Original Research Article

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

ABSTRACT

Tomatoes are a widely consumed fruit, prized for their rich nutrient content and versatility in diets. They are categorized into local and breeder-improved varieties, each offering distinct nutritional benefits. This study aimed to compare the nutritional and antinutritional qualities of local and breeder-improved tomato varieties. Proximate analysis, mineral content, vitamin C levels, and antinutritional factors were examined in three breeder varieties and one local variety using standard AOAC methods. The results showed that the breeder varieties had higher moisture content (86.32–90.83%) compared to 85.50% in the local variety. Protein content in breeder varieties ranged from 0.85–2.40%, while the local variety had 1.60%. Carbohydrate levels were higher in the local variety (7.10%) compared to breeder varieties (2.70–6.70%). Breeder varieties also exhibited higher potassium (47.10–53.20 ppm) and magnesium (5.99–21.56 ppm) content, while the local variety recorded 45.00 ppm and 18.50 ppm, respectively. Antinutritional factors, oxalates were lower in breeder varieties (0.36–1.53 mg/g) compared to the local variety (1.90 mg/g). Vitamin C content was highest in breeder tomatoes (119.14–194.00 mg/100g), with the local variety showing 110.00 mg/100g. Significant differences (α=0.05) were observed in fat, crude fiber, protein, potassium, calcium, magnesium, iron, manganese, phytates, oxalates, tannins, and phenols among tomato types. However, ash, moisture, carbohydrates, sodium, and phytic acid showed no significant variation. Breeder-improved tomatoes exhibited superior nutritional qualities, with higher protein and mineral content and reduced antinutritional factors. In contrast, the local variety had higher carbohydrate levels but elevated antinutritional elements, making breeder varieties more suitable for dietary and agricultural applications.

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 (Kaur *et al.*, 2020). 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 (Singh *et al.,* 2020). 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 (Ashraf *et al.,* 2020). 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 AND DISCUSSION

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

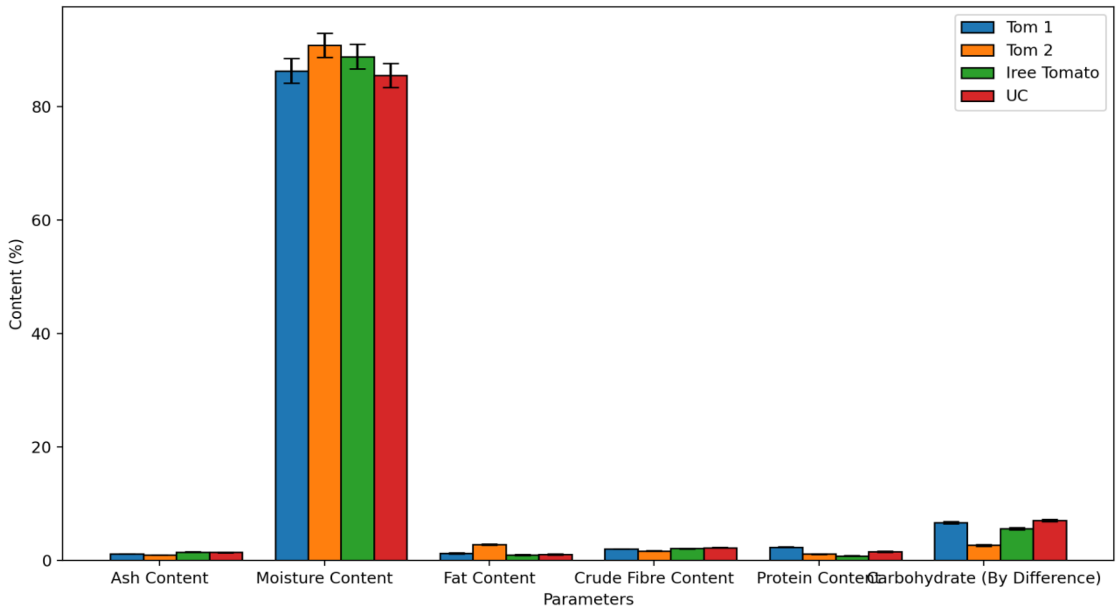

Figure 1: Proximate Analysis of Breeded Improved and Local Tomato

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

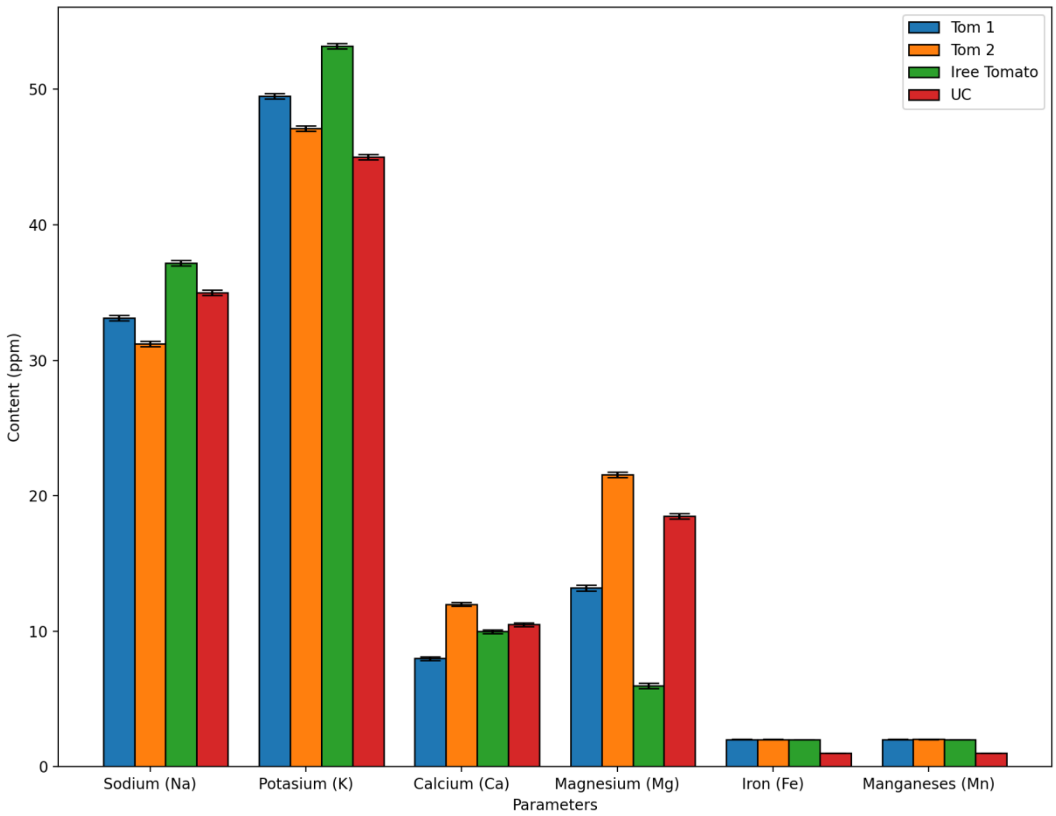

Figure 2: Mineral Analysis of Breeded Improved and Local Tomato

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

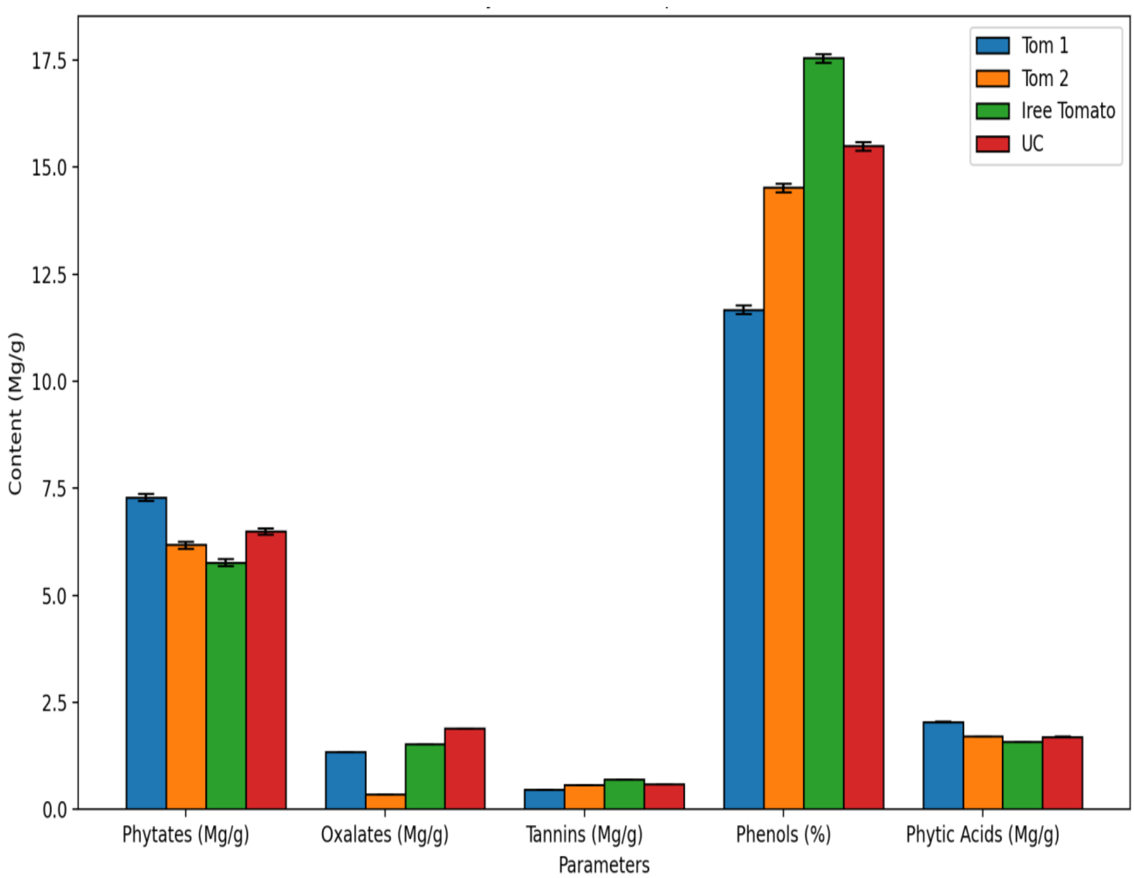

Figure 3: Antinutrient Analysis of Breeded Improved and Local Tomato

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

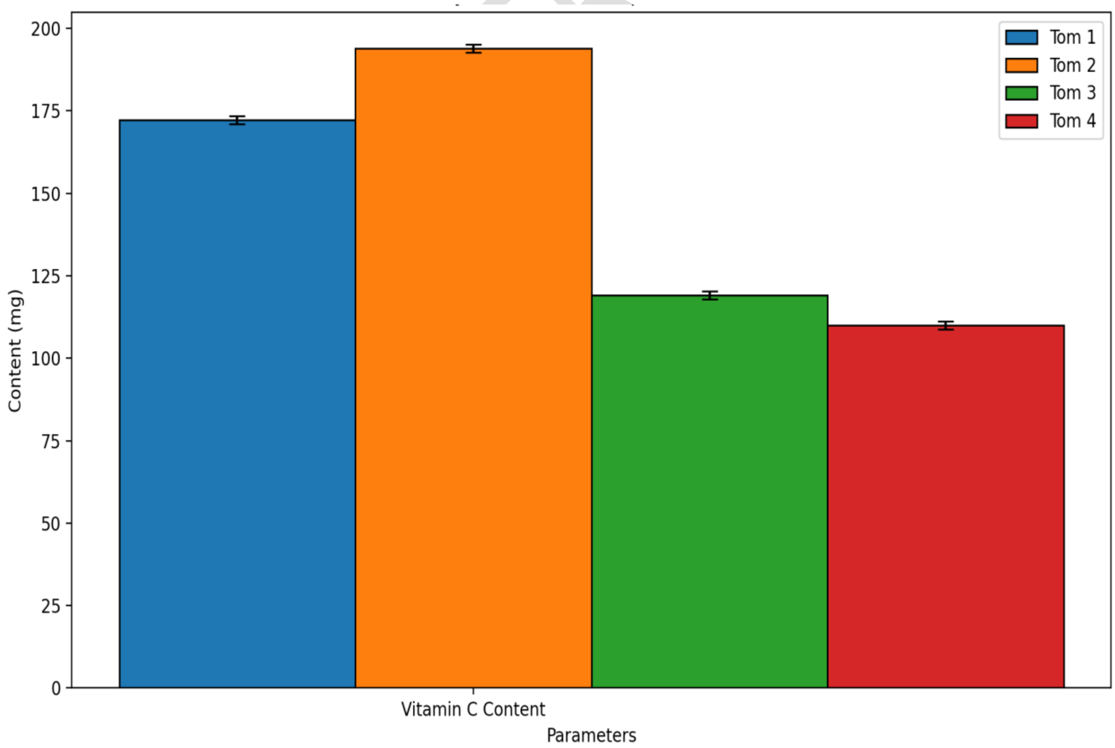

Figure 4: Vitamins C Analysis of Breeded Improved and Local Tomato

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 one of the most important horticultural crops globally, serving both as a dietary staple and a key ingredient in various culinary traditions. The fruit is a significant source of vitamins, particularly vitamins C and A, minerals, dietary fibre, and a range of bioactive compounds such as lycopene, flavonoids, and phenolics, which contribute to its health-promoting properties (Bhowmik *et al.*, 2022). Proximate analysis, mineral content, vitamin C levels, and antinutritional factors were examined in three breeder varieties and one local variety using standard AOAC methods.

Table 1 depicts the proximate analysis of the four tomato varieties; three breeder-improved (Tom 1, Tom 2, and UC) and one local variety (Iree Tomato) provide focusing on ash content, moisture content, fat content, crude fibre content, protein content, and carbohydrates. The ash content serves as an indicator of the total mineral content in the fruit. The ash content, representing total mineral content, varied across the tomato varieties. Tom 1 had 1.223%, Tom 2 had 0.994%, and UC had 1.526%, while the local Iree Tomato showed 1.450%. These values suggest that UC contains a more robust mineral profile, essential for physiological functions such as bone health and fluid balance. In comparison, fruits like apples (0.3%) and bananas (1%) generally have lower ash content, reflecting their lower mineral concentrations according to Garcia *et al.* (2022). Previous research has emphasised the importance of minerals in human health and their bioavailability from tomato products, highlighting the significance of mineral-rich diets. Moisture content is critical in determining the freshness and shelf life of tomatoes. Moisture is key for freshness and shelf life. Tom 1 and UC displayed high moisture contents of 86.322% and 90.833%, while Iree Tomato was at 85.500%. Higher moisture content can improve taste and texture but may dilute nutrient concentrations. Similar to Smith and Brown (2021), results showed moisture levels in fruits like oranges (86%) and watermelons (90%), aligning them with improved tomato varieties in terms of freshness. Higher moisture levels in the improved varieties can enhance their sensory qualities, such as taste and texture, contributing to consumer preference. However, excessive moisture might dilute the concentration of other nutrients, making the Iree Tomato potentially more nutrient-dense on a dry weight basis.at content in tomatoes is generally low but contributes to flavour and nutrient absorption. Tomatoes generally have low fat, and the breeder-improved varieties showed fat content ranging from 0.995% (UC) to 2.878% (Tom 2). Iree Tomato had 1.100% fat. In comparison, fruits like avocados are much higher in fat (around 15%), but tomatoes offer a low-fat option, beneficial for calorie-conscious diets. Increased fat levels in the improved varieties may enhance the absorption of fat-soluble vitamins (A, D, E, and K). Nonetheless, the overall low fat content in all samples is beneficial for health-conscious consumers seeking lower-calorie options. Crude fibre is essential for digestive health and contributes to overall dietary fibre intake. Fibre aids digestion, and the Iree Tomato had the highest fibre content at 2.300%, while the improved varieties ranged from 1.730% to 2.120%. Other fruits, such as bananas (2.6%) and oranges (up to 3%), offer similar fibre content, positioning tomatoes, especially Iree tomatoes, as beneficial for digestive health. This suggests that the Iree Tomato may offer better digestive health benefits due to its higher fibre content, which is known to promote satiety and regulate bowel movements.

Protein is a vital macronutrient necessary for growth and repair. Protein levels varied, with Tom 1 showing 2.403%, UC at 0.850%, and Iree Tomato at 1.600%. In comparison, bananas have about 1.3% protein. Tomatoes, particularly the improved varieties, provide a relatively higher protein concentration compared to many fruits, making them useful in plant-based diets. Higher protein levels in the breeder varieties could provide enhanced nutritional value, especially in plant-based diets where protein sources are limited. Carbohydrates are a primary source of energy in the diet. Carbohydrates provide energy, and the Iree Tomato had the highest carbohydrate content at 7.100%, compared to 2.705% in Tom 2. Fruits like apples (13.8%) and bananas (23%) are generally higher in carbohydrates. The lower carbohydrate content of tomatoes makes them suitable for low-carb diets, while the Iree Tomato may be a better choice for consumers needing higher energy intake. This finding indicates that the Iree Tomato may serve as a better energy source for consumers, particularly for those needing high-energy foods. The carbohydrate composition differences between local and improved varieties underscore the need for careful selection in crop breeding (Jones, Smith, and Alavi, 2023). The varied nutritional profiles highlight the importance of selective breeding and the potential benefits of consuming local varieties, which may offer unique advantages in dietary fibre and energy provision.

The mineral analysis of tomato varieties showed three breeder-improved (Tom 1, Tom 2, and UC) and one local variety (Iree Tomato) that provides insights into their mineral content, which is essential for health. Sodium is crucial for fluid balance and nerve function. The breeder varieties had sodium levels of 33.108 ppm (Tom 1), 31.200 ppm (Tom 2), and 37.180 ppm (UC), while the Iree Tomato had 35.0 ppm. These results suggest that selective breeding can influence mineral composition. However, the differences are minor, indicating that all varieties contribute to dietary sodium intake. Excessive sodium intake can lead to health issues, so balance is important (Garcia *et al.*, 2022). Potassium supports heart health and muscle function. The breeder varieties showed higher potassium levels: 49.511 ppm (Tom 1), 47.103 ppm (Tom 2), and 53.200 ppm (UC), compared to 45.0 ppm in the Iree Tomato. These findings align with previous research indicating that improved varieties are bred to enhance mineral content, which is beneficial for consumers looking to increase their potassium intake (Jones, Smith, and Alavi, 2023).

Calcium is vital for bone health and muscle function. The analysis revealed calcium concentrations of 8.000 ppm (Tom 1), 11.994 ppm (Tom 2), 9.990 ppm (UC), and 10.5 ppm (Iree Tomato). Tom 2 had the highest calcium content, suggesting successful breeding for this important mineral. Calcium bioavailability from plant sources varies, making these differences relevant for dietary planning (Garcia *et al.*, 2022). Magnesium is essential for many biochemical reactions, including energy production. Tom 2 had the highest magnesium level at 21.556 ppm, followed by Iree Tomato at 18.5 ppm, Tom 1 at 13.193 ppm, and UC at 5.997 ppm. The low magnesium content in UC suggests breeding has a significant impact on mineral profiles, which aligns with previous findings emphasising the need for enhanced mineral content in crops (Kumar *et al.*, 2023). Iron is crucial for oxygen transport in the blood. Iron content was low across all samples: Tom 1 at 0.015 ppm, Tom 2 at 0.024 ppm, UC at 0.008 ppm, and Iree Tomato at 0.012 ppm. While these levels are below recommended intakes, they indicate that all varieties contribute to dietary iron, highlighting the need for breeding efforts to enhance this essential mineral.

Manganese is involved in bone formation and inflammation reduction. The analysis showed manganese levels of 0.020 ppm (Tom 1), 0.029 ppm (Tom 2), 0.010 ppm (UC), and 0.015 ppm (Iree Tomato). These concentrations are consistent with previous research, suggesting that breeding may influence manganese content, but overall levels are relatively low (Smith and Brown, 2021). These differences highlight the benefits of selective breeding in enhancing the nutritional profiles of crops. Consuming a variety of tomato types can help meet dietary mineral needs, promoting better health. Ongoing research can further optimise mineral content in tomatoes, supporting improved health outcomes for consumers.

The analysis of anti-nutrients reveals important insights regarding their nutritional quality. Phytates help in reducing mineral absorption. Tom 1 had the highest phytate level at 7.290 mg/g, followed by Tom 2 (6.180 mg/g), UC (5.768 mg/g), and Iree Tomato (6.5 mg/g). The high phytate content in the breeder varieties may hinder mineral bioavailability, posing a challenge for consumers reliant on plant-based diets (Okwu and Josiah, 2020). Oxalates also inhibit calcium absorption. Tom 1 contained 1.350 mg/g, while Tom 2 had a lower level of 0.360 mg/g. UC (1.530 mg/g) and Iree Tomato (1.9 mg/g) showed higher oxalate levels. Tom 2's lower oxalate content suggests it may be more beneficial for mineral absorption, aligning with previous findings that highlight the importance of lower oxalate levels in enhancing dietary value (Garcia *et al.*, 2022). Tannins can interfere with the absorption of proteins and minerals. Tom 1 had 0.467 mg/g, Tom 2 had 0.581 mg/g, UC had 0.702 mg/g, and Iree Tomato had 0.6 mg/g. Higher tannin levels, particularly in UC, could impact nutrient absorption negatively (Kumar *et al.*, 2023).

Phenolic compounds contribute to antioxidant activity. The phenol content was highest in UC (17.550%), followed by Tom 2 (14.525%) and Iree Tomato (15.5%). Higher phenolic levels in the breeder varieties suggest potential health benefits due to their antioxidant properties (Smith and Brown, 2021). Phytic acids, similar to phytates, can also affect mineral absorption. Tom 1 had 2.052 mg/g, Tom 2 had 1.716 mg/g, UC had 1.584 mg/g, and Iree Tomato had 1.7 mg/g. High levels of phytic acids in the breeder varieties may require attention in dietary planning (Jones, Smith, and Alavi, 2023). Breeder-improved varieties have health benefits, such as higher phenolic content; they also present challenges with elevated levels of phytates and oxalates. The Iree Tomato shows a different profile, suggesting a balance between nutrient absorption and beneficial compounds. Ongoing research is needed to enhance nutritional quality while addressing the impact of anti-nutrients on Iree Tomato.

The Vitamin C content in tomato varieties Tom 1, Tom 2, UC, and Iree Tomato shows notable differences. Tom 2 exhibits the highest Vitamin C level, exceeding 200 mg/100g, indicating the advantages of breeding practices that enhance nutrient profiles (Kumar *et al.*, 2023). Tom 1 also shows significant Vitamin C content, supporting the notion that improved varieties generally provide better nutrition (Garcia *et al.*, 2022). In contrast, UC displays moderate Vitamin C levels, highlighting variability among improved cultivars (Jones *et al.*, 2023).

Significant differences at (α=0.05) were found in fat content, crude fibre content, protein, potassium, calcium, magnesium, iron, manganese, phytates, oxalates, tannins, and phenol content among the tomato types, while no significant differences were observed in ash content, moisture content, carbohydrate content, sodium content, and phytic acids. The local Iree Tomato has the lowest Vitamin C content, suggesting that traditional varieties may require genetic or agricultural improvements to boost their nutrient density (Smith and Brown, 2021). These findings emphasise the need for continued research in tomato breeding to enhance both yield and nutritional quality, particularly for local varieties that are essential in diets. Improved tomato varieties offer significant health benefits through increased vitamin C 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.

COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. No financial support or sponsorship was received from any commercial entities, and all analyses were conducted objectively and independently. This research was performed solely for academic purposes and to advance understanding in the comparative nutritional assessment of tomato varieties.

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