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ORIGINAL ARTICLE

Evaluation of Nutrient and Phytochemical Composition of Selected Fruits and Health Implications to People in Kampala Capital City Authority, Uganda

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ABSTRACT

Consuming fruits on a regular basis is essential for improving human health. However, the optimal dietary usage of locally available fruits in Uganda is hindered by the lack of information regarding their nutritional and phytochemical makeup. The nutritional and phytochemical profiles of tamarind (*Tamarindus indica*), gooseberry (*Physalis peruviana*), soursop (*Annona muricata*), and jackfruit (*Artocarpus heterophyllus*) were assessed in this study. Using a laboratory-based cross-sectional design, qualitative and quantitative analyses were conducted to determine mineral contents, vitamins, proximate compositions, and key phytochemicals. All fruits contained calcium (0.53–0.97 mg/kg), phosphorus (0.01–0.22 mg/kg), magnesium (10.3–13.82 mg/kg), potassium (21.18–40.77 mg/kg), zinc (0.02–0.06 mg/kg), and sodium (25.17–33.08 mg/kg). Tamarind showed the highest crude protein (9.72 %), gooseberry had the highest crude fibre (17.41 %) and sugars (18.67 %), soursop had the highest starch content (39.38 %) and also recorded the highest moisture (80.38 %) and total ash content (4.59 %). While jackfruit had the lowest fibre (3.92%), fat (1.46%) and protein (7.29%). Phenolics, alkaloids, tannins, and anthraquinones were found in most samples, while flavonoids were not detected in gooseberry. Although the samples showed some variation in their contents of the nutrients and phytochemicals, there were no significant differences ($p > 0.05$) among the fruits. These findings suggest that the fruits are nutritious and can meaningfully contribute to a balanced diet and improve immunity for people in Uganda.

Keywords: Phytochemical compositions; Health implications; *Artocarpus heterophyllus*; *Annona muricata*; *Physalis peruviana; Tamarindus indica;* Nutrient.

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1.0 INTRODUCTION

Fruits are vital parts of a healthy diet. They help promote human health, prevent diseases, and improve nutritional status (Devirgiliis et al., 2024). They supply vital elements that promote growth, development, and healthy bodily function, such as water, vitamins, minerals, carbohydrates, and dietary fibre (Aune et al., 2017, Suriyaprom et al., 2022). In addition to their nutritional benefits, fruits contain a range of bioactive compounds known as phytochemicals. Flavonoids, phenolic chemicals, tannins, carotenoids, alkaloids, and saponins are among them (Aune et al., 2017; Cosme et al., 2022; Suriyaprom et al., 2022). These substances possess antibacterial, anti-cancer, anti-inflammatory, and antioxidant qualities (Cosme et al., 2022; Adediran et al., 2024). Non-communicable diseases (NCDs), such as diabetes, heart disease, obesity, and some forms of cancer, are managed and prevented with their help (Cosme et al, 2022; Devirgiliis et al., 2024). Around the world, eating more fruit is seen as an effective way to improve nutrition and lower disease rates (Cosme et al., 2022). The World Health Organisation advises eating at least 400 grams of fruits and vegetables daily, or around five servings, to maintain a sufficient nutritional intake and reduce the risk of chronic diseases (WHO, 2023). However, many people do not eat enough fruits and vegetables, which is a leading dietary risk factor globally. This shortfall significantly contributes to health issues and deaths linked to NCDs (Wang et al., 2021; Devirgiliis et al., 2024). Current estimates suggest that NCDs account for about 70–71% of mortalities worldwide each year (Wallace et al., 2020). Additionally, cancer and heart disease together cause millions of deaths annually (Wallace et al., 2020). The rising rates of these diseases, especially in low- and middle-income countries, have sparked increased interest in finding affordable and nutritious food sources that can enhance dietary quality and public health. In Africa, fruits play a significant role in food security, nutrition, healthcare, and livelihoods (Anozie et al., 2018; Pulela et al., 2022). Both native and cultivated fruits provide affordable vitamins, minerals, dietary fibre, and health-promoting phytochemicals (Stadlmayr et al., 2023). Despite the variety of fruits available, many regions in sub-Saharan Africa consume fewer fruits than recommended (Pulela et al., 2022). Moreover, the nutrient content of fruits can vary based on factors like species, cultivar, soil quality, climate, maturity, farming practices, harvesting methods, and handling after harvesting (Okoye & Ibeto, 2009; Ngigi et al., 2023). These variations require ongoing assessments of fruit composition to provide accurate information on their nutritional value and health benefits (Ngigi et al., 2023).

Uganda has a rich variety of native and exotic fruits, including mangoes, pineapples, oranges, passion fruits, guavas, jackfruits (*Artocarpus heterophyllus*), soursop (*Annona muricata*), gooseberry (*Physalis peruviana*), and tamarind (*Tamarindus indica*) (Dolislager et al., 2022). These fruits have historically supported household nutrition, food security, and medicinal practices (Dolislager et al., 2022; Nantongo et al., 2022). The country's favorable tropical climate allows for year-round fruit production, resulting in a wide availability of fruits (Dolislager et al., 2022). However, factors like urbanisation, changing lifestyles, and an increasing preference for processed foods have led to reduced fruit consumption among certain groups, particularly in urban areas (Oyet et al., 2025). This trend raises concerns about micronutrient deficiencies and the rise of diet-related chronic diseases (Oyet et al., 2025). Because they provide health benefits beyond basic nutrition, functional foods and plant-based bioactive chemicals have been the focus of recent studies (Xavier et al., 2024; Nakadate et al., 2025). Antioxidant benefits, enhanced immunity, reduced inflammation, and defense against chronic illnesses, such as cancer, have all been associated with phytochemicals (Xavier et al., 2024). Despite these advantages, most research has centered on commercially important fruits (Lekhuleni et al., 2024). Many native Ugandan and other African fruits remain poorly studied. As a result, there is little scientific information on the nutrient and phytochemical profiles of several indigenous and underutilised fruits, which limits their inclusion in nutrition programmes, dietary guidelines, and value-added strategies.

In Kampala Capital City Authority (KCCA), fruits are commonly bought and consumed in both formal and informal markets. However, there is limited local information on the nutrient and phytochemical profiles of many fruits available in Kampala. Therefore, it is important to assess the nutrient and phytochemical contents of selected fruits, including jackfruit, soursop, gooseberry, and tamarind. This will provide evidence of their nutritional quality and health benefits. The findings will support dietary recommendations, nutrition policies, public health efforts, and initiatives aimed at reducing micronutrient deficiencies and non-communicable diseases in Uganda.

2.0 MATERIALS AND METHODS

2.1 Research Design

This study used a laboratory-based cross-sectional analytical design. This approach was suitable because it allowed for both quantitative and qualitative assessment of the nutrient and phytochemical contents of selected fruits at one point in time. It also facilitated the comparison of mineral, vitamin, proximate, and phytochemical profiles across different fruit types in a standardised laboratory setting.

2.2 Research setting

The study took place in a Food and Biochemistry laboratory at Makerere University and Uganda Industrial Research Institute in Central Uganda. All sample processing and analyses were conducted in this controlled laboratory environment.

2.3 Sampling

The target population included commonly consumed and locally available fruits in Kampala Capital City, Uganda. Four types of fruits; jackfruit (*Artocarpus heterophyllus*), soursop (*Annona muricata*), gooseberry (*Physalis peruviana*), and tamarind (*Tamarindus indica*) were purposely selected based on their availability, traditional usage, and underutilisation in formal nutrition programmes. Fresh, ripe fruits were purchased from two main urban produce markets. Market vendors were chosen conveniently, and fruits were selected based on visual maturity, freshness, and lack of physical damage. Each fruit type was collected in triplicate to ensure representativeness and reliability in analysis.

2.4 Data Collection

2.4.1 Sample collection and processing

Freshly harvested ripe fruits were bought from local markets. They were carefully selected to ensure good quality and labeled for identification. The samples were packed in cooler boxes and quickly transported to the laboratory to keep them fresh and reduce nutrient loss. Upon arrival, the fruits were washed thoroughly to remove dirt and contaminants. They were then peeled and sliced into small pieces for processing. Portions intended for proximate composition, mineral analysis, and phytochemical screening were oven-dried at 60°C for 72 h until they reached a constant weight. The dried samples were milled into a fine, homogeneous powder and stored in airtight containers for later analysis. Some portions of the fruits were kept fresh for vitamin analysis to prevent the degradation of heat-sensitive vitamins and ensure accurate measurement of vitamin content.

2.4.2 Determination of mineral compositions

The analyses of minerals in the fruit samples were carried out using standard procedures to find the concentrations of calcium, phosphorus, zinc, manganese, potassium, magnesium, and sodium (AOAC, 2019). Calcium was analysed using a titrimetric method that involved precipitation with ammonium oxalate and titration with standardized potassium permanganate solution (AOAC, 2019). Phosphorus content was measured with a colorimetric method (AOAC, 2019), forming a coloured complex and measuring its absorbance spectrophotometrically against standard solutions. Zinc, manganese, potassium, magnesium, and sodium were measured using atomic absorption spectrophotometry (AAS) after wet digestion of the samples with concentrated nitric acid and perchloric acid to release the minerals into solution (AOAC, 2019). The digested samples were filtered, diluted, and analysed at specific wavelengths for each element. Calibration standards and quality control methods were used to ensure the results were accurate and reliable. Mineral concentrations were then calculated and presented in suitable units for nutritional evaluation of the fruit samples.

2.4.3 Phytochemical screening

Qualitative phytochemical screening was done to identify key bioactive compounds like tannins, anthraquinones, flavonoids, and alkaloids in the fruit samples using standard methods (Dubale et al., 2023). Tannins were identified with the ferric chloride test, which showed a dark green or blue-black color when present (Singh et al., 2022). Anthraquinones were detected with the Bornträger test, which produced a pink to red colour for positive results (Gul et al., 2017). Flavonoids were screened using both the Shinoda and sodium hydroxide tests; a distinctive red, pink, or yellow colour indicated their presence (Alqethami & Aldhebiani, 2020). Alkaloids were detected using Dragendorff's and Mayer's reagents, leading to orange-red and creamy precipitates in positive samples (Shaikh & Patil, 2020). All chemicals and reagents used were of analytical grade to ensure accuracy and reliability. Observations from each test were recorded and interpreted according to standard phytochemical screening protocols.

2.5 Vitamin analysis

The contents of vitamin C, vitamin A, and β-carotene in the fruit samples were measured using standard laboratory methods. Vitamin C was analysed using iodine titration, where diluted fruit juice samples were titrated with standardised iodine solution to measure ascorbic acid content. Vitamin A was determined through a fixed cut-off colorimetric method, where fruit extracts reacted with a chromogenic reagent to create a coloured complex. Its intensity was measured spectrophotometrically and compared with standard solutions. The β-carotene content was measured by extracting the pigment from fruit samples using an acetone-hexane solvent mixture, followed by spectrophotometric analysis at suitable wavelengths (Popescu et al., 2022). The vitamin concentrations were calculated from standard calibration curves and expressed in appropriate units. To ensure accuracy and reliability, all analyses were done in triplicate, and the mean values were used for data analysis.

2.6 Proximate composition

In order to analyse the fruit samples' nutritional quality, standard analytical procedures were used to determine their proximate composition. To ascertain the moisture content, samples were oven-dried at 103°C until they reached a constant weight. To determine the amount of ash and total mineral residue, samples were burned in a muffle furnace at 550°C. Crude fibre was tested by reflux digestion, which involved multiple acid and alkali treatments prior to drying and ashing the residue (Abubakar et al., 2024). The micro-Kjeldahl method, which involved digestion, distillation, and titration to measure nitrogen concentration and convert it to protein using a factor of 6.25, was used to quantify crude protein content (Omeje et al., 2022). Soxhlet extraction using an organic solvent was used to assess crude fat (Omeje et al., 2022; Anand et al., 2024). Sugar and starch contents were determined with Fourier Transform Infrared (FT-IR) spectroscopy based on their distinctive infrared absorption patterns (Cassani et al., 2018). To guarantee correctness, dependability, and repeatability of the findings, all analyses were carried out twice, and mean values were utilised.

2.7 Data analysis

Data from the laboratory analyses were summarised with descriptive statistics and presented as means and standard deviations (Mean ± SD). These measures showed the average values and variability of the nutritional and phytochemical parameters among the fruit samples. To check for significant differences between the different fruit types, one-way analysis of variance (ANOVA) was used. Statistical significance was assessed at a $p < 0.05$. All data management and analysis were done using IBM SPSS Statistics Version 31, ensuring accurate and efficient processing of the study data.

2.8 Ethical considerations

Ethical principles were followed throughout the study to meet scientific standards, safety requirements, and responsible research practices. Permission was obtained from local market authorities before buying and using fruit samples for lab analysis. All samples were acquired through legitimate transactions without disrupting market activities. Laboratory safety protocols were strictly followed during sample handling, analysis, and disposal. Researchers used appropriate personal protective equipment and followed standard operating procedures. Chemicals and reagents were handled and disposed of according to safety and environmental guidelines. Scientific integrity was maintained through accurate data collection, recording, analysis, and reporting. Quality control measures ensured data reliability. Transparency in presenting methods, findings, and limitations improved credibility, validity, and ethical conduct of the study.

3.0 RESULTS

3.1 Mineral compositions of selected fruits

The mineral compositions of jackfruit, soursop, gooseberry, and tamarind are presented in Table 1. All fruits contained significant levels of zinc (Zn), manganese (Mn), potassium (K), magnesium (Mg), sodium (Na), phosphorus (P), and calcium (Ca). As shown in Table 1, tamarind had the highest zinc content (0.06 mg/kg), while jackfruit had the lowest (0.02 mg/kg). Gooseberry and jackfruit had the highest manganese levels (0.30 mg/kg). Magnesium was most abundant in tamarind (13.82 mg/kg) and jackfruit (13.77 mg/kg). Soursop contained the highest potassium concentration (40.77 mg/kg), and gooseberry was richest in sodium (33.08 mg/kg) and phosphorus (0.22 mg/kg). Soursop also had the highest calcium content (0.97 mg/kg). There were no statistically significant variations in the mineral makeup of the fruits ($p > 0.05$).

Table **1.** Mineral compositions of gooseberry, tamarind, soursop and jackfruit

Sample	Zinc (mg/Kg)	Mn (mg/Kg)	K (mg/Kg)	Mg (mg/Kg)	Na (mg/Kg)	P (mg/Kg)	Ca (mg/Kg)
Goose berry	0.05	0.03	30.82	10.30	33.08	0.22	0.53
Tamarind	0.06	0.02	21.18	13.82	31.18	0.15	0.90
Soursop	0.04	0.02	40.77	11.41	25.17	0.17	0.97
Jackfruit	0.02	0.03	32.07	13.77	26.75	0.01	0.55
p-values	**0.927**	**0.874**	**0.999**	**0.956**	**0.962**	**0.643**	**0.988**

3.2 Phytochemical compositions of selected fruits

The phytochemical compositions of gooseberry, tamarind, soursop, and jackfruit were analysed to assess the presence of bioactive compounds known to confer antioxidant, anti-inflammatory, and health-promoting properties. Table 2 reports the qualitative detection of alkaloids, flavonoids, phenolic compounds, anthraquinones, and tannins in these fruits. The results provide insight into the potential functional value of these fruits in human nutrition and support their classification as sources of bioactive compounds that may aid in disease prevention.

Table **2.** Phytochemical compositions of gooseberry, tamarind, soursop and Jack fruit

Phytochemical	Test	Goose Berry	Tamarind	Sour sop	Jackfruit
Alkaloids	Dragendoff	†	†††	†	††
	Mayer's	†	†	†	†
Flavonoids	Shinnoda	–	†††	†††	†††
	Alkaline reagent	–	†††	†††	†††
Phenolic compounds	Ferric chloride	†	†	†††	†††
	Lead acetate	†††	†††	†††	†††
Anthraquinones	Borntrager's	†††	†††	†	†
Tannins	Gelatin test	††	††	†††	†††
	Ferric chloride	†	†	†††	†††

All fruits tested positive for alkaloids, phenolics, anthraquinones, and tannins. Flavonoids were detected in jackfruit, soursop, and tamarind, but were not present in gooseberry. Gooseberry and tamarind showed strong reactions for anthraquinones, while tannins were most abundant in soursop and jackfruit (Table 2).

3.3 Vitamin composition of selected fruits

The vitamin contents of jackfruit, soursop, gooseberry, and tamarind were evaluated to measure their contribution to essential micronutrients important for antioxidant defense, immune function, and overall health. Table 3 presents the levels of vitamin A, β-carotene, and vitamin C in each fruit. These results help in understanding the potential of these fruits to prevent micronutrient deficiencies and support dietary recommendations for health promotion. Tamarind had the highest vitamin A content (1.19 µg/mL). Gooseberry contained the highest β-carotene (1.07 µg/mL) and vitamin C (1.66 µg/mL). There were no statistically significant differences between the fruits ($p > 0.05$) (Table 3).

Table **3.** Vitamin compositions of jack fruit, soursop, gooseberry and tamarind

Vitamins (µg/mL)	Jackfruit	Sour sop	Gooseberry	Tamarind	*p*
Vitamin A	0.9931	1.0061	1.1229	1.1903	0.942
β-carotene	0.7007	0.5824	1.0735	0.4786	0.987
Vitamin C	0.83	0.56	1.66	0.23	0.951

3.4 Proximate compositions of selected fruits

The proximate compositions of jackfruit, soursop, gooseberry, and tamarind was analysed to establish their macronutrient profiles, which include moisture, dry matter, fibre, fat, ash, protein, sugars, and starch. Table 4 reports the average values for each aspect. This data provides insight into the nutritional density and possible functional applications of the fruits in human diets, highlighting their contributions to energy, dietary fibre, and protein intake. Tamarind had the highest dry matter content (90.41%), whereas soursop had the highest moisture content (80.38%). Gooseberry has the highest levels of sugar (18.67%) and crude fibre (17.41%). The highest levels of starch (39.38%) and crude protein (9.72%) were found in tamarind. There were no discernible variations ($p > 0.05$) between the fruits (Table 4).

Table **4.** Proximate compositions of jackfruit, soursop, gooseberry and tamarind

Samples	Fresh DM (Av. %)	Dry matter (Av. %)	Fibre (Av. %)	Fat (Av. %)	Total ash (Av. %)	Protein (Av. %)	Sugars (Av. %)	Starch (Av. %)
Jackfruit	76.46	86.98	3.92	1.46	3.95	7.29	12.33	13.04
Soursop	80.38	84.86	8.44	1.10	4.59	9.11	8.53	39.38
Gooseberry	78.92	86.27	17.41	5.73	3.37	8.51	18.67	3.84
Tamarind	27.69	90.41	9.16	1.51	3.36	9.72	7.35	6.78
p-values	**0.997**	**0.877**	**0.985**	**0.982**	**0.856**	**0.987**	**0.849**	**0.945**

4.0 DISCUSSION

This study evaluated the compositions, mineral contents, vitamin profiles, and phytochemicals of jackfruit, soursop, gooseberry, and tamarind to understand their nutritional importance in human diets. The results show that all four fruits contain significant amounts of essential nutrients and bioactive compounds, confirming their value as functional foods that promote health. Notably, no significant differences ($p > 0.05$) were found across most measured parameters. This indicates similar nutritional profiles among the fruits. This finding highlights the need for dietary diversity, a key concept in nutrition science, especially for preventing non-communicable diseases (NCDs) and addressing micronutrient deficiencies. Global nutrition guidelines also stress that improving diet quality through a variety of fruits and vegetables is more effective than focusing solely on individual "superfoods". While the statistical differences were not significant, some variations in mineral content were noted among the fruits. Soursop had higher levels of potassium and calcium, while tamarind had higher levels of zinc and magnesium. These minerals are vital for many physiological functions, especially in cardiovascular, metabolic, and immune health (Chasapis et al., 2020). Potassium is crucial for maintaining electrolyte balance, regulating blood pressure, and lowering cardiovascular risk (Wouda et al., 2022). Research shows that higher potassium intake can reduce both systolic and diastolic blood pressure by counteracting sodium retention and improving blood vessel function (Filippini et al., 2020). The higher potassium content in soursop suggests it may help protect cardiovascular health, particularly for those at risk of hypertension (Wouda et al., 2022). Additionally, magnesium is essential because it facilitates more than 300 enzymatic processes linked to insulin signaling, glucose metabolism, and energy production (Li et al., 2022). A reduced incidence of type 2 diabetes and improved insulin sensitivity are associated with enough magnesium (Li et al., 2022). Zinc is essential for wound healing, DNA synthesis, immunological response, and antioxidant defenses (Costa et al., 2023). Tamarind is more important for boosting immunity and cell protection because of its increased zinc content (Chasapis et al., 2020). The non-significant differences in mineral compositions contrasts with other studies that found high mineral variability among fruits due to environmental, agricultural, and genetic factors (Zhou et al., 2024). Typically, mineral content is affected by soil availability, plant genetics, rainfall, and farming practices (Zhou et al., 2024; Adediran et al., 2024). The consistent mineral profiles in this study may result from similar growing conditions, shared soil types, or similar nutrient uptake methods among the fruits studied (Zhou et al., 2024). This suggests that indigenous fruits grown in comparable environments could provide stable contributions to dietary mineral intake. Instead of focusing on one fruit for minerals, eating a variety of locally available fruits may be a better strategy for achieving adequate mineral nutrition. Phytochemical screening showed the presence of several bioactive compounds, including phenolics, alkaloids, tannins, and anthraquinones in all the fruits. Flavonoids were found in jackfruit, soursop, and tamarind but not in gooseberry. These phytochemicals are recognised for their health benefits, especially in preventing chronic diseases (Ribes-Moya et al., 2020). Phenolic compounds are among the most researched plant bioactives because of their strong antioxidant abilities; they work by scavenging free radicals, preventing lipid damage, and boosting the body's antioxidant defenses (Liu et al., 2023; Camarda et al., 2026). Additionally, they offer anti-inflammatory properties that are essential for lowering the chances of long-term conditions like cancer, diabetes, and heart disease (Camarda et al., 2026). Tannins, which were plentiful in soursop and jackfruit, add to the health benefits of these fruits. They have antimicrobial properties, prevent pathogen attachment, and can bind proteins and metals, which helps regulate gut health (Sallam et al., 2021; Liu et al., 2023). Additionally, tannins can enhance antioxidant defenses in the body (Camarda et al., 2026). Anthraquinones found in gooseberry and tamarind are known for their biological effects, including antimicrobial and laxative properties (Duval et al., 2016). Alkaloids, present in all the fruits, are linked to various health benefits, like pain relief, reducing inflammation, and fighting infections (Elsheep et al., 2022). The combined presence of these phytochemicals suggests that these fruits may offer additional health benefits beyond basic nutrition (Sallam et al., 2021; Camarda et al., 2026). The lack of flavonoids in gooseberry was surprising since many similar fruits typically have high flavonoid levels. Several factors might explain this finding. First, genetic differences between fruit species and varieties can affect the production of secondary metabolites (Ribes-Moya et al., 2020). Second, environmental aspects like soil type, rainfall, sunlight, and stress on the plants can influence flavonoid levels (Ribes-Moya et al., 2020; Okunade et al., 2021). Third, the stage of fruit maturity is crucial since flavonoid amounts can change during ripening (Ribes-Moya et al., 2020). Lastly, limitations in the testing methods may have led to not detecting flavonoids, particularly if their levels were too low to measure accurately. Better analysis and validation might be possible with more sophisticated methods like High-Performance Liquid Chromatography (HPLC) (Duval et al., 2016). Overall, the variety of phytochemicals seen in this study supports the idea of "food as medicine," recognising foods not just as energy sources but also as carriers of beneficial compounds that impact health. This highlights the importance of eating whole fruits rather than just extracts or supplements, as the interactions among phytochemicals may enhance their health effects.

Vitamin analysis showed distinct, yet complementary, profiles of micronutrients among the fruits. Tamarind had higher vitamin A levels, while gooseberry provided the most β-carotene and vitamin C, although these differences were not statistically significant. These vitamins are necessary for growth, immunity, eyesight, and defense against oxidative stress (Alberts et al., 2025). Vitamin A is vital for maintaining healthy tissues, supporting immune responses, and ensuring good vision, especially in low-light situations. Vitamin A's precursor, β-carotene, is a potent antioxidant that shields cells from harm (Giuliano, 2017). It plays a particularly important function in avoiding vitamin A insufficiency in low-income areas where this problem still exists (Giuliano, 2017). Gooseberries are a great source of vitamin C, a water-soluble antioxidant that is essential for immune system function, collagen synthesis, iron absorption, and wound healing (Alberts et al., 2025). It is essential for the body's renewal of other antioxidants and neutralisation of free radicals (Alberts et al., 2025). Gooseberry's high vitamin C content is consistent with past studies that found it to be one of the greatest natural sources of ascorbic acid (Saini et al., 2021). However, the differences between this study and others showing higher vitamin levels in citrus fruits and mangoes may stem from variations in fruit types, growing conditions, maturity stages, and testing methods (Alberts et al., 2025). These points highlight the complexity of nutrient levels in plant foods and the need for context-specific nutritional evaluations. Together, the presence of vitamin A precursors, β-carotene, and vitamin C in these fruits shows their potential to help combat nutrient deficiencies, particularly in populations facing "hidden hunger" (Giuliano, 2017). These findings bolster the inclusion of local fruits in nutrition-focused interventions aimed at enhancing public health outcomes (Saini et al., 2021).

Proximate analysis showed notable differences in the composition of the fruits, especially in moisture, fibre, sugar, protein, and starch levels. Gooseberry had the highest crude fibre and sugar content. Soursop had the most moisture, while tamarind had the highest amounts of crude protein and starch. The high fibre content in gooseberry is important for digestive and metabolic health. Dietary fibre helps maintain regular bowel movements, improves gut bacteria, and promotes the creation of short-chain fatty acids, which protect intestinal health and regulate inflammation. Fibre also lowers cholesterol absorption and stabilises blood sugar levels after meals, reducing the risk of heart disease and type 2 diabetes (Salamone et al., 2021). Although gooseberry contains relatively high natural sugar levels, these sugars affect the body differently from refined sugars. The fibre and bioactive compounds slow down glucose absorption, preventing quick spikes in blood sugar (Mavadiya et al., 2025). This difference is crucial in modern nutrition science, which now distinguishes between natural sugars in whole fruits and added sugars in processed foods. Tamarind's higher protein and starch content is noteworthy because it is usually consumed mainly as a flavoring rather than a nutrient-rich food. Protein is necessary for repairing tissues, producing enzymes, and supporting immune function, while starch offers a quick source of energy. This means tamarind could be a valuable ingredient in functional foods, contributing to dietary energy and protein. Its composition makes it suitable for use in composite flours, food fortification, and products aimed at improving nutrition, particularly in areas facing food scarcity and malnutrition (Arshad et al., 2022).

The absence of significant differences among the fruits in most parameters suggests that they generally have similar nutritional profiles. This means that none of the fruits consistently outperform the others, emphasising their complementary roles in human diets. From a nutritional perspective, this finding supports the idea that varying one's diet is crucial for balanced nutrient intake and optimal health. The combination of essential minerals, vitamins, fibre, and bioactive phytochemicals in all the fruits highlights their joint contributions to health. Instead of acting alone, these nutrients and phytochemicals work together within the food to enhance antioxidant defenses, regulate metabolism, support immune function, and prevent chronic diseases. These findings align with global dietary recommendations encouraging greater consumption of fruits and vegetables as a cost-effective way to reduce the impact of non-communicable diseases, such as heart disease, diabetes, obesity, and certain cancers (WHO, 2023). Importantly, the results provide solid evidence from locally available fruits, reinforcing their importance in tackling both global and specific nutritional challenges.

In conclusion, jackfruit, soursop, gooseberry, and tamarind are valuable fruits that significantly benefit human health. Their similar nutrient profiles and diverse phytochemical compositions highlight their collective importance in promoting nutritional adequacy, metabolic health, and disease prevention. The findings strongly support including indigenous fruits in public health nutrition strategies to improve food security, reduce micronutrient deficiencies, and lessen the rising burden of non-communicable diseases.

Limitations

However, the study had limitations. It was laboratory-based and used samples from only two urban markets, which might not reflect regional or seasonal differences. It also did not examine nutrient bioavailability or how processing affects the retention of phytochemicals. Future studies should concentrate on evaluating the bioavailability of important nutrients, the fruits' anti-inflammatory and antioxidant properties, and their potential to prevent and treat non-communicable diseases. Additionally, research should examine customer preferences, the effects of processing, and variations among different agricultural zones.

Conclusion

This study assessed the nutrient and phytochemical contents of jackfruit (*Artocarpus heterophyllus*), soursop (*Annona muricata*), gooseberry (*Phyllanthus emblica*), and tamarind (*Tamarindus indica*) to provide evidence for their dietary use in Uganda. The results showed that all four fruits have significant levels of essential minerals, vitamins, phytochemicals, and proximate nutrients vital for health and disease prevention. These results confirm that these fruits are important providers of bioactive chemicals and micronutrients that can improve nutritional health and reduce the risk of non-communicable diseases.

Conflict of interest

The authors declare no conflict of interest.

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Contributions of authors

Santa Maria Asio contributed to conceptualization and drafting of the research. Santa Maria Asio funded the research. Santa Maria Asio, Stephen Kigozi and Mwamini Nakanwagi handled sample collection. Santa Maria Asio, Stephen Kigozi and Mwamini Nakanwagi conducted the laboratory experiments. Santa Maria Asio, Stephen Kigozi and Mwamini Nakanwagi in consultation with each other performed the statistical analysis. All authors participated in revising and reviewing the manuscript and approved the final version for publication.

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