05[a]	4.75±0.07[a]	15.89±0.32[a]	0.59±0.02[a]	1.92±0.04[a]
TO (S)	84.07±0.09[a]	0.37±0.03[a]	2.91±0.31[b]	10.23±0.05[b]	0.50±0.02[b]	1.29±0.07[b]
PE (H)	72.85±0.41[b]	0.32±0.02[a]	2.73±0.09[a]	23.79±0.14[a]	0.92±0.01[a]	1.11±0.09[a]
PE (S)	75.56±0.56[a]	0.22±0.02[b]	1.74±0.07[b]	20.72±0.56[b]	0.69±0.01[b]	0.79±0.03[b]

Values are presented as mean ± standard deviation (n = 3) on a fresh-weight basis. Within each crop and column, means sharing the same superscript letter do not differ significantly between the healthy (H) and spoilt (S) conditions ($P > 0.05$, Welch's t-test), whereas means with different superscript letters (a, b) differ significantly ($P < 0.05$), with "a" denoting the higher mean. PU = pumpkin (*Cucurbita argyrosperma*); TO = tomato (*Solanum lycopersicum*); PE = pepper (*Capsicum annuum*).

4.0 DISCUSSION

Proximate and phytochemical assays are extremely important in determining the nutritional and medicinal worth of plant parts such as fruits, seeds, and leaves. Healthy food contains a variety of plant compounds that can assist enhance human diets and prevent disease, these substances have antimicrobial and antioxidant properties.

As a result, proximate analysis provides basic information for assessing the quality and nutritional worth of fresh produce. Assessing nutrition is vital to determine whether people are meeting their dietary needs, and examining edible fruits provides useful information for future research (Sibiya *et al.,* 2021). Healthy pumpkin fruits contained all eight plant compounds studied, including tannins, phlobatannins, saponins, cardiac glycosides, anthraquinones, flavonoids, alkaloids, and steroids. When the pumpkin deteriorated, it lost the majority of these compounds while retaining only flavonoids and steroids. Spoilage led to significant nutritional changes ($P < 0.05$), increasing moisture levels from 78.19 ± 0.03% to 82.64 ± 0.49% and softening fruit tissue. Spoilage also resulted in decreases in protein (3.39% to 2.69%), carbohydrates (18.29% to 13.15%), fiber (1.91% to 1.10%), and ash (0.59% to 0.39%), which may reflect microbial utilization of stored nutrients and, because the results are expressed on a wet-weight basis, partial dilution by the higher water content of spoilt tissue. Except for steroids, each healthy tomato contained all of the compounds tested. Spoilt tomatoes tested negative for all the compounds screened, which may reflect enzymatic and microbial degradation of these compounds, although the organisms responsible were not isolated in this study. Healthy tomatoes had the highest protein level (4.75± 0.07%), but spoilage decreased it to 2.91±0.31% ($P \leq 0.05$). Spoilt tomatoes had the highest water content (84.07 ±0.09%) and decreased carbohydrates (from 15.89% to 10.23%) and fiber (from 1.92% to1.29%). Except for phlobatannins, healthy peppers contained all of the compounds studied. When pepper spoilt, its original compounds disappeared, but phlobatannins appeared, a result that is difficult to interpret from a qualitative test alone; it may reflect a stress-induced response or a reaction of degradation products in the assay, and it requires confirmation. Carbohydrates (23.79±0.14%) and ash (0.92 ±0.01%) were greatest in healthy pepper. While moisture increased from 72.85% to 75.56% ($P \leq 0.05$), spoilage reduced carbohydrates to 20.72%, ash to 0.69%, and protein from 2.73% to 1.74%, and fat to 0.22 ±0.02%. Plant chemicals such as alkaloids, flavonoids, terpenoids, tannins, phenols, and saponins are used to make medicines, healthful food products,

flavorings, and natural bug repellents (Sarwar *et al*., 2023). They also protect plants from adverse weather, pollutants, and pests (Harborne & Williams, 2000). Flavonoids are a wide class of plant antioxidants that improve food quality. They regulate cell signalling, whereas alkaloids found in plants such as coffee act as brain stimulants (Hossain *et al*., 2025). Alkaloids also alleviate pain, spasms, and nerve activity (Okwu, 2001, 2004; Olaleye, 2007). Saponins aid to clean teeth and prevent dental plaque formation (Okwu & Ekeke, 2003). Tannins, flavonoids, and alkaloids contribute to fruits' total antioxidant capacity. Plants' health benefits are determined by their unique chemical makeup (Agu & Okolie, 2017).

Plant compounds can reduce the risk of heart disease, cancer, bladder problems, aging, and Alzheimer's disease (De Pascual-Teresa *et al.,* 2010; Makkar *et al.,* 2007). Some of these compounds have also been reported to protect plants against fungi such as *Aspergillus* and *Penicillium*, which cause rot and may produce toxic metabolites. Previous research has reported these compounds in healthy fruits of pepper(Pérez-Gálvez *et al*., 2003; Saidu & Garba, 2011) pumpkin (Batool *et al.,* 2022; Gavril *et al.,* 2024), watermelon (Oseni & Okoye, 2013), pawpaw (Lydia *et al.,* 2016), and tomato (Chime & Aiwansoba, 2023; Ibitomi *et al*., 2024).

The loss of plant compounds in spoilt fruits is consistent with microbial and enzymatic degradation of plant tissue. However, because no microbiological isolation or identification was carried out in this study, the losses cannot be attributed specifically to fungal activity rather than to bacterial, enzymatic, or oxidative pathways; this should be confirmed in future work. While normal water content helps with digestion, body hydration, and freshness, very high water content promotes rapid microbial rot and shortens storage life (Igwilo *et al.,* 2018). High moisture supports the growth of bacteria and molds, lowering food quality.

Healthy fruits had higher levels of fat, protein, carbohydrates, minerals, and fiber, which is consistent with findings on pepper (Effiong & Udo, 2010), watermelon (Ogoloma *et al.,* 2013), and oranges (Bala & Bashar, 2017). In contrast, the lower nutrient levels in spoilt fruits may reflect the use of plant carbohydrates and proteins by spoilage microorganisms (Fatima et al., 2009), in addition to the dilution effect of the higher moisture content. High moisture levels in spoilt vegetables are commonly associated with soft-rot deterioration. Post-harvest decay of produce has been attributed largely to improper handling, inappropriate storage, and long display durations in markets (Muhammad *et al.,* 2004).

This study has limitations that should be considered when interpreting the findings. The phytochemical screening was qualitative, so the absence of a positive reaction indicates a concentration below the detection limit of the assay rather than true absence. Spoilage organisms were not isolated or identified. Proximate values are expressed on a wet-weight basis, so higher moisture in spoilt fruit partly dilutes the other constituents; dry-weight data would separate dilution from true loss. Samples came from a single market, and the recommendations on post-harvest handling and cold-chain storage are inferred from the results rather than tested directly.

Overall, these findings show that post-harvest spoilage in Abaji Market not only reduces economic value of food, but also significantly reduces its macronutrient density and secondary metabolites. Improved post-harvest management, cold-chain logistics, and proper market storage infrastructure are critical for maintaining produce quality and protecting public health.

5.0 CONCLUSION

This study emphasizes the marked influence of post-harvest spoilage on the nutritional and phytochemical quality of pumpkin (*Cucurbita argyrosperma*), tomato (*Solanum lycopersicum*), and pepper (*Capsicum annuum*) from Abaji Market in Nigeria. Healthy fruits have a complex phytochemical composition, which included alkaloids, flavonoids, tannins, saponins, and glycosides, as well as increased levels of crude protein, carbohydrates, crude fat, ash, and dietary fiber. These findings show that post-harvest spoilage not only affects fresh produce's market value and shelf life, but

also depletes it of critical dietary elements and health-promoting phytochemical constituents. To reduce these significant nutrient and economic losses, it is critical to improve post-harvest handling methods, storage facilities, and preservation technology throughout local supply chains.

REFERENCES

AACC. (1999). Approved Methods of the American Association of Cereal Chemists (Method 08–01.01: Ash—Basic Method).

AACC International. AACC. (2000). Approved Methods of the American Association of Cereal Chemists (Method 44–15A: Moisture—Air-Oven Methods).

AACC International. AACC. (2000). Approved Methods of the American Association of Cereal Chemists (Method 30–25.01: Crude Fat in Wheat, Corn, and Soy Flour, Feeds, and Mixed Feeds). AACC International.

Ademosun, O. T., Adebayo, A. H., & Ajanaku, K. O. (2024). Nutritional Indices, Phytochemistry, and the In Vitro Antioxidant Activity of Carrot Fortified Tomato Concentrate. *Journal of Food Quality*, *2024*(1), 9301631.

Adeoye, I. B., & Aderibigbe, O. R. (2021). Economics of value addition in tomato. *Nigerian Journal of Horticultural Science*, *25*(3), 74-79.

Agatemor, U. M. M., Nwodo, O. F. C., & Anosike, C. A. (2018). Phytochemical and proximate composition of cucumber (Cucumis sativus) fruit from Nsukka, Nigeria. *African journal of Biotechnology*, *17*(38), 1215-1219.

Agu, K. C., & Okolie, P. N. (2017). Proximate composition, phytochemical analysis, and in vitro antioxidant potentials of extracts of Annona muricata (Soursop). *Food science & nutrition*, *5*(5), 1029-1036.

Akinboye, O. E., Afodu, O. J., Oyekale, O. O., Awoyinka, R. I., & Abolaji, A. O. (2024). Effects of four different processing methods on nutrients and bioactive profiles of tomato (*Solanum lycopersicum* L.). *Nigerian Journal of Agriculture and Agricultural Technology*, *4*(3), 1–11.

Amaechi, N. C., Udeogu, E., Okoronkwo, C. U., & Irondi, C. P. (2021). Nutritional and phytochemical profiles of common pepper (Capsicum spp.) foliage consumed as leafy vegetables in Southeast Nigeria. *Food Research*, *5*(5), 136-144.

AOAC. (2005). *Official methods of analysis of AOAC International* (18th ed.). AOAC International.

Bala, M., & Bashar, J. B. (2017). Proximate and mineral elements composition of five locally consumed fruits in Kano State, Nigeria. *Bayero Journal of Pure & Applied Sciences*, *10*(2), 172.

Batool, M., Ranjha, M. M. A. N., Roobab, U., Manzoor, M. F., Farooq, U., Nadeem, H. R., ... & Ibrahim, S. A. (2022). Nutritional value, phytochemical potential, and therapeutic benefits of pumpkin (Cucurbita sp.). *Plants*, *11*(11), 1394.

Chatepa, L. E. C., Masamba, K. G., & Uluko, H. (2022). Nutritional, biochemical and phytochemical characterization of seeds and seed oil of pumpkins (Cucurbita maxima) grown in Malawi. *African Journal of Pure and Applied Chemistry*, *16*(3), 57-65.

Chime, A. O., & Aiwansoba, R. O. (2023). Phytochemical and Proximate Evaluation of Fresh and Spoilt Fruits of Tomatoes (Solanum lycopersicum L.) Sold in Five Major Markets in Benin City, Edo State, Nigeria. *Afr Sci*, *24*(2), 105-12.

De Pascual-Teresa, S., Moreno, D. A., & García-Viguera, C. (2010). Flavanols and anthocyanins in cardiovascular health: a review of current evidence. *International journal of molecular sciences*, *11*(4), 1679-1703.

Dike-Iheanyi, E. I., Okoye, C. J., Okoroigwe, F. C., Ezeanyanwu, V. C., & Ifemeje, J. C. (2024). Determination of proximate content and phytochemical analysis of some selected grains, fruits and vegetables commercially sold in Eke Awka Market, Awka, Anambra State, Nigeria. *Research Invention Journal of Public Health and Pharmacy*, *3*(2), 53-62.

Effiong, G. S., & Udo, I. F. (2010). Nutritive values of four indigenous wild fruits in Southeastern Nigeria. *Electronic Journal of Environmental, Agricultural & Food Chemistry*, *9*(7), 1168.

Erol, Ü. H., Gümüş, P., & Arpacı, B. B. (2024). Comparative analysis of fatty acid profiles, phytochemical and mineral contents of pepper spice types in Türkiye. *Mustafa Kemal Üniversitesi Tarım Bilimleri Dergisi*, *29*(1), 133-147.

Famojuro, T. I., Famojuro, O. B., Datok, T., Ihuma, J. O., Bitrus, A. R., & Odoh, R. E. (2025). Phytochemical evaluation, proximate analysis and antioxidant activity of the peels of five fruits commonly consumed in Nigeria.*Nigerian Journal of Natural Products and Medicine,* 28(1) 17-24

Fatima, N., Batool, H., Sultana, V., Ara, J., & Ehteshamul-Haque, S. (2009). Prevalence of post-harvest rot of vegetables and fruits in Karachi, Pakistan. *Pak. J. Bot*, *41*(6), 3185-3190.

Gavril, R. N., Stoica, F., Lipșa, F. D., Constantin, O. E., Stănciuc, N., Aprodu, I., & Râpeanu, G. (2024). Pumpkin and pumpkin by-products: A comprehensive overview of phytochemicals, extraction, health benefits, and food applications. *Foods*, *13*(17), 2694.

Harborne, J. B., & Williams, C. A. (2000). Advances in flavonoid research since 1992. *Phytochemistry*, *55*(6), 481-504.

Haruna, A. (2020). Phytochemical analysis of some selected indigenous fruits collected from lokogoma-abuja, nigeria. *Journal of Diseases and Medicinal Plants*, 6(2): 50-55

Hasan, S. K., Kabir, M. R., Kabir, M. R., Islam, M. R., Akhter, M. J., & Moury, J. Y. (2022). Proximate composition, minerals, phytochemicals, and functional activities of jujube fruits grown in Bangladesh. *Journal of Agriculture and Food Research*, *8*, 100302.

Hossain, M. S., Wazed, M. A., Asha, S., Amin, M. R., & Shimul, I. M. (2025). Dietary phytochemicals in health and disease: mechanisms, clinical evidence, and applications—a comprehensive review. *Food Science & Nutrition*, *13*(3), e70101.

Ibitomi, O. O., Adefila, E. I., Adeyemi, C. O., Olaniyi, S. S., & Abubakar, A. (2024). Comparative Analysis of Nutritional and Phytochemical Properties of Fresh Tomato, Sundried Tomato and Processed Tomato Paste. *Ilorin Journal of Science*, *11*(3 (Special)), 111-117.

Igwilo, I. O., Iwualla, L. C., Igwilo, S. N., Agbara, A. C., & Okpala, C. O. (2018). Proximate analysis and phytochemical composition of fresh and dried fruit of Morinda Lucida. *The Bioscientist*, *6*(1), 31-39.

Islary, A., Sarmah, J., & Basumatary, S. (2016). Proximate composition, mineral content, phytochemical analysis and in vitro antioxidant activities of a wild edible fruit (Grewia sapida Roxb. ex DC.) found in Assam of North-East India. *J Invest Biochem*, *5*(1), 21-31.

Kalauni, S. K., Pokhrel, K. P., & Khanal, L. N. (2024). Proximate Analysis and Comparative Evaluation of Antioxidant, Antidiabetic and Antibacterial Activities of Capsicum Species Consumed in Nepal. *Amrit Journal*, *4*(1), 48-59.

Lydia, E., John, S., Mohammed, R., & Sivapriya, T. (2016). Investigation on the Phytochemicals present in the Fruit peel of Carica papaya and evaluation of its Antioxidant and Antimicrobial property. *Research Journal of Pharmacognosy and Phytochemistry*, *8*(4), 217.

Makkar, H. P. S., Francis, G., & Becker, K. (2007). Bioactivity of phytochemicals in some lesser-known plants and their effects and potential applications in livestock and aquaculture production systems. *animal*, *1*(9), 1371-1391.

Muhammad, S., Shehu, K., & Amusa, N. A. (2004). Survey of the market diseases and aflatoxin contamination of tomato (Lycopersicon esculentum Mill) fruits in Sokoto, northwestern Nigeria. *Nutrition & Food Science*, *34*(2), 72-76.

Natesh, H. N., Abbey, L., & Asiedu, S. K. (2017). An overview of nutritional and antinutritional factors in green leafy vegetables. *Horticulture International Journal*, *1*(2), 58-65.

Ogoloma, M. U., Nkpaa, M. K., Akaninwor, J. O., & Uwakwe, A. A. (2013). Proximate, phytochemical and mineral elements compositions of some edible fruits grown in oil producing community of rivers state, Nigeria. *IOSR-JESTFT*, *5*, 38-46.

Okwu, D. E. (2001). Evaluation of chemical composition of indeginous species and flavouring agents. *Global journal of pure and Applied Sciences*, *7*(3), 455-460.

Okwu, D. E. (2004). Phytochemicals and vitamin content of indigenous spices of South Eastern Nigeria. *Journal of Sustainable Agriculture and the Environment*, **6(1) 30-37**

Okwu, D. E., & Ekeke, O. (2003). Phytochemical screening and mineral composition of chewing sticks in South Eastern Nigeria. *Global Journal of Pure and Applied Sciences*, *9*(2), 235-238.

Olaleye, M. T. (2007). Cytotoxicity and antibacterial activity of methanolic extract of Hibiscus sabdariffa. *Journal of Medicinal Plants Research*, *1*(1), 9-13.

Oloruntola, O. D., Falowo, A. B., Oladebeye, F. S., Ayodele, S. O., Fasuhami, O. S., Adesanmi, M. I., ... & Udofia, P. S. (2023). Comparative assessment of proximate and phytochemical composition and antioxidant, anti-diabetic, and anti-inflammatory properties of pericarp and seeds of Capsicum annum L. *L. Sci. Letters*, *11*(3), 86-93.

Onuguh, I. C., Imuetinya, A. T., Isaac, A. Y., Nnadozie, R. I., & Ozor, J. U. (2025). Comparative Proximate Analysis of Tomato (Solanum lycopersicum L.) Fruits Sold in Markets in Benin City, Nigeria. International Journal on Emerging Technologies, 16(1), 121–125.

Oseni, O.A. & Okoye, V.I. (2013). Studies of Phytochemical and Antioxidant propertiesof the Fruit of Watermelon (*Citrulluslanatus*). *Journal of Pharmaceutical and Biomedical Sciences,* 27(27):508-514

Pérez-Gálvez, A., Martin, H. D., Sies, H., & Stahl, W. (2003). Incorporation of carotenoids from paprika oleoresin into human chylomicrons. *British Journal of Nutrition*, *89*(6), 787-793.

Popoola, O. T., Issa, H. A., Adegun, I. K., & Ibrahim, H. K. (2026). Proximate and Mineral Analysis of Evaporative-Cooled Tomatoes. *LAUTECH Journal of Engineering and Technology*, *20*(1), 112-124.

Sadiq, I. S., Saminu, M. Y., Zainab, L., Adeleye, A. O., Sanni, L. E., & Dandalma, Z. A. (2021). Proximate analysis and phytochemical screening of watermelon (citrullus lanatus) pulp, peels and seeds. *Dutse Journal of Pure and Applied Sciences*, *7*(4a), 174-182.

Saidu, A. N., & Garba, R. (2011). Antioxidant activity and

phytochemical screening of five species of capsicum fruits.*International Research Journal of Biochemistry and Bioinformatics,*Vol. 1(9) pp. 237-241.

Saio, V., & Syiem, D. (2015). Phytochemical analysis of some traditionally used medicinal plants of north-east India. *J. Sci. Environ. Today*, *1*, 6-13.

Sarwar, A. G., Akter, D., Karim, M. M., Mia, M. A., Khatun, M. M., Kabir, A. A., & Haque, M. S. (2023). Proximate composition and phytochemical analysis of six minor fruits of Bangladesh. *Bangladesh Journal of Botany*, *52*(1), 111-118.

Sha'a, K. K., Clarkson, G. P., & Artimas, S. P. (2019). Phytochemical analysis, proximate composition and antinutritional factors of Corchorus oliterius plant. *International Journal of Biological and Chemical Sciences*, *13*(4), 2147-2157.

Sibiya, N. P., Kayitesi, E., & Moteetee, A. N. (2021). Proximate analyses and amino acid composition of selected wild indigenous fruits of Southern Africa. *Plants*, *10*(4), 721.

Ulger, T. G., Songurn, S., Grak, O., & Cakiroglu, F. P. (2018). Role of vegetables in human nutrition and disease. *London, UK: Intech Open*, 7-32.

Uyang, H. F., Ndana, R. W., Mofio, B. M., Osanaiye, B. C. A., & Ndana, V. S. (2025). Phytochemical and Proximate Analysis of Wild Fruits and Vegetables from the Federal Capital Territory, Abuja. *Faculty of Natural and Applied Sciences Journal of Applied Chemical Science Research*, *2*(2), 28-38.