2023 International Research Conference of Sri Lanka Technology Campus
Colombo, Sri Lanka. 14th-15th December 2023

Health Safety and Quality of Guava Produced in Selected Guava Production Systems in Anuradhapura and Matale Districts

Udayangani Edirisinghe
Department of Crop Science
University of Peradeniya
Peradeniya, Sri Lanka
ag16011@agri.pdn.ac.lk

Sugathas Sinthuja
Department of Agriculture Technology
Sri Lanka Technological Campus
Padukka, Sri Lanka
sinthujas@sltc.ac.lk

Palitha Weerakkody
Department of Crop Science
University of Peradeniya
Peradeniya, Sri Lanka
wapweerakkody@agri.pdn.ac.lk

Chaminda Gunawardane
National Institute of Post-Harvest Management
Anuradhapura, Sri Lanka
crohan74@gmail.com

***Abstract*—Guava (*Psidium guajava* Linn.) is one of the principal tropical fruits that is largely consumed and has a high export potential in Sri Lanka. Along this line, addressing the question of "health safety of guava fruits" under different crop management conditions was found to be a timely and important topic, because the consumer concerns over the fresh fruit quality and health safety have increased substantially in recent years. Therefore, this study was conducted to determine whether there is a correlation between crop management conditions and the fruit qualities and pesticide residue level of guava. For the qualitative assessments, guava samples were collected from farmer fields at the harvesting maturity stage. Total Soluble Solid (TSS), titratable Acidity (TA), fruit volume, fruit weight, fruit diameter, fruit firmness, peel color values, and pesticide residue level were quantified in fresh samples. Based on the results, the residues of common pesticides were not detected in all the samples. Meanwhile, the crop management intensity was found to be not significant ($P<0.05$) on all the selected quality parameters of fresh guava. The low rate of application due to the high cost of pesticides and adherence to safety guidelines were found to be the most probable reasons for this situation. As a summary of the results, it can be concluded that present-day crop management in guava cultivations does not have any harmful effect on fresh fruits with respect to pesticide residues. However, this conclusion needs verification through repeated studies, using a better sampling strategy, before recommending the health safety of fresh guava in Sri Lanka.**

Keywords—Pesticide residue, guava, gas chromatography-mass spectrometry, crop management

I. Introduction

Guava (*Psidium guajava* Linn.), one of the principal tropical fruits, is extensively consumed in Sri Lanka in its fresh form and holds significant export potential. It belongs to the family Myrtaceae. Guava is called "the apples of the tropics". It is because fresh guava fruit is a good source of plenty of vitamins, minerals, fibers, and antioxidants. Within Sri Lanka, guava has high demand throughout the year. This fruit crop can grow under wider climatic and soil conditions. There can be identified several guava-based cropping systems like mono-cropping systems, home gardening, Intercropping systems, multiple cropping systems, etc. The intensity of crop management differs from one cropping system to another. There have been about 177 pathogens reported in the guava plant [1]. These pathogens cause several pre- and post-harvest diseases of guava. Therefore, pesticide application in the guava production systems is high. Studies on the impact of pesticides on human health showed that toxicological exposure caused by the intake of foods is five times higher compared to other exposures like air and water [2].

Therefore, conducting a well-planned sampling-based pesticide residue analysis will bring about much-needed evidence to assure health safety under different crop management intensities, enabling the enforcement of regulations on pesticide usage. Moreover, the trust built within consumers on health safety will further increase the demand for guava in the local market, positively influence per capita fruit intake among Sri Lankans, and contribute to the much-needed import substitution in the fruit sub-sector in the agri-food system of Sri Lanka. Therefore, our objectives were to determine the level of fruit quality and pesticide residues in guava grown under different crop management conditions in the Anuradhapura and Matale districts and to determine the use of "freedom from pesticide residues" as a quality parameter for guava.

II. Methodology

A. Field Survey

The initial step involved conducting a comprehensive questionnaire-based field survey in 46 mini orchards/guava farms, which were identified in the Anuradhapura district (including Tirappane, Kekirawa, Galnewa, Ipalogama, Kekirawa, Thalawa, Thambuththegama, Rajanganaya) and Matale district (specifically, Dambulla and Wewala). These orchards were selected based on recorded guava cultivation data from the National Institute of Post-Harvest Management, Anuradhapura. Multiple visits were undertaken to interview farmers, and the questionnaire was completed simultaneously.

B. Grouping of Farmers

Based on collected primary data from the survey, the cropping system's nature, and management condition level

were identified. Management intensity indexes (Crop Management Index, Pest Management Index) were calculated to group guava farms based by their management practices as described by [3] and [4]. The calculation of these indexes involved interviewing farmers to evaluate the utilization of seven external input variables: synthetic fertilizers, organic fertilizers, insecticides, weedicides, fungicides, nematicides, and irrigation. The pest management index was also considered when calculating the crop management indexes. Based on the obtained crop management intensity index scores falling within the ranges of 7-11, 12-16, and 17-21, the guava farms were then classified into three distinct categories reflecting low, intermediate, and high levels of crop management intensity, respectively.

C. Sampling of Guava Fruits

For the sampling of guava for the laboratory analysis, five farms were selected randomly within each category of crop management intensity (treatments). The sample size was 5 fruits, gathered from 5 trees (replicates) from each farm (replicate). Guava fruits were manually harvested at harvesting maturity and an effort was made to pick fruits located in the middle part of the canopy to avoid over or under estimation of pesticide residues. All collected samples were properly wrapped, labeled and transported to the National Institute of Postharvest Management (NIPHM) in Anuradhapura.

D. Analysis of Fruit Quality Parameters

At the laboratory, various fruit quality parameters were assessed. These included Total Soluble Solids (TSS) measured using a digital refractometer, firmness using a penetrometer, and for the titratable acidity, the aliquot was titrated against 0.1M NaOH, and the external qualities such as fruit diameter measured precisely using a digital caliper with an accuracy of ± 0.01 mm, fruit weights using a top-loading electronic balance with an accuracy of ±0.01 g, fruit Volume employing the water displacement method, and fruit color using chroma meter.

E. Pesticide Residue Analysis

After the quality analysis, 50g of sample was prepared and the pesticide residues were extracted by the QuEChERS method (Quick Easy Cheap Effective Rugged and Safe) according to the AOAC official method [5] and the pesticide residual levels were determined by gas chromatography (GC-2016, TYPE: Z326K, Germany).

F. Statistical Analysis

Experiment was conducted as a Completely Randomized Design (CRD) and Analysis of Variance (ANOVA) was performed. Means were compared using LSD test with Minitab software, version 20.0.

III. Results and Discussion

A. Field Observations

In Anuradhapura district, guava production spans small, medium, and large scales, with some farmers exporting while others serve the local market. Historically, fruit flies and root-knot nematodes were significant pests, but root-knot nematodes are now less problematic. This led some farmers to switch to alternative crops. Most guava farmers prefer manual weeding with grass cutters due to costly and limited chemical weedicides, resulting in varied pesticide application frequencies.

B. Pesticide Residual Levels Detection

Analysis of the fifteen guava samples revealed the absence of detectable pesticide residues. This outcome can be attributed to several factors, including the current practice among guava farmers of using pesticides at lower application rates due to their high cost and limited availability. Furthermore, most guava farmers adopt the practice of bagging fruits at an early stage of development, which contributes to a potential reduction in the need for insecticides. Bagging not only protects the fruits but also minimizes direct exposure to contact-type pesticides. Additionally, a significant number of guava farms categorized as high crop management intensity, particularly large-scale ones exporting to Malaysia, adhere to fruit quality and safety guidelines. This necessitates the application of recommended pesticide levels. According to the survey results, the majority of farmers maintain long pre-harvest intervals, typically lasting two to three weeks. This extended period allows for the gradual degradation of pesticide residues to lower concentrations.

Further, it's also important to note that the absence of detectable pesticide residues does not necessarily imply that the guava is entirely pesticide-free. The lower limit of detection using Gas Chromatography-Mass Spectrometry (GC-MS) is 0.01 mg/kg. Therefore, the pesticide residues content in the samples may be simply too low to be detected by the GC-MS.

C. Fruit Quality

There were no significant differences observed in firmness, titratable acidity, total soluble solid content, average fruit weight, average fruit diameter, and average fruit volume among guava fruits subjected to three different management treatments (at $P<0.05$) (Tab. 1). In conclusion, the study found that crop management intensity had no significant impact on the selected fruit quality parameters.

Several factors may account for the absence of significant differences in fruit qualities within crop management intensity levels, even when different fertilizer and water management conditions were applied. Firstly, the high cost and limited availability of fertilizer during the study period likely discouraged farmers from overusing it. Secondly, many guava farms were established in paddy fields as mixed crops, potentially providing an already established soil fertility advantage. This, in turn, could ensure better moisture conditions for guava due to the inherent water availability in paddy fields. Furthermore, guava farmers' preference for manual weed removal using grass cutters, without removing weed debris from the field, may contribute to the presence of organic matter, which can benefit soil fertility.

In terms of fruit maturity assessment, peel color changes in guava are a key visual indicator. However, the results indicated no significant difference ($P<0.05$) in color values among the three treatments (Tab. 2). This lack of significant difference suggests that all samples were at a similar maturity stage.

TABLE I. AVERAGE FIRMNESS, TITRATABLE ACIDITY, TOTAL SOLUBLE SOLUTES, AVERAGE WEIGHT, FRUIT VOLUME, AND FRUIT DIAMETER OF GUAVA (BANGKOK GIANT) IN DIFFERENT TREATMENTS

Treatment	Average Fruit Firmness (Kg)	Titratable Acidity (Citric Acid %)	Total Soluble Solid Content (Brix^{o})	Average Fruit Weight (g)	Average Fruit Volume (cm^3)	Average Fruit Diameter (mm)
High Management	3.27± 1.07^{a}	0.15±0.02^{a}	9.30±1.16^{a}	0.247±0.02^{a}	195± 14.7^{a}	92.42 ± 2.5^{a}
Medium Management	4.62± 2.20^{a}	0.18± 0.02^{a}	8.59± 1.08^{a}	0.211± 0.03^{a}	199± 26^{a}	85.85 ± 4.2^{a}
Low Management	4.00± 1.07^{a}	0.16± 0.01^{a}	9.87± 1.93^{a}	0.229± 0.01^{a}	195± 22.1^{a}	89.93 ± 1.7^{a}

*Values in the same column with different superscript letters differ significantly (P<0.05).

Each value represents mean + S.D. of five replicates.

TABLE II. COLOR VALUES OF GUAVA (BANGKOK GIANT) IN DIFFERENT TREATMENTS

Treatment	Average Fruit Color Values		
	L* Values	***a* Values***	***b* Values***
High Management Intensity Level	62.77±5.96^{a}	-16.84±0.85^{a}	34.19±0.86^{a}
Medium Management Intensity Level	66.27±2.53^{a}	-15.55±1.43^{a}	35.78±0.62^{a}
Low Management Intensity Level	66.85±2.57^{a}	-15.33±1.14^{a}	35.58±1.79^{a}

Values in the same column with different superscript letters differ significantly (P<0.05) L= 0: black, 100: white; a* = (-): greenness, (+): redness; b* = (-) blueness, (+): yellowness. Each value represents the mean ± S.D. of five replicates.

IV. CONCLUSION

The present study was conducted as a preliminary investigation within limited time constraints and with a restricted sample size to assess pesticide residues and selected fruit qualities in fresh guava. Samples were gathered from the Anuradhapura and Matale districts during the period where ban on the agro-chemicals importation. The crop management intensity was categorized into three levels: high, medium, and low, based on a developed crop management index. The results indicate that guava fruits primarily grown in the Anuradhapura district do not show any significant effects attributable to varying crop management intensities (P<0.05). Additionally, the study suggests that guava consumption is safe in terms of pesticide residue levels. Because the situation (ban on the agro-chemical importation) prevailed during sampling time may be main reasons for this observation. Therefore, it is recommended that a more comprehensive sampling procedure be employed to ensure the representation of major guava- producing areas in Sri Lanka, which would provide a more reliable assessment of the current situation.

REFERENCES

[1]. A. K. Misra,"Guava diseases—their symptoms, causes and management." In Diseases of Fruits and Vegetables: Volume II: Diagnosis and Management, Springer Netherlands, pp. 81-119,2004.

[2]. W.L. Claeys, J.F. Schmit., C. Bragard, G. Maghuin-Rogister, L. Pussemier and B. Schiffers, “Exposure of several Belgian consumer groups to pesticide residues through fresh fruit and vegetable consumption Food control, vol. 22, pp.508-516, 2011.

[3]. A.H. Mas and T.V. Dietsch, “An index of management intensity for coffee agroecosystems to evaluate butterfly species richness”, Ecol. Appl., vol. 13, pp.1491-1501, 2003.

[4]. G. Hernández-Martínez, R.H. Manson and A.C. Hernández, “Quantitative classification of coffee agroecosystems spanning a range of production intensities in central Veracruz, Mexico”, Agric. Ecosyst. Environ, vol. 134, pp.89-98, 2009.

[5]. AOAC, “Official methods of analysis”, 14th Eds. Washington, DC, pp. 420–423, 2007.