



## Assessment on Guava Diversity, Production and Utilization in Taita Taveta County, Kenya

\*Ngoro L. L., Omami E. and Chiveu C. J.

University of Eldoret, School of Agriculture and Biotechnology, Seed Crop and Horticultural Sciences Department, P.O. Box 1125-30100, Eldoret

\*Corresponding author's email address: [liliandoro@gmail.com](mailto:liliandoro@gmail.com)

### Abstract

*Psidium guajava L.* is an important tropical fruit grown for its nutritional benefits and medicinal uses. The crop mainly grows unattended; sprouting from seeds dispersed unintentionally and fruit utilization in Kenya has been low over the years due to lack of information on fruit nutritional composition and awareness of its health benefits. A survey was conducted using both closed and open-ended questionnaires to determine the production methods used by the farmers for guava production, the diverse guava flesh colours that exist and fruit utilization within four agro ecological zones; upper midland (UM 3), Lower midland (LM 4), Lower midland (LM 5) both irrigated and rain fed and inner lowland zone in TaitaTaveta county of Kenya. Research observations indicated farmers owned land that was used for agricultural purposes except in Taveta (LM 5) irrigated region where 2.9 % did not own land. Red fleshed guava fruits were the most domesticated accession, domesticated by 95.9% of the respondents. Significant difference was observed in methods of propagation used by the farmers, Chi- square value  $p < 0.001$ . A bigger percentage (76.4%) reported the seeds to be dispersed by animals. There is no a proper market that exists thus fruits were grown for domestic consumption and over- ripened guava fruits were left under the tree to rot. Only 4.5 % of the respondents from the inner lowland zone made juice from the fruits although this did not differ significantly from the rest of the regions, chi-square value  $> 0.001$ . Farmers do not store the fruits since eating commences immediately after harvesting and in most cases the fruits are left for the children. In conclusion farmers need to be educated on production practices and the nutritional importance of the fruit. Market outlets have to be created and value addition of the fruit done.

**Keywords:** Guava diversity, propagation, utilization

### INTRODUCTION

Guava (*Psidium guajava L.*) is an important tropical fruit belonging to the family Myrtaceae (Sisir, *et al.*, 2012). It is grown for its nutritional benefits and medicinal uses. Guava has a low glycemic index due to its high fiber hence useful for weight loss. The fiber content also helps in managing diabetes by slowing down sugar absorption in the blood (Anil, 2018). Guava fruits are round or oval and are eaten as a fresh fruit at two stages: mature green and fully ripe (Adel, 2014). Guava fruit has been reported to contain four to ten times vitamin C than that found in citrus fruits, of which the skin contains the highest amount (USDA, 2016). The fruit is also a good source of vitamin A and pectin (Priyanka, *et al.*, 2016). Various industrial and pharmaceutical products have been developed from guava, including jellies, juices, ice creams, yogurt and nectars among others (Guitierrezetal, 2008). Functional products such as guava cheese,

a healthy fruit snack, semi- solid concentrate have been formulated using guava puree, added sucrose, chia seeds and almonds (Priyanka, *et al.*, 2016).

Kenya has diverse agro ecological zones that can support production of a wide range of exotic fruits. In 2016, Horticultural Crop Development Authority reported 412 Ha were under guava production which produced 3027 metric tons. The area under production increased to 500 Ha resulting to an increase by 9.94 percent in the year 2017. Leading counties in guava production in Kenya include: Mandera, Makueni, Vihiga, Homabay, Kiambu, Kilifi, Kisii, Nyamira and TaitaTaveta contributing 35.0, 20.0, 6.8, 5.9, 5.4, 4.8, 3.6, 2.5 and 1.9 respectively to the total production (HCDA, 2017). In most parts of Kenya guava has been growing wildly and its cultivation has not been embraced. This has attributed to underutilization of the fruit. There is little information on guava which has limited its production and promotion along the value chain (Chiveu, 2018).

Guava has been commercialized in more than sixty countries. The area, production and productivity of guava during 1991- 2010 had been fluctuating. The overall productivity had been less than its potential in India (MOA, 2013). In Pakistan 20- 40% of fruits losses occur due to improper management practices and lack of advance techniques (Said, *et al.*, 2017). Low productivity is a problem in Sudan which has resulted from seed propagation resulting into seedlings that are not true to type (Groot & Bleijievens, 2017).

Guava yield is quite low, 10- 12 tons/ ha, considerably less than the potential. The gap between the potential and actual yield is wide due to poor management practices. Campaigns to eradicate negative perception of guava fruit started in 2016. According to Agatha, Kenya is importing guava fruits from Israel yet it has the potential to produce enough for its own consumption (Agatha, 2019). Therefore, a study was conducted in four agro ecological zones in TaitaTaveta County to determine the diverse fruit flesh colours that exist, guava production methods used by farmers and utilization of the fruit either in fresh form or processed products. Hence, the objective was to evaluate the baseline information on domesticated guava accessions, production and utilization in TaitaTaveta County of Kenya.

## METHODOLOGY

A survey was conducted in TaitaTaveta County (Coastal region), within the four sub-counties (Mwatate, Taveta, Voi and Wundanyi). This study was carried out in the months of August to September in 2019. Topographically the county is divided into three major zones which include; Upper zone comprising of Taita, Mwambirwa and Sagalla hills regions having an altitude of between 304 to 2, 208 metres above sea level (masl). The lower zone consisting of plains and the volcanic foothill covering Taveta region (CIAT, 2016). The county is divided into eight agro ecological zones which makes it a good presentation of other regions in Kenya where guava is cultivated (Jaetzold *et al.* 2010). TaitaTaveta has an area of 17083.9 Km<sup>2</sup> and a population of 340,671 according to 2019 national census. The region has varied rainfall and terrain with the lower zones receiving an average of 440 mm of rain per annum and the highland areas receiving up to 1900 mm of rainfall.

The county experiences two rain seasons; long rains between the months of March and May and short rains between November and December. Guava is adapted to a wide range of climatic conditions due to its diversity and was found in all the sub counties of TaitaTaveta. The agro ecological zones in TaitaTaveta County is a representation of other regions in Kenya where the fruit can be cultivated. Some parts of Western Kenya

are located at the upper midland zone (UM 3); Central region of Kenya, lower midland zone (LM 4). The lower midland zone (LM 5, irrigated) represents other regions receiving less than 450 mm of rainfall per annum where guava is cultivated. According to TaitaTaveta County (2009) the region has varied soil types and the dominant soils on the Taita hills range from humic cambisols, humic nitisols to dystic regosols of moderate to high fertility. Regosols and orthic rendzinas soils of high fertility occur on the hills. Upper zones comprise of humic cambisols and chromic acrisols. Foothills bordering the mountains and hills have soils of chromic luvisols and rhodic ferralsols of low natural fertility. This different soil types have greatly contributed to the fruit diversity because soil mineral composition is among the factors affecting guava fruit diversity.

**Table 1: Study site characteristics comprising of agro ecological zones, rainfall and soils**

Site	Agro ecological zone	Rainfall per annum	Soil
Wundanyi	Upper midland zone UM 3	900- 1200 mm	Sandy clay loam to clay
Mwatate	Lower midland LM 4	600- 800 mm	Sandy clay loam
Taveta	Lower midland LM 5(Rain- fed)	550- 700 mm	Silty clay loam- clay
Taveta	LM 5 (Irrigated)	340- 450 mm	Cracking clay
Voi	Inner Lowland IL5	550- 680 mm	Sandy clay loam

*Source: MoALF*

Stratified random sampling was carried out where each agro-ecological zone formed a stratum. Within each stratum random sampling of farms cultivating guava was done following administrative boundaries. Both closed ended and open-ended questionnaires were used to collect data on existing guava fruit flesh colours, production methods used by the farmers and fruit utilization. A total of two hundred and ninety-three respondents were interviewed. Data was analyzed using SPSS VS 20.0 (IBM, 2011) Descriptive statistics and cross tabulations were computed for the various factors across the agro ecological zones.

## RESULTS

All interviewed farmers owned land that was used for agricultural purposes except in the lower midland (LM 5); irrigated where 2.9 % did not own land having a chi- square value > 0.001 which did not differ statistically as depicted by figure 1 below.

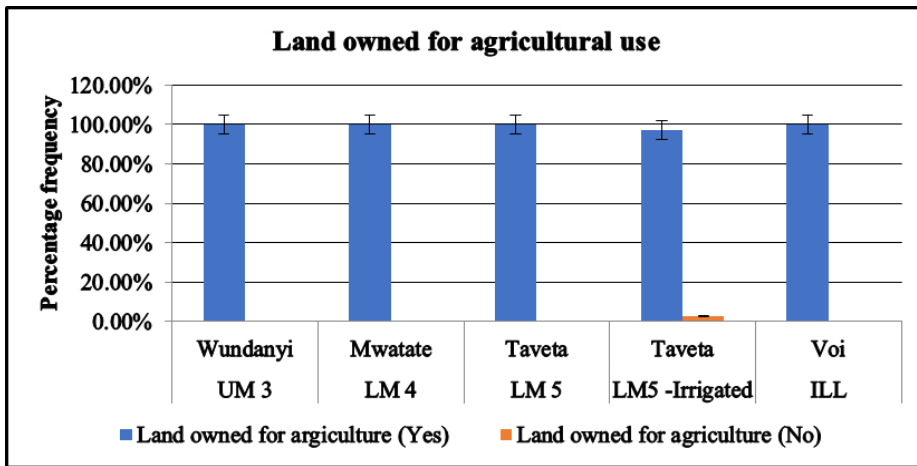


Figure 1: Land ownership for agricultural use in five agro- ecological zones: Upper midland; UM 3 (Wundanyi), Lower midland; LM 4(Mwatate), Lower midland; LM 5(Taveta rainfed), Lower midland; LM 5 (Taveta irrigated region) and Inner low- land; ILL (Voi) of TaitaTaveta county of Kenya

The domesticated guava accessions included; red fleshed, white fleshed and pink fleshed. Red fleshed guava was the most domesticated followed by white fleshed while pink fleshed was the least being domesticated within Wundanyi and Taveta irrigated regions as shown in figure 2 below.

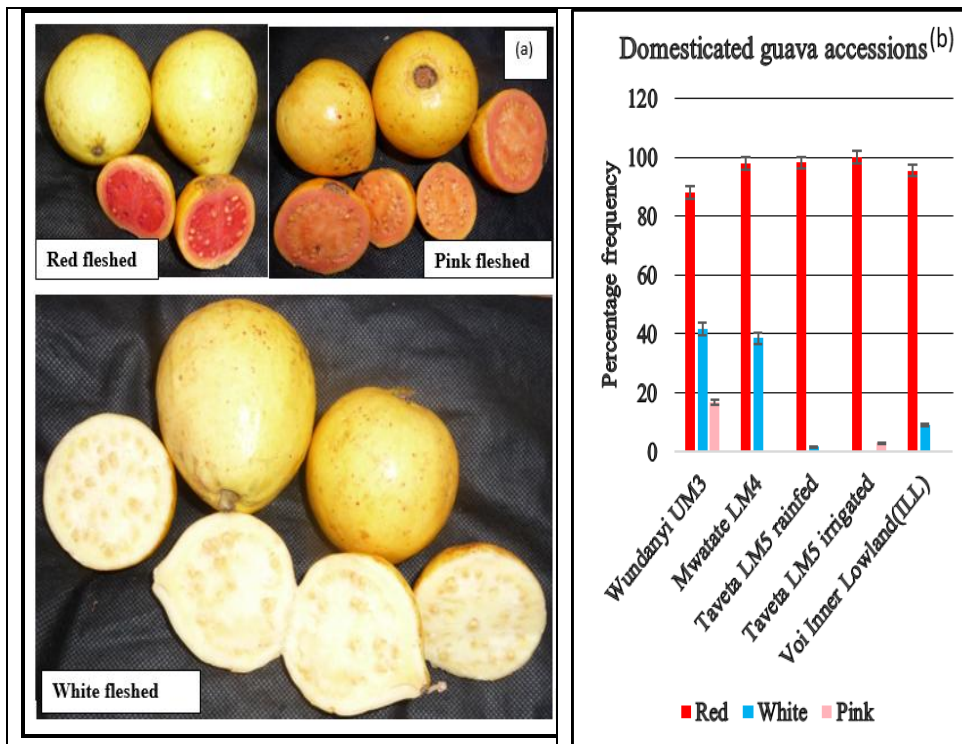


Figure 2(a) and (b): Domesticated guava accessions in five agro- ecological zones: Upper midland; UM 3 (Wundanyi), Lower midland; LM 4(Mwatate), Lower midland; LM 5(Taveta rainfed), Lower midland; LM 5 (Taveta irrigated region) and Inner low- land; ILL (Voi) of Taita Taveta county of Kenya

Farmers affirmed guava seeds to be dispersed by animals except in the inner lowland (Voi) region where a bigger percentage reported to be planting the seeds as observed in figure 3 below.

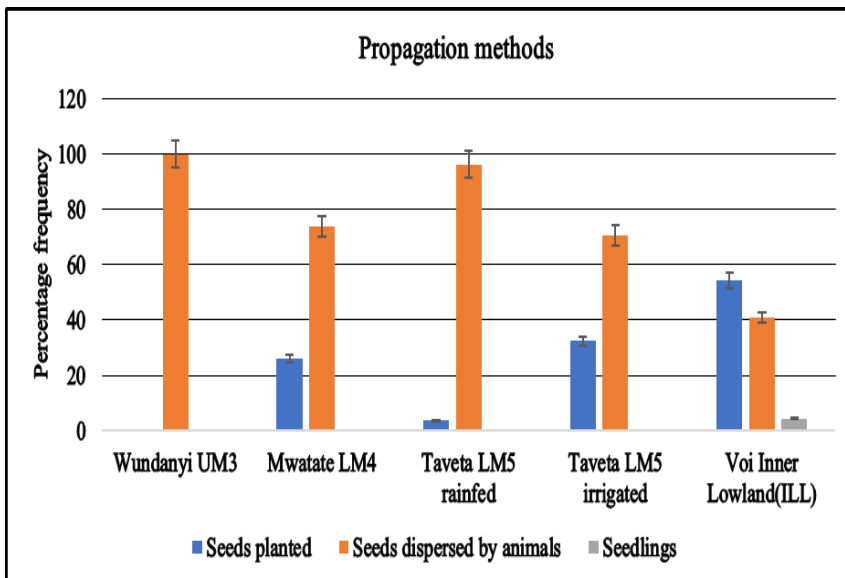


Figure 3: Propagation methods used by farmers in five agro- ecological zones: Upper midland; UM 3 (Wundanyi), Lower midland; LM 4(Mwatate), Lower midland; LM 5(Taveta rainfed), Lower midland; LM 5 (Taveta irrigated region) and Inner low- land; ILL (Voi) of Taita Taveta county of Kenya

Most farmers reported to consume guava fruits due to its availability in all regions except in Mwatate where a bigger percentage reported the fruits to be sweet as depicted by figure four below. Statistical difference was observed  $\chi^2 < 0.001$

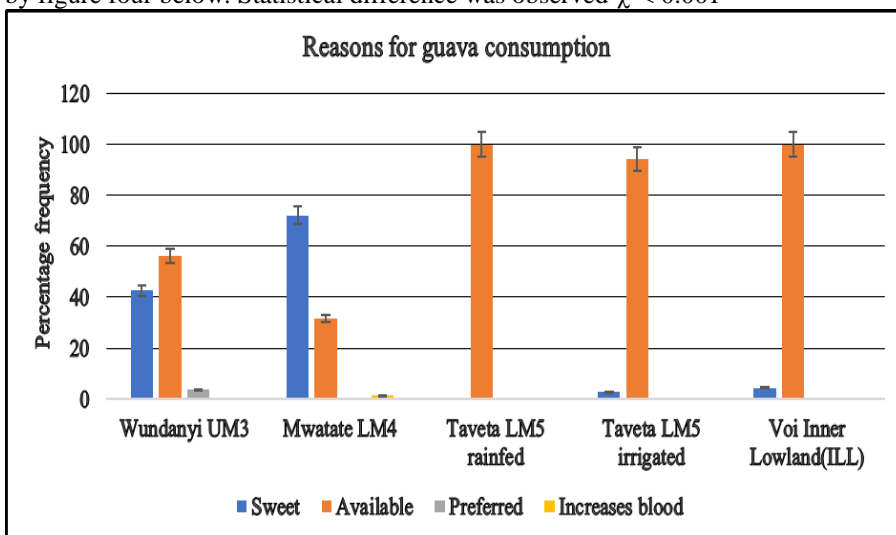


Figure 4. Reason for guava consumption in five agro- ecological zones: Upper midland; UM 3 (Wundanyi), Lower midland; LM 4(Mwatate), Lower midland; LM 5(Taveta rainfed), Lower midland; LM 5 (Taveta irrigated region) and Inner low- land; ILL (Voi) of Taita Taveta county of Kenya

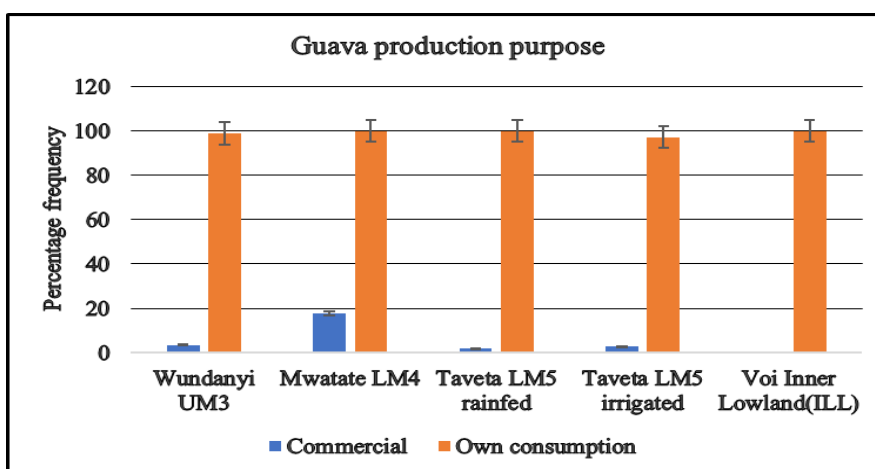
Majority of the farmers did not practice agronomic practices such as spacing, fertilizer application and pest and disease management as shown in table two above. There were no statistical differences, chi- square value > 0.001

**Table 2: Guava agronomic practices in five agro- ecological zones of Taita Taveta County of Kenya**

Region	Spacing of plants (No spacing)	Fertilizer use in guava (No fertilizer application)	Pest and disease management (No management)
Wundanyi UM3	100	100	100
Mwatate LM4	99	95.9	99
Taveta LM5 rainfed	100	100	100
Taveta LM5 irrigated	100	100	100
Voi Inner Lowland (ILL)	100	100	100

Upper midland; UM 3 (Wundanyi), Lower midland; LM 4 (Mwatate), Lower midland; LM 5 (Taveta rainfed), Lower midland; LM 5 (Taveta irrigated region) and Inner Lowland; ILL (Voi)

Most farmers reported to grow guava fruits for their own consumption. Less than 20% of the farmers reported to sell the fruits as observed in figure 5 below.



**Figure 5: Guava production purpose in five agro- ecological zones: Upper midland; UM 3 (Wundanyi), Lower midland; LM 4(Mwatate), Lower midland; LM 5(Taveta rainfed), Lower midland; LM 5 (Taveta irrigated region) and Inner low- land; ILL (Voi) of Taita Taveta county of Kenya**

Most farmers reported to consume guava fruits once in a week expect at the lower midland (LM 5)- irrigated where a bigger percentage consumed the fruit at least once in a month. Some farmers from lower midland (LM4) and inner lowland consumed the fruits daily. One percent of the respondents from Mwatate sub-county did not consume the fruits as depicted by figure 6 below.

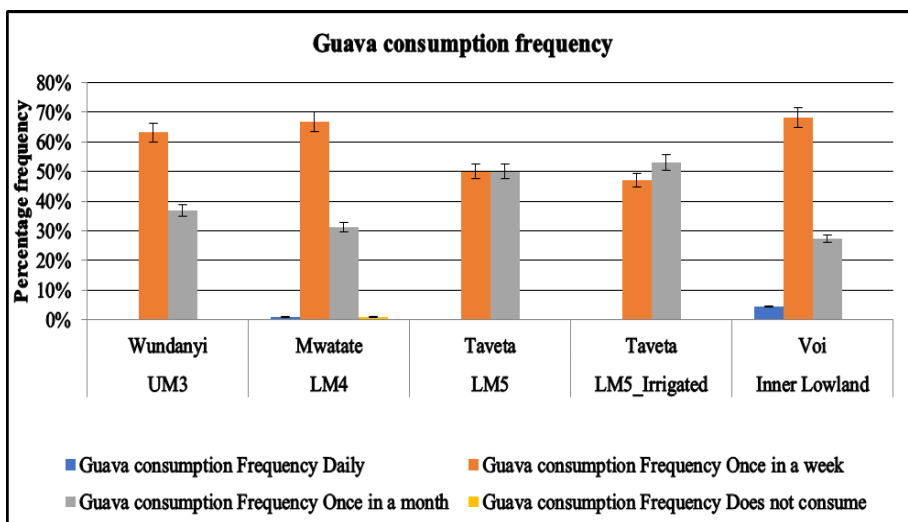


Figure 6: Guava consumption frequency in five agro- ecological zones: Upper midland; UM 3 (Wundanyi), Lower midland; LM 4(Mwatate), Lower midland; LM 5(Taveta rainfed), Lower midland; LM 5 (Taveta irrigated region) and Inner low- land; ILL (Voi) of Taita Taveta county of Kenya

Farmers neither preserved the fruits nor added value to it. They disposed of over-ripened guava fruits while only a few made seeds and fed animals. There were no statistical differences  $\chi^2 > 0.001$  as shown in figure 7 below.

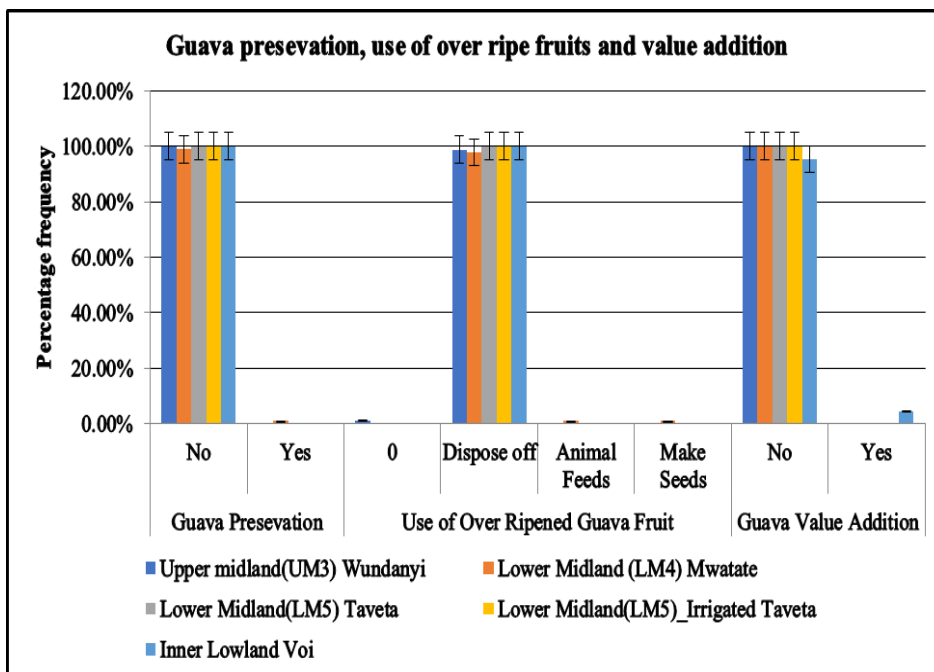


Figure 7: Guava presevation, Use of over ripened fruits and Value addition status in five agro- ecological zones: Upper midland; UM 3 (Wundanyi), Lower midland; LM 4(Mwatate), Lower midland; LM 5(Taveta rainfed), Lower midland; LM 5 (Taveta irrigated region) and Inner low- land; ILL (Voi) of Taita Taveta county of Kenya

## DISCUSSION

### **Guava Diversity and Production Practices**

Red fleshed guava accession is domesticated across all the agro ecological zones because the fruits in some regions are sweeter than other fleshed colours as shown in figure two above. Farmers also reported low incidence of attack by microbial organisms of the red fleshed fruits compared to the white fleshed. Some farmers reported the red fleshed colour to be indigenous while the white fleshed colour was introduced from other places thus referring it as “English Variety.” According to CABI (2019) guava was introduced to Kenya though the country of origin is not mentioned and considered an invasive species. Chiveu, *et al.*, (2015) reported 177 guava accessions exist in Kenya from various regions; Coast, Eastern, Rift Valley and Western.

Guava was mainly propagated via seeds dispersed by animals although farmers took care of the crop as depicted in figure three above. This is in coterminous with the findings of Berens, *et al.*, (2007); Makau (2017) who reported 82% of the seedling species were dispersed by animals especially birds around the Kakamega forest farms. Guava seed dispersal in Vihiga County farmlands was by the bats. Marco (2011) found the frugivorous birds to be of great importance since they were able to move widely and visit fruiting plants hence promoting long-distance seed dispersal. Guava fruits have been neglected because they do not have adequate market and also farmers are not aware about the importance of the crop as depicted by figure four above. Ekesa, *et al.*, (2009) reported guava being domesticated where trees were scattered in the farms and nearby forest areas.

Developing nations such as Kenya should continue to expand its global share of tropical fruit production. Main focus has been given to the major tropical fruits. Minor tropical fruits, such as lychees, durian, rambuttan and guava are traded in smaller volumes at the regional level as reported by (www.fao.org). However, guava dominated the other minor fruits not only in Kenya but also worldwide in the year 2015 – 2017 (Sabine, 2018).

Farmers do not take into consideration agronomic practices such as spacing, pests and disease management and fertilizer application as depicted by table two above. This is probably due to lack of market thus the crop grows unattended. According to Nuamah, *et al.*, (2012) fruit growers took no action to control fruit flies in their farms and 85% of farmers affirmed they needed training on pests and their management. However, VanMele, *et al.*, (2001) found 97% of the farmers used insecticides to control pests in Mangoes in Mekong Delta. At the lower midland (LM 4) few farmers reported to use compost manure to grow the fruits along the terraces.

Farmers reported to produce the fruit for their own consumption as observed in figure five above since the fruits lacked market. Most farmers reported to continue producing the fruit if there will be a market for their produce in future. Horticulture Crop Directorate report (2015- 2016) reported an increase in guava production even though this accounted for 0.101% of the total.

### **Utilization of Guava Fruits**

All respondents consumed fresh guava fruits with a higher percentage consuming the fruit at least once in a week except a few respondents from Mwatate region who did not consume the fruits despite them cultivating as observed in figure six above. This is similar to the findings of Chiveu, *et al.*, (2016) who reported guava fruits to be



consumed fresh in Kenya. However, Obaga & Mwaura (2018) reported processing of banana fruits to crisps and flour which significantly increased income. Guavas produced are eaten immediately across the agro ecological zones hence the fruits are not preserved as shown in figure seven above. The consumption of the fruit is not constant because farmers prefer other fruits such as bananas. In some regions within the lower midland (LM4) and inner lowland guavas are seasonal, bearing once in a year. The fruit is considered as food for children. This is in agreement with Verheij (2006) who reported most people in Africa are not fruit minded thus considered as food for the birds and children. Farmers do not do any value addition to the fruit and in most cases over-ripened guava fruits are left to rot under the tree.

## CONCLUSION AND RECOMMENDATION

In conclusion guava fruits exist in various flesh colours in TaitaTaveta County of Kenya. However, the fruit has been neglected and no much attention has been given because the fruit has no proper market. Farmers consume the fruits freshly. Over-ripened guava fruits are left under the tree to rot.

Farmers need to be educated on the nutritional importance of the crop and production practices in order to improve the value chain. The crop needs promotion and value addition. Market outlets should be created. To produce true to type, the fruit has to be propagated vegetative.

## REFERENCES

- Adel, A. K. (2014). *Maturity Quality and Maturity Indices*. California: University of California.
- Agatha, N. (2019). Free Seedlings to Save Guava Fruits. *The Star*.
- Anil, K. (2018). Importance for Life 'Psidium guava'. *Researchgate*.
- Arjun, K., & Sushree, S. M. (2018). Review on Medicinal Properties of *Psidium guajava*. *ResearchGate*.
- Armachius, J., Vumilia, Z., & Faith, Y. (2017). Postharvest Management of Fruits and Vegetables. A potential for Reducing Poverty, Hidden Hunger and Malnutrition in Sub- sahara Africa *Cogent Food and Agriculture* 3(1).
- Aulakh, J., & Regmi, A. (2013). Post -Harvest Food Losses Estimation- Development of Consistent Methodology.
- Berens , D., Schaab , G., Farwig , N., & Katrin , B. (2007). Exotic Guavas are Foci of Forest Regeneration in Kenyan Farmland.
- CABI. (2019). Invasive Species Compendium; *Psidium guajava*
- Chiveu, C. J. (2018). *Assessment of Genetic and Nutritional Diversity, and Salinity Tolerance of Kenyan Guava: an Underutilized naturalized Fruit Species*. University of Gottingen, Germany, Georg-August.
- Chiveu , C. J., Mueller , M., Krutovsky , K. V., & Kehlanbeck , K. (2015). Genetic Diversity of Common Guava in Kenya: An Underutilized Naturalized Fruit Species.
- Chiveu, J., Naumann, M., Pawelzik, E., & Kehlenbeck, K. (2016). Morphological Diversity of the Underutilised Fruit Species Guava in Kenya *Tropentag*.
- Duke, G. O., Abong, G. O., Okoth, M. W., Gachui, C. K., & Mwang'ombe, A. W. (2019). Current Status of Guava (*Psidium Guajava L.* ) Production, Utilization, Processing and Preservation in Kenya: A Review *Current Agriculture Research Journal*.
- Ekesa , B., Walingo , M. K., & Abukutsa-Onyango , M. O. (2009). Accesibility to and Consumptioin of Indigenous Vegetables and Fruits by Rural Households in Matungu Division, Western Kenya. *ResearchGate*.
- FAO. (2018). Post harvest Management of Mango for Quality and Safety Assurance
- Gajanana, T. M., Sudha, M., Arvind, S., & Dakshinamoorthy, V. (2010). Postharvest Handling , Marketing and Assessment of Losses in Papaya *ResearchGate* 851(519-526).
- Groot, N., & Bleijievens, K. (2017). East Sundan Horticulture Study. *Agro Fair Taste. RVO*.
- Guitierrezetal, P. M. P. (2008). *Pidium guajava*; A Review of its Traditional Uses, Phytochemistry and Pharmacology. *Journal of Ethnopharmacology*(117), 1-27.
- HCDA. (2017). *Horticulture Validated Report*.
- Jaime, C., & Justin, K. (2018). Farming Practices, Knowledge and Use of Intergrated Pest Management by Commercial Fruit and Vegetable Growers in Missouri *Journal of Intergrated Pest Management* 9(1):21; 1-119(21), 1-11.

- Kareem, A., Manan, A., Saeed, S., Rehman, S., Shahzad, U., & Nafees, M. (2016). Effect of Different Concentrations of IBA on Rooting of Guava (*Psidium guajava L.*) in Low Tunnel Under Shady Situation. *Journal of Agriculture and Environment for International Development*, 110(2), 197-203.
- Maindi, N. (2014). Maindi N. (2014) Membership Decision and Intensity of Participation in Avocado Producer and Marketing Groups In Kandara Sub County, Murang'a County . ResearchGate *ResearchGate*
- Makau , R. (2017). The Role of Fruit Bat Eidolon Helvum and Avian Frugivores in Guava Seed Dispersal and Tree Establishment in Agricultural Landscapes in Vihiga, Western Kenya.
- Marco, A. (2011). Frugivory , Post Feeding Flights of Frugivorous Birds and Movement of Seeds in a Brazilian Fragmented LandScape in Biotropica. 43(3), 335- 342.
- MOA. (2013). Indian Horticulture Database. *National Horticulture*.
- Nuamah, K. A., Billah , M. K., & Obeng-Ofori, D. (2012). Farmers Knowledge and Perceptions of Fruit Fly Pests and Their Management in Northern Ghana. *Greener Journals of Agricultural Sciences, Research Gate*
- Obaga, B. R., & Mwaura, F. O. (2018). Impact of farmers Participation in Banana Value Addition in Household Welfare in Kisii Central Sub- County *International Academic Journal of Social Sciences and Education* 2(1), 25-46.
- Priyanka, P., Rajitha, S., Lioyd, T., & Martha, V. (2016). Development of a Functional Food Product using Guavas. *Biomedical and life Scinces*, 7(10).
- Reddy, B. M. C., Gurav, S. B., Swamy, P. N., Rajan, S., Singh, A. K., & Nath, V. (2016). *Guidelines for Conduct of Test for Distinctiveness, Uniformity and Stability on Guava*. New Delhi: Government of India.
- Sabine, A. (2018). Minor Tropical Fruiuts. *Food OutLook*.
- Said, R., Farzana, B., Nadeem, K., Abdul, M. K., Zahir, S., Asif, I., et al. (2017). Postharvest Life of Guava (*Psidium guajava L.*) Varieties as Affected by Storage Intervals at Room Temperature. *Pakistan Journal of Agriculture*, 30(2), 155-161.
- Singh, K. K. (2018). A Review: Macro-propagation of Guava(*Psidium guajava*). *Pharmacognosy and Phytochemistry*, 7(2), 2629-2634.
- Sisir, K. M., Irenaeus, T. K. S., Gurung, M. R., & Pathak, P. K. (2012). Taxonomy and Importance of Myrtaceae. *ResearchGate*, 959(959), 23-34.
- USDA. (2016). *Guava Vs Orange -In- Depth Nutrition Comparision*: U.S. Department of Agriculture.
- VanMele, P., Thi Thu, C., & Vanhuis, A. (2001). Farmers Knowledge , Perceptions and Practices in Mango Pest Management in the Mekong Delta, Vietnam *International Journal of Pest Management* 47(1), 7-16.
- Verheij, E. (2006). *Fruit Growing in the Tropics ISBN 90- 8573- 0562*
- Zamir, R. (2017). Effect of Different Auxins on Rooting of Semi Hard and Soft Wood Cuttings of Guava (*Psidium guajava L.*) CV.Safeda. *Nucleus*, 54(1), 46-54.