Comparative Nutritional and Antinutritional Qualities of Local and Breeder Tomato Improved Varieties

ABSTRACT

Tomatoes are a globally consumed fruit valued for their rich nutrients and dietary versatility. This study compared the nutritional and antinutritional properties of three breeder-improved tomato varieties and one local variety using standard AOAC methods. Results indicated that breeder varieties had higher moisture (86.32–90.83%) than the local variety (85.50%), along with superior protein (0.85–2.40% to 1.60%), potassium (47.10–53.20 ppm to 45.00 ppm), and magnesium (5.99–21.56 ppm to 18.50 ppm). Conversely, the local variety exhibited higher carbohydrates (7.10% to 2.70–6.70%). Breeder varieties also demonstrated lower oxalate levels (0.36–1.53 mg/g to 1.90 mg/g) and higher vitamin C content (119.14–194.00 mg/100g to 110.00 mg/100g). Significant differences (α=0.05) were found across most parameters except for ash, moisture, carbohydrates, sodium, and phytic acid. Overall, breeder tomatoes offer enhanced nutritional benefits and reduced antinutritional factors, making them more suitable for dietary and agricultural use compared to local varieties.

Keywords: Antioxidant, Cultivar, Minerals, Nutrient.

1. **INTRODUCTION**

Tomatoes (*Solanum lycopersicum*) are one of the most important horticultural crops globally, serving both as a dietary staple and a key ingredient in various culinary traditions. Originally domesticated in South America, tomatoes have since become a widely cultivated crop across different climates, thanks to their adaptability and nutritional benefits. The fruit is a significant source of vitamins, particularly vitamin C and A, minerals, dietary fiber, and a range of bioactive compounds such as lycopene, flavonoids, and phenolics, which contribute to its health-promoting properties (Bhowmik *et al.*, 2022). The broad appeal of tomatoes lies not only in their versatility but also in their role as a major contributor to human nutrition.

The global tomato market is largely dominated by improved, high-yield varieties developed through breeding programs. These improved varieties are designed to be more resistant to pests and diseases, as well as to offer higher yields under various environmental conditions (Kafkaletou *et al.*, 2024). Local varieties, on the other hand, are often seen as less desirable in commercial agriculture due to their lower productivity and vulnerability to diseases. The nutritional profile of tomatoes is particularly noteworthy for its high concentration of antioxidants, which play a critical role in combating oxidative stress, a condition associated with various chronic diseases including cardiovascular disease, cancer, and neurodegenerative disorders (Garg *et al.*, 2021). Among these antioxidants, lycopene is perhaps the most researched due to its potential health benefits, including reducing the risk of prostate cancer and promoting heart health. Lycopene is responsible for the characteristic red color of ripe tomatoes and has been extensively studied for its biological functions. Recent research continues to explore the multifaceted health benefits of lycopene, with a particular focus on its anti-inflammatory and anticarcinogenic properties (Petya *et al.*, 2021).

In addition to their nutritional advantages, tomatoes have become the focus of scientific investigation aimed at enhancing their qualities through breeding programs. Improved tomato cultivars have been developed to increase yield, disease resistance, and adaptability to changing environmental conditions (Hodgins and Reid 2024). These breeding programs also focus on improving the nutritional content of tomatoes, particularly their vitamin and antioxidant profiles. For instance, breeder-improved varieties are often fortified with higher levels of vitamins and minerals compared to their local or traditional counterparts (Jiang *et al.,* 2021). However, local varieties, while often less productive or resistant to diseases, can sometimes offer superior taste and nutritional qualities. Comparative studies between local and breeder-improved varieties of tomatoes have become increasingly important as researchers seek to balance agricultural productivity with nutritional quality (Kumar *et al.,* 2023).

Tomatoes are celebrated for their rich nutrient profile, which makes them an essential part of a balanced diet. They are an excellent source of vitamins A, C, K, and a variety of B vitamins, including folate. Moreover, they provide important minerals such as potassium, magnesium, and phosphorus (Ayaz *et al.,* 2022). The high vitamin C content in tomatoes enhances immune function, while vitamin A is crucial for maintaining healthy vision, skin, and immune defenses (Ballester *et al.,* 2024). Potassium, one of the primary minerals in tomatoes, supports heart health by helping to regulate blood pressure and prevent cardiovascular diseases. Recent studies have also highlighted the role of potassium in reducing the risk of stroke, with tomatoes being a natural, low-calorie source of this essential mineral (Moretti *et al.,* 2021). The aim of this study is to conduct a comparative evaluation of the nutritional and antinutritional qualities of local and breeder-improved tomato varieties.

2. MATERALS AND METHODS

Sample Collection

Tomato samples were collected; three breeder-improved varieties were sourced from National Horticultural Research Institute (NIHORT) and one local variety from Iree market. The samples underwent a series of analyses to evaluate their nutritional and antinutritional content. Standard methods as outlined by the Association of Official Analytical Chemists (AOAC, 1990) were employed throughout the experiment.

Sample Preparation

Fresh and mature tomatoes from each variety are selected and thoroughly washed to remove dirt and pesticides, then air-dried (Ashraf *et al.,* 2020). They are cut into small pieces and homogenised to create a uniform sample, ensuring that all parts, including the skin and seeds, are represented (Ayaz *et al.,* 2022). The homogenised samples are stored in airtight containers, with sensitive compounds like vitamin C protected by freezing at -20°C until analysis. For proximate composition, some samples were dried using an oven to remove moisture and then ground into powder. 10 g each of the dried and fresh samples is weighed, labelled, and prepared for analysis in duplicates to ensure accuracy (Ayaz *et al.,* 2022).

Proximate Analysis

Proximate analysis was carried out to measure the moisture, ash, fat, crude fibre, protein, and carbohydrate content of each sample. Moisture content was determined using the gravimetric method, wherein samples were oven-dried at 105°C until a constant weight was reached. The ash content was measured by incinerating samples at 550°C for four hours in a muffle furnace and weighing the residue. Fat content was extracted using the Soxhlet method with petroleum ether as the solvent, while crude fibre was determined by boiling the samples first in 1.25% sulphuric acid and then in 1.25% sodium hydroxide. Protein content was determined using the Kjeldahl method, which involved measuring nitrogen content and multiplying it by a factor to estimate the protein concentration. Carbohydrate content was calculated by difference, subtracting the total of moisture, ash, fat, protein, and crude fibre from 100% (AOAC, 1990).

Minerals Analysis

Mineral analysis was performed using both flame photometry and atomic absorption spectrophotometry (AAS). Sodium (Na) and potassium (K) concentrations were measured using a flame photometer, while calcium (Ca), magnesium (Mg), iron (Fe), and manganese (Mn) were analysed using AAS (Pearson, 1976).

Vitamin C Analysis

Vitamin C content was determined through a titration method using 2,6-dichlorophenolindophenol, which is commonly used to quantify ascorbic acid in food samples. The results were recorded when a distinct colour change was observed, indicating the endpoint of the titration (James, 1996).

Antinutritional Analysis

The antinutritional factors were also assessed. Phytates were determined using the Young and Greaves method, which involved soaking the sample in hydrochloric acid (HCl) and titrating with ferric chloride ($FeCl_3$) (Young and Greaves, 1940). Oxalates were measured by titration with potassium permanganate ($KMnO_4$) after extraction with sulphuric acid (Day and Underwood, 1986). Tannin content was estimated using the Van-Burden and Robinson method by reacting the sample with ferric chloride and potassium ferrocyanide. The absorbance was measured at 120 nm using a spectrophotometer. Phenols were quantified with the Folin-Ciocalteu reagent, and absorbance was read at 700 nm (Singleton *et al.*, 1999). Phytic acid levels were calculated from the phytate titration results using a conversion factor.

Statistical Analysis

Data were analysed using Analysis of Variance (ANOVA) to assess significant differences in the nutritional and anti-nutritional qualities between the tomato varieties. The mean values of each parameter were compared using the Duncan's Multiple Range Test at a 5% significance level.

3. RESULTS

Table 1: Proximate Analysis (%) of Breeded Improved and Local Tomato

Parameter	Tom 1	Tom 2	UC	Iree Tomato	P-Value
Ash Content	1.223±0.023	0.994±0.020	1.526±0.022	1.45±0.023	0.080
Moisture Content	86.322±2.150	90.833±2.140	88.837±2.170	85.5±2.130	0.230
Fat Content	1.296±0.080	2.878±0.083	0.995±0.083	1.1±0.084	0.0001
Crude Fibre Content	2.062±0.023	1.730±0.022	2.120±0.020	2.3±0.021	0.010
Protein Content	2.403±0.064	1.177±0.064	0.850±0.064	1.6±0.064	0.002
Carbohydrate (By Difference)	6.694±0.187	2.705±0.187	5.672±0.187	7.1±0.187	0.640

Legend:

Tom 1 (Breeder improved varietie)

Tom 2 (Breeder improved varietie)

UC (Breeder improved varietie)

Iree Tomato (Iree Local Varietie)

± Standard error of means of three experiments

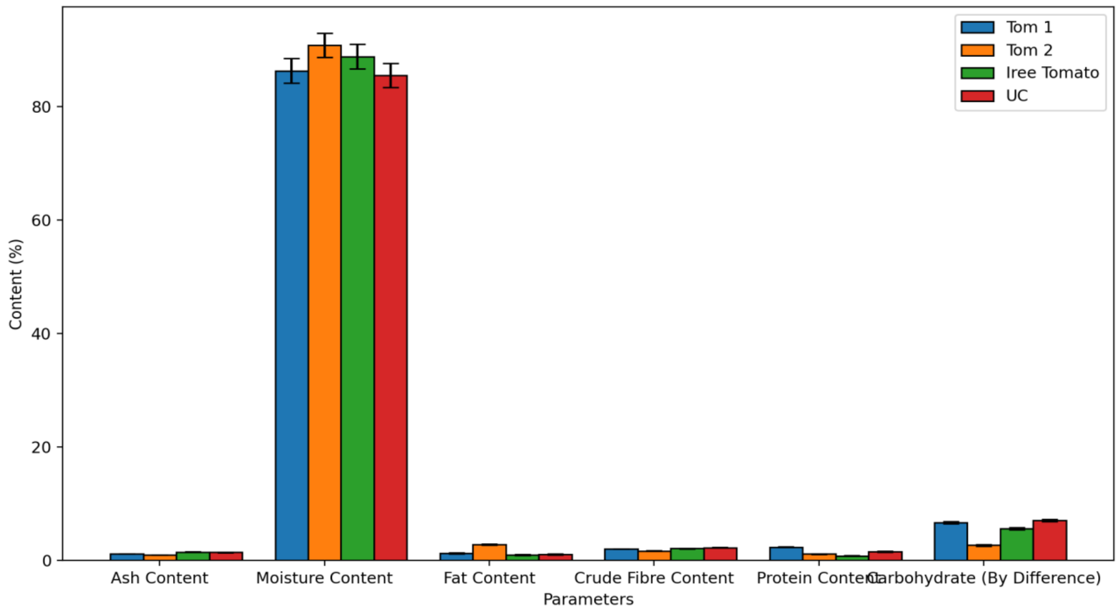

Figure 1: Graph of Proximate Analysis of Breeded Improved and Local Tomato

Legend:

Tom 1 (Breeder improved varietie)

Tom 2 (Breeder improved varietie)

UC (Breeder improved varietie)

Iree Tomato (Iree Local Varietie)

Table 2: Minerals Analysis (ppm) of Breeded Improved and Local Tomato

Parameter	Tom 1	Tom 2	UC	Iree Tomato	P-Value
Sodium (Na)	33.108±0.100	31.200±0.100	37.180±0.100	35.0±0.100	0.350
Potasium (K)	49.511±0.100	47.103±0.100	53.200±0.100	45.0±0.100	0.020
Calcium (Ca)	8.000±0.070	11.994±0.070	9.990±0.070	10.5±0.070	0.030
Magnesium (Mg)	13.193±0.100	21.556±0.100	5.997±0.100	18.5±0.100	0.001
Iron (Fe)	2.015±0.005	2.024±0.005	2.008±0.005	1.012±0.005	0.0001
Manganeses (Mn)	2.020±0.004	2.029±0.004	2.010±0.004	1.015±0.004	0.00001

Legend:

Tom 1 (Breeder improved varietie)

Tom 2 (Breeder improved varietie)

UC (Breeder improved varietie)

Iree Tomato (Iree Local Varietie)

± Standard error of means of three experiments

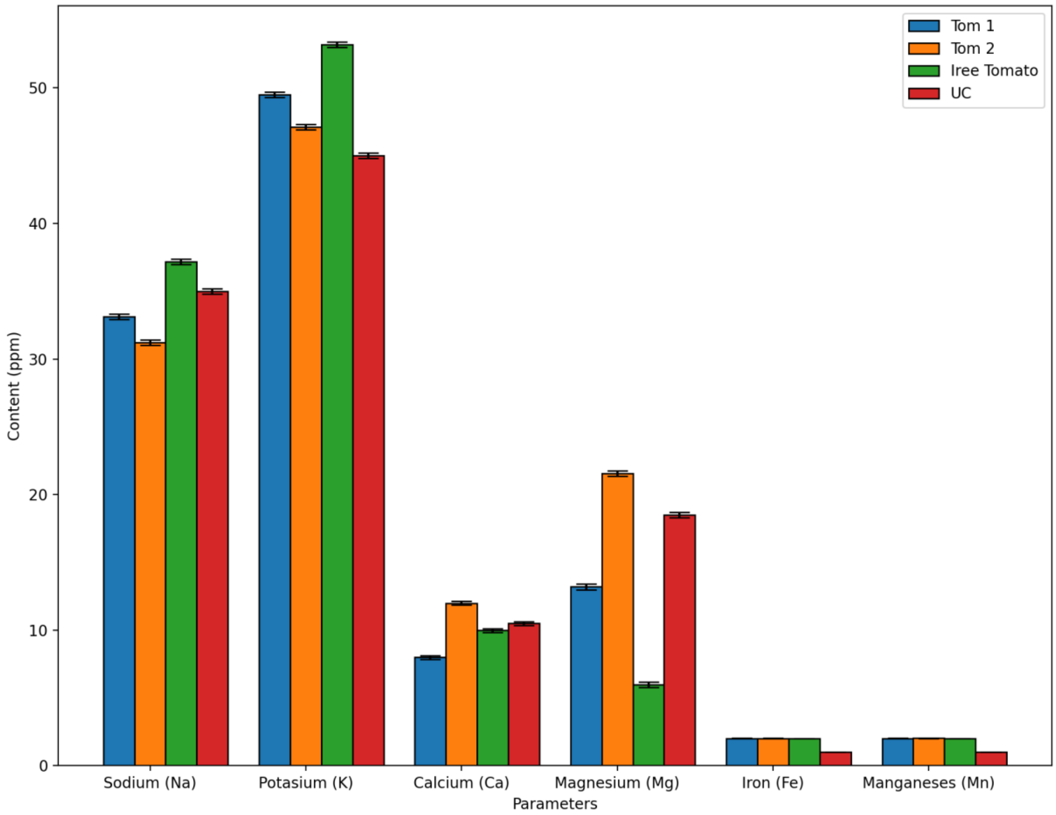

Figure 2: Graph of Mineral Analysis of Breeded Improved and Local Tomato

Legend:

Tom 1 (Breeder improved varietie)

Tom 2 (Breeder improved varietie)

UC (Breeder improved varietie)

Iree Tomato (Iree Local Varietie)

Table 3: Anti-Nutrients Analysis of Breeded Improved and Local Tomato

Parameter	Tom 1	Tom 2	UC	Iree Tomato	P-Value
Phytates (Mg/g)	7.290±0.080	6.180±0.080	5.768±0.080	6.5±0.080	0.020
Oxalates (Mg/g)	1.350±0.005	0.360±0.005	1.530±0.005	1.9±0.005	0.010
Tannins (Mg/g)	0.467±0.001	0.581±0.001	0.702±0.001	0.6±0.001	0.040
Phenols (%)	11.675±0.100	14.525±0.100	17.550±0.100	15.5±0.100	0.005
Phytic Acids (Mg/g)	2.052±0.005	1.716±0.005	1.584±0.005	1.7±0.005	0.060

Legend:

Tom 1 (Breeder improved varietie)

Tom 2 (Breeder improved varietie)

UC (Breeder improved varieties)

Iree Tomato (Iree Local Varietie)

± Standard error of means of three experiments

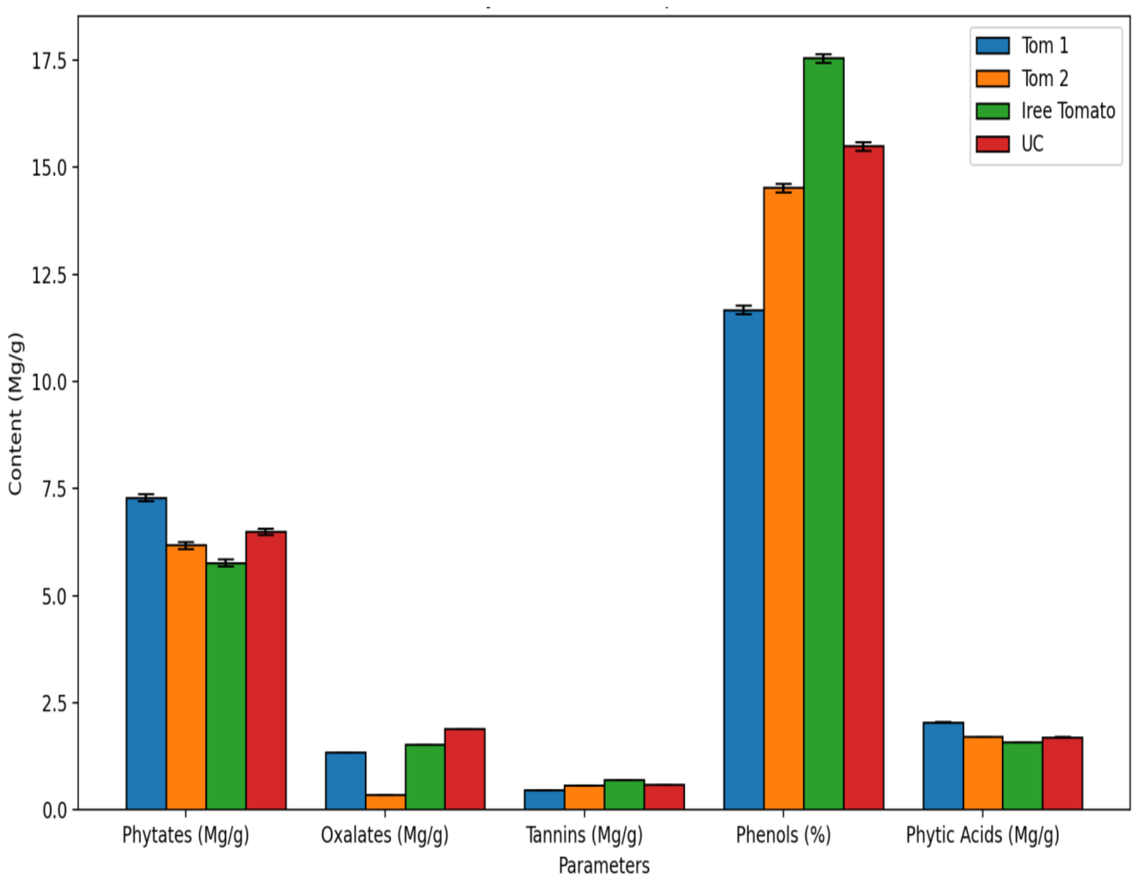

Figure 3: Graph of Antinutrient Analysis of Breeded Improved and Local Tomato

Legend:

Tom 1 (Breeder improved varieties)

Tom 2 (Breeder improved varieties)

UC (Breeder improved varieties)

Iree Tomato (Iree Local Varietie)

Table 4: Vitamin C Analysis of Breeded Improved and Local Tomato

Parameter	Tom 1	Tom 2	UC	Iree Tomato
Vitamin C Content	172.196±1.20	194.003±1.20	119.140±1.20	110.0±1.20

Legend:

Tom 1 (Breeder improved varieties)

Tom 2 (Breeder improved varieties)

UC (Breeder improved varieties)

Iree Tomato (Iree Local Varietie)

± Standard error of means of three experiments

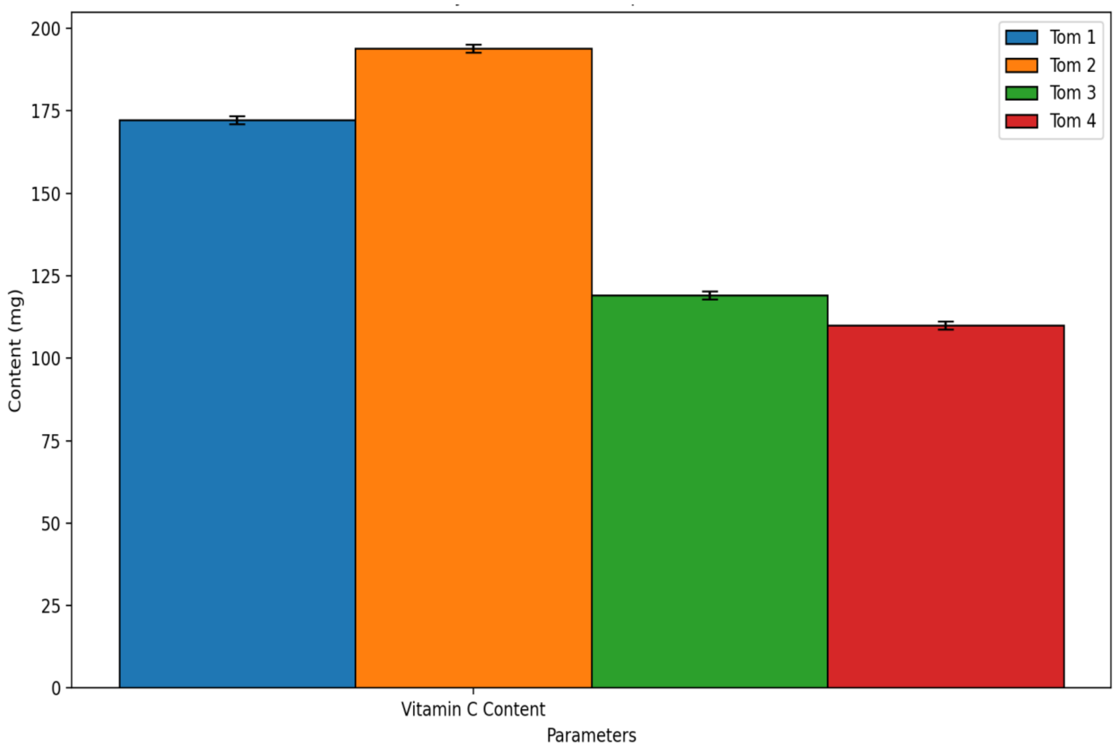

Figure 4: Graph of Vitamins C Analysis of Breeded Improved and Local Tomato

Legend:

Tom 1 (Breeder improved varieties)

Tom 2 (Breeder improved varieties)

UC (Breeder improved varieties)

Iree Tomato (Iree Local Varietie).

Discussion

Tomatoes (*Solanum lycopersicum*) are among the most important horticultural crops globally, functioning as both a dietary staple and a key ingredient in diverse culinary traditions. They are a rich source of essential nutrients, including vitamins C and A, minerals, dietary fiber, and bioactive compounds such as lycopene, flavonoids, and phenolics, which contribute significantly to their health-promoting properties (Bhowmik *et al.,* 2022). This study examined the proximate composition, mineral content, vitamin C levels, and antinutritional factors of three breeder-improved varieties and one local variety using standard AOAC methods. The proximate composition of the four tomato varieties three breeder-improved (Tom 1, Tom 2, and UC) and one local variety (Iree Tomato) is presented in Table 1. The analysis focused on ash content, moisture content, fat content, crude fiber content, protein content, and carbohydrates. Ash content, indicative of total mineral concentration, varied across the varieties. UC exhibited the highest ash content (1.526%), followed by the local Iree Tomato (1.450%), Tom 1 (1.223%), and Tom 2 (0.994%). These values suggest UC offers a more robust mineral profile, which is essential for physiological functions such as bone health and fluid balance. Comparatively, fruits like apples (0.3%) and bananas (1%) have lower ash content, reflecting their reduced mineral concentrations (Garcia *et al.,* 2022).

Moisture content is a critical determinant of freshness and shelf life. The improved varieties Tom 1 and UC demonstrated high moisture content (86.322% and 90.833%, respectively), while the Iree Tomato had a lower moisture content of 85.500%. Higher moisture levels enhance sensory qualities like taste and texture but may dilute nutrient concentrations, aligning with findings by Smith and Brown (2021) that fruit freshness often correlates with higher moisture. The fat content of tomatoes, though generally low, contributes to flavor and nutrient absorption. The fat content ranged from 0.995% (UC) to 2.878% (Tom 2), with the local Iree Tomato containing 1.100%. In comparison, high-fat fruits like avocados contain approximately 15% fat. The relatively low fat content across all varieties supports calorie-conscious diets while aiding the absorption of fat-soluble vitamins (A, D, E, and K).

Crude fiber content, essential for digestive health, was highest in the Iree Tomato (2.300%), followed by the improved varieties, which ranged from 1.730% to 2.120%. This finding positions Iree Tomato as a particularly beneficial option for enhancing digestive health, promoting satiety, and regulating bowel movements. Protein content, a vital macronutrient for growth and repair, was highest in Tom 1 (2.403%), followed by the Iree Tomato (1.600%) and UC (0.850%). These values suggest that breeder-improved varieties could contribute to enhanced nutritional value, especially for plant-based diets where protein sources are limited.

Carbohydrate content, a primary energy source, was highest in the Iree Tomato (7.100%) and lowest in Tom 2 (2.705%). While tomatoes generally have lower carbohydrate levels compared to fruits like apples (13.8%) and bananas (23%), the Iree Tomato's higher carbohydrate content makes it suitable for consumers requiring higher energy intake.

The mineral composition analysis revealed variations in sodium, potassium, calcium, magnesium, iron, and manganese levels among the tomato varieties. Sodium levels ranged from 31.200 ppm (Tom 2) to 37.180 ppm (UC), with the Iree Tomato at 35.0 ppm. These minor differences suggest all varieties contribute to dietary sodium intake, aligning with the recommended balance to avoid excessive consumption (Garcia *et al.*, 2022).

Potassium levels were highest in UC (53.200 ppm), followed by Tom 1 (49.511 ppm), Tom 2 (47.103 ppm), and Iree Tomato (45.0 ppm). The enhanced potassium content in breeder-improved varieties underscores their potential benefits for heart health and muscle function (Jones *et al.,* 2023). Calcium content was most abundant in Tom 2 (11.994 ppm), with the Iree Tomato showing 10.5 ppm. Calcium, crucial for bone health, varied significantly, reflecting the impact of selective breeding practices. Similarly, magnesium levels were highest in Tom 2 (21.556 ppm) and lowest in UC (5.997 ppm), demonstrating the potential of breeding to influence nutritional profiles. Iron levels were relatively low across all varieties, with Tom 1 at 0.015 ppm and UC at 0.008 ppm. These levels highlight the need for targeted breeding strategies to enhance iron bioavailability in tomatoes.

The analysis of antinutritional factors, including phytates, oxalates, and tannins, revealed significant variations. Phytate levels were highest in Tom 1 (7.290 mg/g) and lowest in UC (5.768 mg/g). Oxalate content was notably lower in Tom 2 (0.360 mg/g), while the Iree Tomato exhibited higher levels (1.9 mg/g). These findings suggest that breeder varieties may present challenges in mineral bioavailability due to elevated levels of phytates and oxalates (Sanchez *et al.,* 2024). Tannin levels were highest in UC (0.702 mg/g), potentially impacting protein and mineral absorption negatively. Despite these challenges, the breeder-improved varieties demonstrated higher phenolic content, with UC recording the highest level (17.550%), highlighting their antioxidant properties (Sanchez *et al.,* 2024).

Vitamin C content varied significantly, with Tom 2 exhibiting the highest level (>200 mg/100g), showcasing the advantages of breeding practices in enhancing nutrient density (Gavrielidou *et al.*, 2024). Conversely, the Iree Tomato had the lowest Vitamin C content, indicating the need for agricultural improvements to boost nutrient profiles in traditional varieties. Significant differences (α = 0.05) were observed in parameters such as fat content, crude fiber, protein, potassium, calcium, magnesium, iron, manganese, phytates, oxalates, tannins, and phenolic content among the tomato varieties. However, ash, moisture, carbohydrate, sodium content, and phytic acids did not vary significantly. These findings highlight the nutritional advantages of improved tomato varieties while underlining the unique benefits of local varieties like Iree Tomato, particularly in fiber and carbohydrate content.

4. CONCLUSION AND RECOMMENDATION

The comparative evaluation of improved and local tomato varieties demonstrates that improved varieties, particularly Tom 2 and UC, generally exhibit superior nutritional qualities, such as higher moisture, protein, and mineral content, along with reduced antinutritional factors. However, the local Iree Tomato still shows potential, particularly in its carbohydrate content and phenolic compounds, which contribute to antioxidant properties. The study highlights the benefits of breeding programs in enhancing nutrient profiles and minimising antinutritional factors in improved varieties. Despite its lower nutrient profile, the local variety remains valuable, with scope for improvement through breeding. Continued breeding efforts should focus on enhancing the nutritional quality of local tomato varieties by increasing their vitamin and mineral content while reducing antinutritional factors. This will improve their nutrient bioavailability. Additionally, public education campaigns should encourage the consumption of both improved and local varieties, promoting a balanced approach to diet.

ACKNOWLEDGEMENTS

I express my sincere gratitude to the National Horticultural Research Institute (NIHORT) for providing the breeder-improved tomato varieties used in this study. Special thanks to the Department of Science Laboratory Technology at Osun State Polytechnic, Iree, for access to laboratory facilities and technical support during the research. Additionally, I appreciate the efforts of my supervisors and co-supervisor at Lead City University, Ibadan, and Bamidele Olumilua University of Education, Science and Technology, Ikere-Ekiti, for their supervision, invaluable insights and contributions to manuscript preparation. There is no sponsorship from any agency at all, so no involvement in the interpretation of data or writing of the manuscript.

AUTHORS' CONTRIBUTION'S

Abejoye Olayinka Abidemi conducted laboratory experiments, collected and analyzed the data, and contributed to the writing and drafting of the manuscript. **Bamkefa Bukola Ayodeji** cordinate **s**upervision, data curation, writing- reviewing, editing visualization and reviewed the manuscript for intellectual content. **Olowe Busayo Mutiat** supervised data collection, validated the results, and provided critical feedback that helped shape the research. Assisted. All authors read and approved the final version of the manuscript.

DISCLAIMER

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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