Assessment of Drying Methods for Shelf Life Extension and Nutritional Composition of Tomato Fruits

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Abstract

The high moisture content of tomato fruits limits their storage and availability. This study evaluated the role of drying in extending shelf life and its effect on nutritional quality. Fresh samples (10 kg) were processed by sun-drying (36–40 °C, 7 days) and oven-drying (50 °C, 17 h). Proximate, mineral, and vitamin contents were analysed using standard laboratory methods. Dried samples were packaged in aluminium foil and stored for 12 weeks in a dry cabinet. After this storage period, post-storage analyses were conducted. Drying was observed to significantly reduce moisture and increase ash, fibre, protein, and carbohydrates ($p \leqslant 0.05$). Sun-dried tomatoes retained higher ash (5.90 ± 0.44 %), fibre (3.07 ± 0.04 %), protein (7.01 ± 0.01 %), and carbohydrates (75.12 ± 0.01 %), while oven-dried samples had higher fat (1.09 ± 0.04 %) and moisture (13.00 ± 0.10 %) ($p \leqslant 0.05$). After storage, moisture, ash, and fibre levels declined, whereas protein and carbohydrate levels increased. Mineral analysis revealed a decrease in phosphorus, sodium, calcium, and iron after drying, while nitrogen, magnesium, and zinc levels increased. Oven-dried samples preserved higher nitrogen (2.52 ± 0.02%), potassium (166.07 ± 0.0001 mg/100g), and iron (0.44 ± 0.02 mg/100g) levels ($p \leqslant 0.05$). Vitamins A, C, folate, β-carotene, and lycopene declined significantly after drying. Oven-drying retained more vitamin C (10.03 ± 0.02 mg/100 g), β-carotene (14.28 ± 0.04 mg/100 g), and lycopene (28.19 ± 0.002 mg/100 g) ($p \leqslant 0.05$). Storage further reduced the levels of calcium, sodium, and lycopene. Drying effectively extended the shelf life of tomato fruits, and oven-drying better preserved sensitive micronutrients, supporting its use in small- and medium-scale processing.

Keywords:
Nutrient retention, Oven-drying, Postharvest preservation, Sun-drying, Tomato fruit

Introduction

Extending the storage duration of tomato fruits using drying techniques is crucial for its contribution to food preservation, sustainability, and nutritional quality (Raghavan et al., 2022; Pravitha et al., 2024). Tomato fruits are renowned for their rich flavour and nutritional value; however, their perishable nature, due to their high moisture content, poses a challenge to their transportation, storage, and year-round availability (Bhatkar et al., 2021). This is common in regions where fresh produce is less readily available (Yadav et al., 2022). It has been noted that the production and consumption of tomatoes worldwide have increased significantly over the years due to their substantial contributions to people's health and diets (Collins et al., 2022). Globally, tomato production exceeds 187 million tonnes annually (FAO, 2023). Still, postharvest losses remain a persistent challenge, with estimates ranging from 25% to 42%, depending on the region and handling practices (Onwude et al., 2020). Sub-Saharan Africa is disproportionately affected, where inadequate preservation systems, poor infrastructure, and climatic conditions contribute to losses of 30–50% (Sani et al., 2024). In the sub-Saharan region, Nigeria is the largest tomato producer, with an annual output exceeding 4.1 million metric tonnes (FAO, 2023). Postharvest losses are estimated at 40–50%,

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representing one of the highest rates in the region (Ajetunmobi et al., 2024). These statistics underscore that postharvest loss of tomatoes is a global issue and a critical regional and national challenge that requires urgent intervention.

Considering the persistent critical challenge of postharvest losses of tomato fruits, it has become necessary for tomato farmers and processors to adopt effective storage methods, processing techniques, and preservation methods to ensure that the shelf life is extended and the products are available throughout the year. One of the preservative measures relevant to this all-important fruit is drying. Drying as a preservation method helps reduce significant moisture from tomatoes. It also helps inhibit enzyme activities and reduce the growth of spoilage microorganisms (Fathi et al., 2022). The choice of drying method is crucial, as its effectiveness varies in terms of moisture removal and nutrient retention. More so, their effect on the overall properties (both physical and chemical) of fruits also varies (Radojčin et al., 2021). It is also important to note that the concentration of key vitamins, minerals, and phytochemicals can be altered by drying (Wang et al., 2023). For instance, while some nutrients may be preserved or even enhanced, others, such as Vitamin C, are heat-labile and may degrade (Giannakourou & Taoukis, 2021). Therefore, a comprehensive assessment of the nutritional changes that occur during drying is crucial.

Despite prior research, recent studies (Ahmed et al., 2024; Abdullahi et al., 2024; Pravitha et al., 2024) confirm that nutrient degradation during drying and subsequent storage remains a significant concern, particularly for heat- and light-sensitive vitamins such as vitamin C and lycopene. However, despite existing research on drying techniques, knowledge gaps remain regarding the comparative effects of sun-drying and oven-drying on the proximate and micronutrient composition of tomatoes, particularly after extended storage. This study aimed to identify the most effective drying technique for preserving nutritional quality while extending shelf life. This was done by comparing the effects of sun drying and oven drying on the proximate, mineral, and vitamin composition of tomato fruits before and after 12 weeks of storage.

Materials and Methods

Study location

The research was conducted at the Plant Science and Biotechnology Laboratory, Faculty of Science, Rev. Fr. Moses Orshio Adasu University, Makurdi (formerly Benue State University, Makurdi). Makurdi is the capital of Benue State, located in the North Central region of Nigeria. It lies approximately between Latitudes 6.5° and 8.5° North, and Longitudes 7.47° and 10° East, with a tropical climate and distinct wet and dry seasons (Ode et al., 2023).

Sample collection

Fresh tomato fruits were purchased from Wurukum Market within Makurdi metropolis. Selection was based on firmness, colour, and size uniformity. Samples were transported to the Plant Science and Biotechnology Laboratory in clean, ventilated baskets. Approximately 10.0 kg of fruit was purchased; 8.0 kg was allocated to drying experiments and 2.0 kg to baseline (fresh) analyses.

Sample preparation and drying process

Fresh, mature, and ripe tomatoes were manually sorted to ensure colour uniformity (bright red), size (50–70 g per fruit), and firmness. Sorting was carried out on a clean stainless-steel sorting table under natural light by two trained technicians. Damaged, bruised, and diseased fruits were removed by visual inspection, and extraneous materials (such as leaves, stems, and soil particles) were manually detached before washing**.**

Washing was performed in perforated plastic baskets (20 L capacity) under running tap water for 5 minutes to remove surface dirt. Fruits were then air-dried on stainless-steel trays (40 × 60 cm, mesh size 2 mm) for 10 minutes to remove excess water.

Tomatoes were sliced to a thickness of 4 mm using a stainless-steel kitchen knife, and the slice thickness was cross-checked with a digital Vernier calliper (Japan) to ensure consistency. The pooled sample was subdivided into six composite batches of 1.0 kg each (n = 3 for sun drying; n = 3 for oven drying), treated as independent process replicates.

Sun drying

Tomato slices were spread on stainless-steel mesh trays (40 × 60 cm, mesh size 2 mm) and sun-dried until constant weight was achieved. Drying occurred at an average ambient temperature of 36–40 °C for 10 hours daily over a period of seven consecutive days. Slices were turned manually every 2 hours to ensure uniform exposure. Trays were elevated 1 m above ground level on wooden stands and covered with fine muslin netting to prevent contamination by insects and dust. At night, trays were transferred indoors to avert moisture reabsorption from dew.

Oven drying

A separate portion of tomato slices was dried in a thermo-setting laboratory oven (DHG-9140A, Yiheng Scientific Instruments, Shanghai, China) at a stable temperature of 50 °C for 17 hours until constant weight was reached (Royen et al., 2018). Slices were manually turned every 30 minutes during the first 2 hours, then checked every 2 hours thereafter. Trays were rotated between oven shelves every 4 hours to minimise positional effects. The oven's built-in fan maintained air circulation. After drying, slices were transferred into desiccators containing fresh silica gel and cooled for 1 hour (Iammarino et al., 2021). They were packed in aluminium foil, sealed in a paper bag, and stored in a clean, dry cabinet for further analysis.

Proximate analysis

Moisture, ash, fat, fibre, protein, and carbohydrate contents were determined using the AOAC (2016) method. Each analysis was performed in triplicate on subsamples from each drying batch, and results were expressed as mean ± standard deviation.

Determination of mineral components

Nitrogen, phosphorus, potassium, magnesium, calcium, manganese, sodium, zinc, and iron were determined using Atomic Absorption Spectrophotometry (PerkinElmer AAnalyst 400, USA), following AOAC (2016) protocols and the procedure of Ahmed et al. (2019). Lead was also assayed to ensure food safety. All analyses were carried out in triplicate.

Determination of vitamins

Vitamin C and folate were quantified using a UV-Visible spectrophotometer (Shimadzu UV-1800, Japan) according to the method described by Khadka and Pathak (2023). Vitamin A was determined using the spectrophotometric method of Ahmed et al. (2019). β-carotene and lycopene were extracted utilising an acetone–hexane mixture and quantified spectrophotometrically (Abdul-Hammed et al., 2013). All assays were conducted in triplicate, and results were expressed as mean ± standard deviation.

Sample storage

The dried tomato samples were stored for 12 weeks in an aluminium foil bag sealed with a paper bag to prevent absorption of atmospheric moisture.

Data analysis

The data obtained was computed on IBM SPSS Version 20.0. Analysis of Variance (ANOVA) was used to evaluate differences in nutritional composition between the fresh and dried samples. Mean separation was performed using the Duncan Multiple Range Test (DMRT). In contrast, differences in nutritional components before and after storage were determined using the Dependent T-test ($n = 3$, $df = 2$). All significant differences were observed at 5% level of significance.

Results and Discussion

The results of this study revealed significant impacts of drying methods and storage on the nutritional and proximate compositions of tomato fruits. Notably, drying (both sun-drying and oven-drying) effectively reduces moisture, extending shelf life and concentrating essential nutrients.

Effect of drying on the proximate composition of tomato fruits

Table 1 shows the effect of drying on the proximate composition of tomatoes. The results showed that the dried samples had significantly higher proximate components than the fresh ones, except for moisture content, at a $P \leq 0.05$ significance level. The assessment of the proximate composition between the two drying methods revealed that the sun-dried samples had significantly higher crude ash, fibre, protein, and carbohydrate contents than the oven-dried samples. In contrast, the oven-dried samples had higher moisture and crude fat content ($P = 0.000$).

The effect of drying on the proximate composition of tomatoes showed significantly reduced moisture content in both drying methods, with sun-dried samples exhibiting lower moisture than oven-dried samples. This finding aligns with recent studies that suggest drying substantially reduces water activity, thereby limiting microbial growth and enzymatic activity, which are key contributors to spoilage (Olumekun et al., 2022; Omodara et al., 2023). The reduction in moisture content in dried samples also led to a proportional increase in the concentration of other nutrients, as indicated by the significantly higher levels of crude ash, fibre, protein, and carbohydrates. Okereke et al. (2023) also reported similar trends of nutrient densification through dehydration in dried vegetables. Sun-dried samples generally retained higher nutrient levels (excluding fat and moisture) than oven-dried counterparts, possibly due to prolonged exposure to mild thermal stress, which may enhance specific nutrient profiles (Ayodele et al., 2023). However, the slightly higher crude fat content in oven-dried samples might reflect thermal-induced lipid concentration, as observed by Babatunde et al. (2022).

Evaluation of proximate composition of dried tomato chips after 12 weeks of storage

Figure 1 shows the effect of storage on the proximate composition of sun-dried tomato chips. It was observed that after 12 weeks of storage, a significant decrease in moisture content (T = 19.14; P = 0.000), crude ash (T = 18.464; P = 0.000), and fibre (T = 9.666; P = 0.002) occurred. On the other hand, crude fat (T = 3.357; P = 0.044) and carbohydrate (T = 8.746; P = 0.013) increased while in storage, while no significant difference in protein was observed (T = 1.699; P = 0.188). Figure 2 shows the effect of storage on the proximate composition of oven-dried tomato chips. The moisture content and crude fats were observed to increase slightly after storage. No significant difference was, however, observed (P > 0.05). On the other hand, there was a significant increase in carbohydrate content (T = 6.693; P=0.022) and a decrease in crude ash (T = 96.766; P = 0.000) and fibre (T = 20.335; P = 0.000) after storage. There was a slight decrease in Protein after storage; however, no significant decrease was observed (T = 2.846; P = 0.065). In this study, the proximate composition of dried tomatoes was observed to be affected by storage conditions. In sun-dried samples, moisture, ash, and fibre decreased significantly, likely due to moisture loss from desorption and oxidative degradation (Chiemela et al., 2022). Interestingly, carbohydrate level increased, likely due to compositional shifts caused by loss of labile components (Omodara et al., 2023). A similar pattern was observed in oven-dried samples, with carbohydrates increasing significantly after storage (P = 0.022), which aligns with a previous study by Lawal and Olorode (2021) that showed an increase in sugar concentration after long-term storage due to polysaccharide hydrolysis. However, not all studies support this trend. Iammarino et al. (2021) reported a decline in protein level in oven-dried tomato slices during storage, attributing the difference to protein denaturation under oxidative conditions. Similarly, Pravitha et al. (2024) emphasised that storage often results in nutrient degradation rather than enrichment, especially in hot and humid climates.

Table 1: Effect of drying on the proximate composition of tomato fruits

Proximate composition (%)	Fresh sample	Sun-dried	Oven-dried
Moisture Content	94.12 ± 0.00[a]	7.83 ± 0.12[b]	13.00 ± 0.10[c]
Crude Ash	0.58 ± 0.00[d]	5.90 ± 0.44[e]	3.70 ± 0.10f
Crude Fibre	0.67 ± 0.00[g]	3.07 ± 0.04[h]	1.50 ± 0.36[i]
Crude Fat	0.85 ± 0.00[j]	1.05 ± 0.04[k]	1.09 ± 0.04[l]
Crude Protein	0.81 ± 0.00[m]	7.01 ± 0.01[n]	6.30 ± 0.10[o]
Carbohydrates	2.97 ± 0.00[p]	75.12 ± 0.01[q]	74.41 ± 0.00[r]

The values are Mean ± SD in triplicate. Mean values with similar superscripts in a row are not significant.

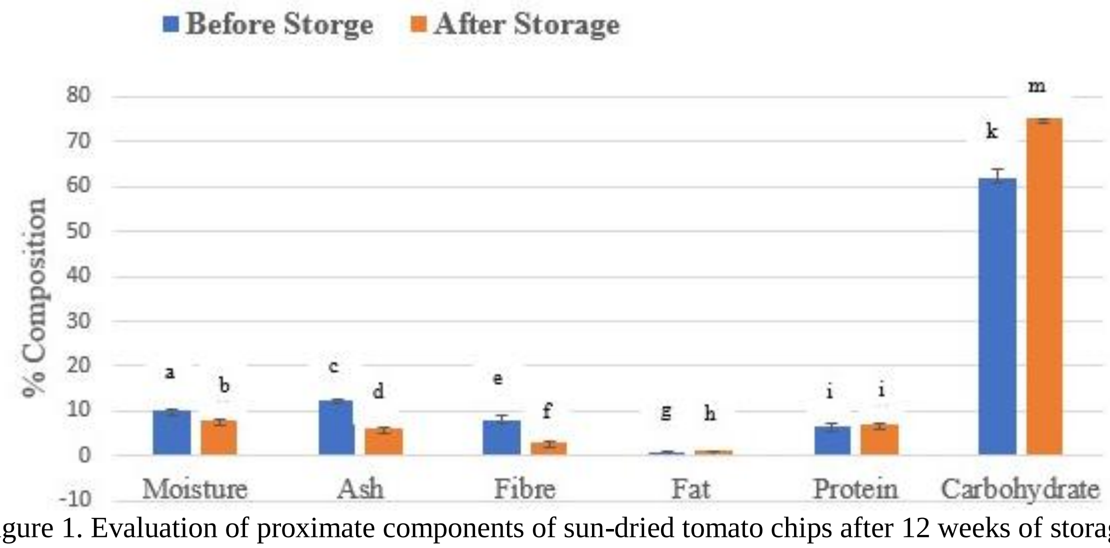

Figure 1. Evaluation of proximate components of sun-dried tomato chips after 12 weeks of storage

The values represent Mean ± SD in triplicate. For each proximate component, Mean values with similar superscripts are not significant.

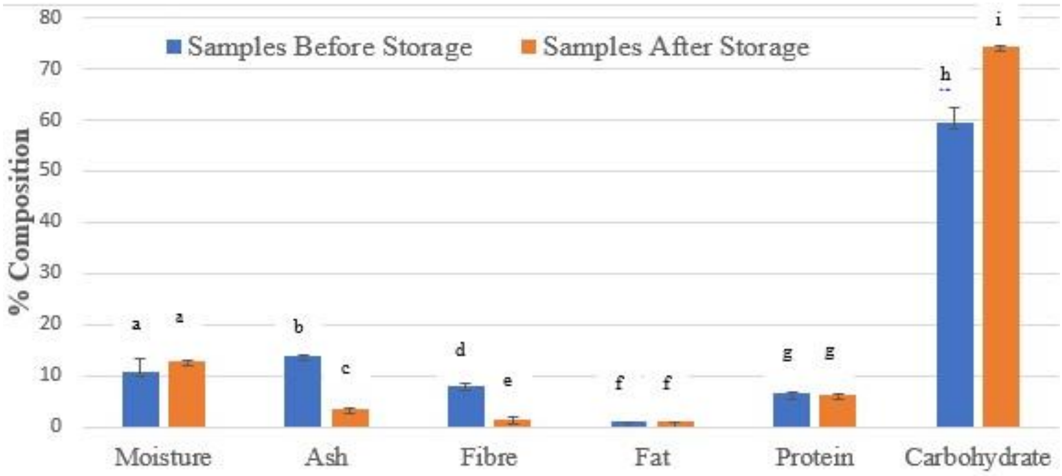

Figure 2. Evaluation of proximate components of oven-dried tomato chips after 12 weeks of storage

The values represent Mean ± SD in triplicate. For each proximate component, Mean values with similar superscripts are not significant.

These contrasting findings suggest that the apparent increases in protein and carbohydrate in the present study may be relative rather than absolute, resulting from the degradation of more labile fractions than actual nutrient gain.

Effect of drying on the mineral and vitamin contents of tomato fruits

The effect of drying on the mineral and vitamin contents of tomato fruits is presented in Table 2. For the mineral composition, the results showed a significant decrease in Phosphorus (P) and Sodium (Na) contents in the sun-dried and oven-dried samples compared to the fresh samples ($P \leq 0.05$). There was also a significant decrease in the Calcium (Ca) and Iron (Fe) contents in the sun-dried samples compared to the fresh sample ($P \leq 0.05$). The results further showed that the dried tomato samples had significantly higher Nitrogen (N), Magnesium (Mg), and Zinc (Zn) contents than the fresh samples ($P \leq 0.05$). When comparing the two drying methods, the oven-dried samples had significantly higher concentrations of Nitrogen (N), Phosphorus (P), Potassium (K), and Iron (Fe) than the sun-dried samples ($P \leq 0.05$). There was, however, no significant difference in Magnesium (Mg) contents between them ($P>0.05$). No Lead (Pb) was observed in the fresh and dried samples. For the vitamin content, there was a significant loss in vitamins A and C, Beta-Carotene, Folate, and Lycopene after drying ($P \leq 0.05$). The comparison of the loss of vitamin A and Folate between the two drying methods showed no significant difference ($P > 0.05$). However, vitamin C, Beta-Carotene, and lycopene contents were higher in the oven-dried samples than the sun-dried samples ($P \leq 0.05$). The impact of drying on mineral and vitamin composition showed that drying considerably altered the mineral profile. Losses in phosphorus, sodium, calcium, and iron, particularly in sun-dried samples, reflect the leaching effect and possible thermal degradation during extended drying (Udeh et al., 2023). Conversely, increased nitrogen, magnesium, and zinc levels in dried samples suggest concentration effects due to moisture removal, which agrees with the results of a similar study by Agbo et al. (2022). Between the two drying methods, oven-drying better preserved minerals such as iron and phosphorus, possibly due to controlled heat exposure that minimised oxidative degradation (Abdullahi et al., 2024). Notably, the absence of detectable lead (Pb) in all samples is consistent with previous reports, which show that tomatoes cultivated under non-industrial conditions rarely accumulate heavy metals at harmful levels (Ahmed et al., 2019; Bala et al., 2023). Similar findings were reported by Abdullahi et al. (2024), who found no Pb residues in dried vegetables processed in rural Nigerian settings. This suggests that both the cultivation environment of the samples and the drying processes employed in this study did not introduce heavy-metal contamination, thereby reinforcing their suitability for safe postharvest preservation.

Vitamins were significantly affected by drying. Vitamins A and C, beta-carotene, folate, and lycopene decreased markedly, consistent with their known heat-labile nature (Ismail et al., 2023). Oven-dried tomatoes retained more vitamin C, beta-carotene, and lycopene than sun-dried ones, possibly due to the shorter exposure time to high temperatures than prolonged sun exposure, which also involves light-induced degradation (Ahmed et al., 2022).

Table 2: Effect of Drying on the Mineral and Vitamin Contents of Tomato Fruits

Mineral/ Vitamin	Concentration		
	Fresh sample	Sun-dried sample	Oven-dried sample
Nitrogen (N) (%)	1.92±0.01^{j}	2.30±0.00^{k}	2.52±0.02^{l}
Phosphorus (P) (mg/100 g)	27.51±0.01^{m}	18.18±0.01^{n}	20.11±0.01^{o}
Magnesium (Mg) (mg/100 g)	19.77±0.01^{b}	21.05±0.03^{a}	21.13±0.07^{a}
Sodium (Na) (mg/100 g)	1.73±0.02^{c}	0.860±0.01^{b}	0.91±0.01^{b}
Potassium (K) (mg/100 g)	167.94±0.06^{cd}	163.26±0.11^{c}	166.07±0.001^{d}
Iron (Fe) (mg/100 g)	0.38±0.01^{p}	0.35±0.01^{q}	0.44±0.02^{r}
Zinc (Zn) (mg/100 g)	1.65±0.01^{a}	1.85±0.01^{e}	1.88±0.02^{e}
Manganese (Mn) (mg/100 g)	0.02±0.00^{f}	0.02±0.00^{f}	0.02±0.03^{f}
Lead (Pb) (mg/100 g)	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
Calcium (Ca) (mg/100 g)	3.80±0.14^{g}	3.92±0.09^{g}	3.08±0.04^{h}
Vitamin C (mg/100 g)	13.57±0.03^{s}	9.70±0.08^{t}	10.03±0.02^{u}
Vitamin A (mg/100 g)	0.049±0.007^{f}	0.018±0.001^{h}	0.021±0.003^{h}
Beta-Carotene (mg/100 g)	26.121±0.025^{v}	13.242±0.001^{w}	14.276±0.036^{x}
Folate (mg/100 g)	0.003±0.00^{y}	0.001±0.000^{i}	0.002±0.001^{i}
Lycopene (mg/100 g)	67.149±0.664^{z}	26.251±0.001^{a}	28.194±0.002^{b}

The values are Mean ± SD in triplicate. Mean values with similar superscripts in a row are not significant.

Effect of Storage on the Mineral and Vitamin Compositions of Dried Tomato Fruits

The T-test results (Table 3) indicate that storage led to significant changes in the mineral and vitamin compositions of sun-dried tomato fruits. For minerals, significant reductions were observed in Phosphorus (P), Sodium (Na), Iron (Fe), and Calcium (Ca), with T-values of 15.167, 16.000, 13.000, and 21.333, respectively ($P \leq 0.05$). Magnesium (Mg) and manganese (Mn) showed no significant difference, with T-values of 11.750 and 6.500, respectively ($P > 0.05$). For vitamins, no significant changes were found in Vitamins A and C, Beta-Carotene, and Folate after storage ($P > 0.05$), while a significant change was observed in Lycopene ($P = 0.012$).

The results also showed the storage effect on the mineral and vitamin compositions of oven-dried tomato fruits. The impact of storage on the minerals shows a significantly reduced concentration of Magnesium (Mg), Sodium (Na), and Calcium (Ca) after storage ($P \leq 0.05$), with T-values of 84.000, 19.000, and 25.000, respectively. The other minerals were relatively stable, with no significant differences observed, even though slightly higher values were obtained before storage ($P > 0.05$). For vitamins, vitamin C and lycopene decreased significantly after storage ($P \leq 0.05$), while Vitamin A, Beta-Carotene, and Folate remained stable, with a slight decrease ($P \leq 0.05$) Storage was observed to influence the stability of the micronutrients, and in sun-dried tomatoes, phosphorus, calcium, sodium, and iron significantly decreased over 12 weeks, which is consistent with mineral loss due to oxidation and handling degradation (Chinedu et al., 2023). In oven-dried samples, similar losses were observed for magnesium, sodium, and calcium, aligning with reports by Ogunsola et al. (2023), who documented mineral leaching and oxidation during the storage of dried fruits. However, not all studies reported significant mineral depletion during storage. Several authors, including Iammarino et al. (2021) and Raghavan et al. (2022), noted that most minerals are non-volatile and structurally stable; thus, apparent decreases can reflect moisture or matrix changes rather than actual elemental loss, while some datasets even show stable or higher post-storage mineral concentrations due to concentration effects as residual moisture declines. Similarly, vitamin stability during storage is context-dependent: under opaque, low-oxygen packaging and calm conditions, vitamin C losses can be minimal, and carotenoids (β-carotene/lycopene) may appear stable or even increase in measured concentration because isomerisation and matrix softening can enhance extractability (Ahmed et al., 2022; Ismail et al., 2023). These contrasting findings suggest that the magnitude and direction of storage effects depend on packaging permeability, residual moisture, headspace oxygen, temperature, and handling, and that the decreases observed in our sun- and oven-dried samples may likely reflect higher oxygen exposure and more extended storage periods relative to studies reporting stability.

Table 3: Effect of storage on the mineral and vitamin compositions of sun-dried and oven-dried tomato fruits

Mineral/ Vitamin	Sun-dried samples			Oven-dried Samples		
	Before Storage	After Storage	P-value	Before Storage	After Storage	P-value
Nitrogen (N) (%)	2.30±0.00	2.25±0.07	0.500	2.52±0.02	2.35±0.07	0.239
Phosphorus (P) (mg/100 g)	18.18±0.01	17.27±0.07	0.042	20.11±0.01	19.12±0.16	0.078
Magnesium (Mg) (mg/100 g)	21.05±0.03	21.52±0.03	0.054	21.13±0.08	20.29±0.64	0.008
Sodium (Na) (mg/100 g)	0.86±0.01	0.54±0.01	0.040	0.91±0.01	0.44±0.02	0.033
Potassium (K) (mg/100 g)	163.26±0.11	163.10±0.67	0.748	166.07±0.01	164.73±0.92	0.291
Iron (Fe) (mg/100 g)	0.35±0.01	0.28±0.01	0.049	0.44±0.02	0.33±0.00	0.090
Zinc (Zn) (mg/100 g)	1.85±0.01	1.56±0.07	0.087	1.88±0.02	1.75±0.00	0.076
Manganese (Mn) (mg/100 g)	0.015±0.07	0.002±0.00	0.097	0.017±0.07	0.016±0.00	0.705
Lead (Pb) (mg/100 g)	0.00±0.00	0.00±0.00	1.000	0.00±0.00	0.00±0.00	1.000
Calcium (Ca) (mg/100 g)	3.92±0.09	2.64±0.01	0.030	3.08±0.04	2.45±0.07	0.025
Vitamin C (mg/100 g)	9.695±0.078	9.520±0.042	0.090	10.03±0.003	9.06±0.001	0.010
Vitamin A (mg/100 g)	0.018±0.001	0.014±0.001	0.070	0.021±0.003	0.010±0.014	0.400
Beta-Carotene (mg/100 g)	13.242±0.001	13.227±0.001	0.231	14.276±0.036	12.900±0.311	0.120
Folate (mg/100 g)	0.0013±0.0004	0.0012±0.001	0.500	0.002±0.000	0.003±0.001	0.334
Lycopene (mg/100 g)	26.257±0.001	26.224±0.001	0.012	28.194±0.002	25.255±0.064	0.009

The values are Mean ± SD in triplicate.

Conclusion

This study was conducted to compare the effects of sun drying and oven drying on the proximate, mineral, and vitamin composition of tomato fruits before and after 12 weeks of storage. The results showed that drying effectively extends tomato shelf life by significantly reducing moisture content and concentrating nutrients. Sun-drying, although widely used, resulted in greater nutrient losses, particularly of heat- and light-sensitive vitamins. In contrast, oven drying provided a more controlled process that better preserved vitamin C, β-carotene, and lycopene, as well as certain minerals such as potassium and iron.

Storage further influenced nutrient retention, with notable decreases in minerals, such as calcium and phosphorus, as well as vitamins, including vitamin C and lycopene. However, the partial stability of β-carotene, folate, and vitamin A suggests that not all micronutrients are equally affected under the applied storage conditions.

These findings confirm that oven-drying offers advantages for small- and medium-scale processors in food-insecure regions where cold storage is not feasible. Nonetheless, nutrient stability depends not only on the drying method but also on packaging and storage conditions. Future research should evaluate alternative preservation techniques such as solar-assisted drying and vacuum packaging, and extend storage trials beyond 12 weeks to better capture long-term stability trends.

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