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A PRELIMINARY SURVEY ON POSTHARVEST CHALLENGES OF SMALL - SCALE FARM HOLDERS OF MANGO (*Mangifera indica* L) OF BATTICALOA DISTRICT, SRI LANKA; STATUS AND REQUIREMENT

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***Abstract*— Mango (*Mangifera indica* L.) is one of the most famous and valuable fruits in Sri Lanka. Mango is a potential source of household income for the resource-poor or small- scale farm holders in Batticaloa district, Sri Lanka. Following the opportunistic non-random sampling, 120 small-scale farm holders from four Divisional Secretariat divisions, were selected based on the availability of small mango orchards, in Batticaloa district. Investigative Survey Research Approach (ISRA) was carried out in this study. A predesigned semi-structured questionnaire was used to obtain information. Key-informant interviews, local market visits, and field verification also conducted during the study. The nature and extent of postharvest losses during the storage were quantified, at storage conditions for 180 randomly selected healthy mango fruits, collected from the study area. The study evidenced that about 44% of mangoes are harvested without correct harvesting maturity and about 16.5% of losses are caused due to the inappropriate harvesting practices. Furthermore, 5% of the loss has occurred during storage at the farm level. Postharvest losses of mango are predominately caused due to several reasons such as improper maturity at harvesting, mechanical damage, sap burning, and diseases incidents.**

Keywords— ***Disorders, Harvesting methods, Mango, Post-harvest losses, Sanitation practices***

I. INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most economically significant and choicest seasonal fruit in the world due to its pleasant flavour, delicious taste, and nutritional value. The mango is also known as the ‘‘king of fruits’’ and extensively cultivated throughout the tropical and subtropical regions (Sivakumar et al., 2011; Singh et al., 2013; Baloch and Bibi, 2012; Katoch et al., 2019, Lawson et al., 2019; Singh et al., 2019). The production trend also is increasing every year (Dameshwari and Ravindra, 2017). It has been well documented that mango fruit as an important source of nutrients, vitamins, minerals and phytochemicals such as lupeol, mangiferin and phenolic acids. The fruit also has properties of antioxidant, anti-inflammatory and anticancer (Lauricella et al., 2017; Vithana et al., 2019; Maldonado - Celis et al., 2019; Lauricella et al., 2017; Septembre - Malaterre et al., 2016). Mango is native to tropical Asia, and production of mango has increased dramatically over the past two decades. It is one of the most popular of all tropical fruits too (Sab et al., 2017; Shah et al., 2010). Mango fruit takes second place as a tropical crop, behind only bananas in terms of production and land use (Parvez, 2016). According to FAO (2018), mango production is higher in emerging countries than in developed countries. FAO (2018), further highlighted that the demand for the mango fruits is growing both the developing and developed countries. However, Post-harvest losses become a significant impact on the growing economy of mango.

Mango is adhesion with the Sri Lankan culture for a long time. It has also been suggested that the name of the capital city, Colombo, may be derived from the Sinhalese phrase "Kola amba thota," which translates as "harbour with leafy mango trees"(Peiris, 2016).

In Sri Lanka, mango is one of the most cultivated fruit and is responsible for earned foreign exchange by exporting raw and processed mango. Mango is adaptable to a wide variety of soil types and climate conditions. The mango cultivation extends to wet, dry, and intermediate zones in the island

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(Peiris, 2016). According to Agricultural Statistics (2018), mango cultivation in Sri Lanka is extended to 28,272 ha and production is 151,733 t per year.

Mangos are generally available in Sri Lanka, during the period from October to December/January and April to July (Kuganesan et al., 2017; Peiris, 2016). However, diverse environment condition in Sri Lanka leads to mango fruiting across the country almost throughout the year (Kapilan and Anpalagan, 2015). Small-scale farms are the major contributors of mango to local markets as commercial production is more limited (Peiris, 2016). During the supply chain, it reduces the marketability of mango fruits in the local and export market (Nunes et al., 2007; Roy and Joshi, 2015). Number of factors are influenced the quality of mango fruits throughout the supply chain, such as inadequate farm sanitation practices, poor harvesting practices, packaging operations, post-harvest treatments, temperature management, rough handling, transport and storage conditions, and ripening at destination (Sivakumar et al., 2011; Esguerra and Rolle, 2018). These factors could directly or indirectly affect the income of small – scale farm holders and need to mitigate the post-harvest losses during the supply chain. This study is aimed to understand the reasons for the post-harvest losses of mango at the small – scale farm level in Batticaloa, Sri Lanka. The study also focused in to suggest some practices to mitigate post-harvest losses and increase the income of the farmers.

II. MATERIALS AND METHODS

The survey was conducted in four Divisional Secretariat Koralaipattu, Koralaipattu South, Eravurpattu and Manmunai North, Batticaloa district (Fig.1.). Opportunistic non-random sampling (Convenience sampling) method was used to interview the one hundred and twenty (120) mango growing small-scale farmers. The survey was conducted using the method of Investigative Survey Research Approach (ISRA) (Anazodo et al., 1986). Information was collected using a semi structured questionnaire, which intended to obtain the following information: harvest time, harvesting method, harvesting maturity, losses during harvest, mode of storage, transportation, and packaging systems. Key-informant interviews, local market visits and field verification were also conducted to obtain more information. The nature and extent of postharvest losses during the storage were quantified. The samples were collected at the small-scale farm site (orchard cultivation) by randomly obtained the 180 mangoes through all the five DS divisions. The randomly collected samples were further visually observed to find diseased and healthy fruits. Collected diseased fruits were rejected and resampled until obtaining the disease-free sample units. The samples were then stored at ambient temperature (30 ± 2°C) by without physical touch of each mango for four days. No, pre-treatment was carried out before the storage. The samples were analyzed to quantify the diseased, latex burnt and other damaged fruits. The data were analyzed with the help of descriptive statistics and the one- way ANOVA. Statistical analysis was carried out using Minitab 14.0 (version 14) for windows.

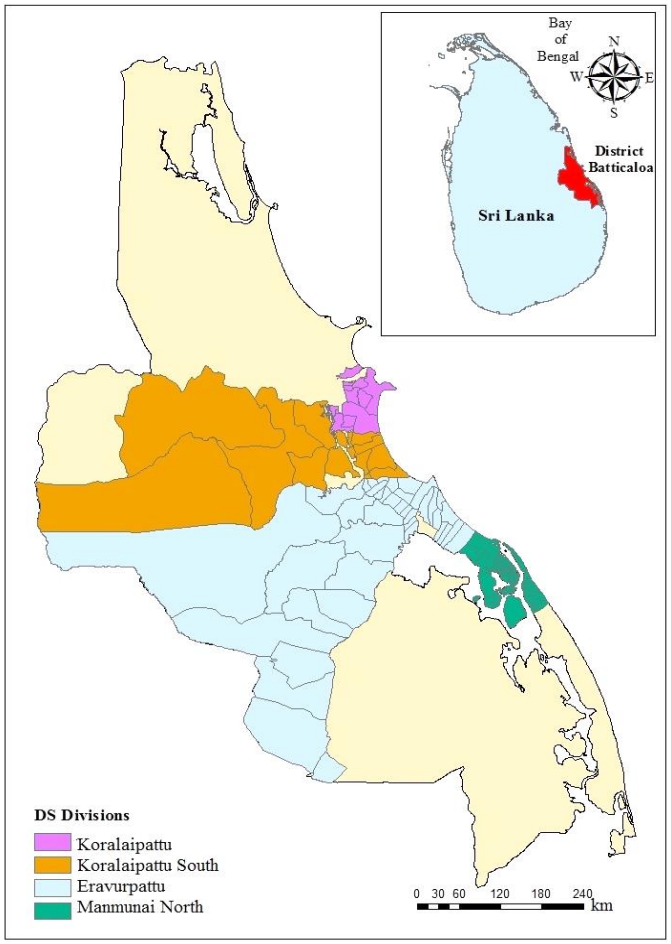

Fig.1. Schematic map of the selected study area in Batticaloa district of Sri Lanka.

III. RESULTS AND DISCUSSION

Karuthacolomban and Willard are the most common mango verities in the Batticaloa district, Sri Lanka. Locally harvested fully matured mango is sold the range of 25 - mostly 75 LKR (Sri Lankan Rupee) per fruit at the market during the study period.

Harvesting Maturity and Future Losses

The study shows that considerable post-harvest losses during harvesting, handling, and storage among small-scale farm holders. There are no significant differences among the selected DS divisions in the Batticaloa district for above-mentioned losses (One-way ANOVA, $p > 0.05$).

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Mango is a climacteric fruit, and generally harvested at the mature green stage, and ripens up during the marketing process (Baloch and Bibi, 2012). Maturity at harvest will affect the rate of ripening, and the final quality of the edible fruit (Memon et al., 2013). The study resulted that considerable amount of mangoes are harvested at immature stage in the study area. Immature mangoes are distinguished by; dark green and no shoulders. While the mature fruits are characterized by the presence of, lighter green and shoulders forming (Ellong et al., 2015). Percentage of immature, and mature mango fruit at the time of harvest was about 32%, and 68% respectively. However, this happens especially due to the influence of mango collectors (buyers).

It was observed that the mango collectors usually come and demand the whole trees or a block of trees after estimating the fruit load on the trees. The mango collectors tend to harvest all the fruits as much as possible, from a tree in a single picking. As the mango collectors are coming from long distance (even from the nearby district like Ampara), to cut down the transport expenses, they harvest the mangos on one trip. This situation is leading to the harvest of immature fruits too. However, farmers indicated that the method of purchasing is not cheap for them. Since, while purchasing the trees, if those have more immature fruits then the demand also will reduce. Nevertheless, adequate transportation and poor storage facilities are leading to sell the mango fruits at low prices at the farm level. Further, harvested fruits are being transported immediately after harvest. “Buddy” trucks (small trucks) are mainly used by the mango collectors for transportation. Enough data could not be achieved during the research about harvest losses during transportation. However, it is noted that there are no sanitation practices considered before loading them into the trucks. Transport of whole the harvest together without any packaging is a common practice in the study area. In addition, there is no evidence use of any specialized transport vehicles exclusively for fruits transportation.

The selection of adequate maturity indices is crucial since the quality of the postharvest life of mango fruit is depends on the stage of maturity at harvest (Kienzle et al., 2011). The fruits need to be harvested at the ideal stage in order to develop the most adequate qualities such as flavour and aroma. As well, harvested at exact physiological maturity is also important to have longer postharvest life (Ranganathan et al., 2015; Amin et al., 2008).

Mango fruits ripen quickly after harvest (Ahmed, and Ahmed, 2014). Harvest of immature fruits will not ripen naturally and it needs to use artificial ripening methods such as fuming or usage of chemicals. However, this will lead to poor taste, odour and reduce the preferably of the consumers (Kapilan and Anpalagan, 2015). In general, maturity is defined by physical, physiological and chemical parameters. Physical parameters to determine the maturity of mango is commonly practised from the time of harvesting to selling point in the study area, and it includes softness of the fruit peel colour and development of shoulders. However, these factors are varying according to the mango varieties (Ahmed, and Ahmed, 2014; Sivakumar et al., 2011; Yahia, 2011). Suitable maturity indices for harvesting are very important to minimize the quantitative and qualitative losses and improve the income for the small-scale farm holders too (Murthy et al., 2009).

Losses at Harvest

The study shows that improper harvesting practices cause significant losses at the harvest. Bruising, physical damage and sap (latex) contamination are recorded separately to explore the effect on the method of harvest, fruit (Fig. 2.). Results indicated that the, 83.5% of fruits are free from any disorder, and about 16.5% of losses are caused due to the bruised and other physical damaged at the farm. The intensity of the bruising is varied according to the verity, size, maturity stage and the temperature etc (Opara and Pathare, 2014; Aliasgarian et al., 2015). However, bruising, and other physical damages at this stage is about 10 % and 6% respectively, in existing harvesting system.

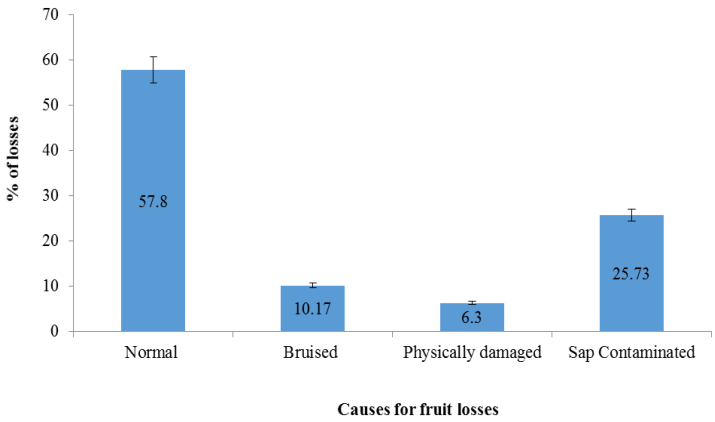

Fig. 2. Post-harvest losses of Mango at harvest.

Latex burning is another factor, observed in the study area. As the peduncle is broken, latex typically spurts and/or oozes out and contact with the fruit surface can cause the latex burning (San et al., 2019).

Immediately after the harvest, washing of mango is essential in order to avoid the latex burning. Several studies suggested that hot water treatment (50 - 52°C, for 3 - 5 min) would be significant. The latex burning causes black lesions on the fruit skins and leads to the rotting during the storage (De La Cruz Medina, and García, 2002).

Rather than the skin damage, sticking of sap appears to interfere with the development of fruit peel colour (Amin et al., 2008). To reduce the latex damage, after harvest the fruits should keep (after removing the stalk) with end - down the cut stems to allow drain off the latex (Peiris, 2016). Further,

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mechanical injuries also observed during harvesting of mangoes (Fig. 3.), where some of the fruits with physical damages are left at the field and those fruits are becoming the source of inoculum for various other infections.

(a) (b)

Fig. 3. (a) Bruising of fruit due to inappropriate harvesting methods and (b) diseased fruits.

The market survey was indicated that (at the point of sale), fruits which are harvested from local farms are associated with brushing and the diseases (Fig.4.). Therefore, the avoidance of injuring the fruit would prevent several problems, including a significant reduction in decay. Bruises and other mechanical damage not only affect appearance but also provide entrance to pathogenic microorganisms as well (Olayemi, et al., 2010).

Besides, it is noted that the harvesting of mangoes does not have any particular time during the day and fruits are harvested in the late morning to evening in the study area. Harvesting at the afternoon can causes shrinkage to the fruits due to the higher temperature and evaporation. Hence, it may not be better practised to follow (Kereth et al., 2013; Palipane and Rolle, 2008).

Fig. 4. Mango fruits in the market with various defects.

Harvesting Method in the Study Area

Results showed that the harvest of mango is mostly done with manual harvesting, where buyers harvest the fruits using a long pole with a hook at the end also along with the net, in which the fruits are pulled down from the tree into the net. Also, fruit picked by the hook (without a net) is always dropped and injured. In a few places, pole with a net at the end is used to pick fruits from the trees. As well, people also shake the trees to drop the fruits and then pike up the fallen fruits from the ground. This practice also causes very serious damage and losses to fruit. The optimum harvesting practices involve the use of secateurs and cut the stem 1 - 2 cm away from the fruit. This technique will reduce latex exudation and staining. In addition, it will reduce the entrance of microorganism (Memon et al., 2013). Anthracnose disease is the most common disease of mangoes in Sri Lanka. The disease is initiated with localized small, dark brown circular spots and increased rapidly in size and formed dark depressed lesions in ripened fruits. The verity 'Karuthacolomban' is highly susceptible to the disease stem end rot. (Yahaya and Mardiyya, 2019; Krishnapillai and Wijeratnam, 2014; Peiris, 2016).

Evaluation of Losses of Mangoes during Storage

The survey resulted that the storage of harvested mango is carried out on the floor in small rooms or the corridor at the small-scale farm level. Before the mango store, on the floor, it is covered commonly with the sacs or straw (Fig.5.).

(a) (b)

Fig. 5. Post-harvest practices at farm level. (a). Storage of harvested mangoes. The fruits are kept on the ground at the farm level and fruits are also contaminated with latex. (b). Mangoes are kept beneath the sun right after the harvested.

Storage of mango is generally carried out only 2 - 4 days. Questionnaires revealed that up to 5% of mangoes are discarded after the storage. These losses are caused mainly due to the stem end rot of the fruits. However, the study is evidenced that the losses of mango fruits after the 4 days of storage is about 40% due to the multiple disorders.

However, about 60% of mango fruits are retained healthy after the storage, without having any disorders and with proper ripening. Moreover, within the majority of the diseased fruits (Fig.6.), losses caused due to the pathogenic diseases and latex burning are caused the next ranked impact of the mango quality losses. In addition, the lack of uniform colouration, skin abrasions, and localized softening causes about 9.5% quality losses.

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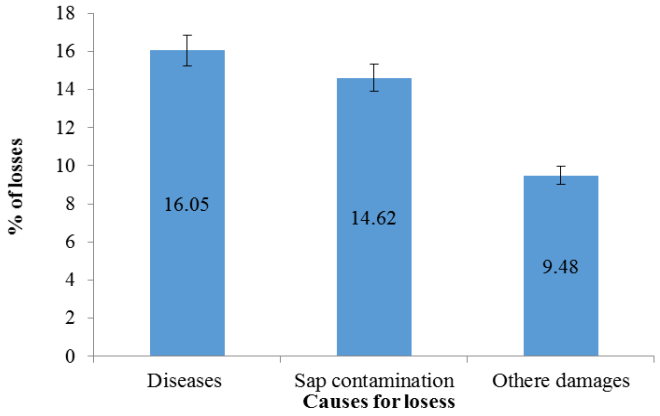

Fig. 6. Losses (%) of mangoes during storage. The Anthracnose and stem end rot were the most common diseases in the study area.

IV. CONCLUSION AND RECOMMENDATIONS

Lack of awareness on the mango post-harvest handling practices and inadequate facilities are the main challengers for the farmers in the study area in reducing loses. The losses can be overcome by careful handling and practising the appropriate methods for mango harvesting. However, the development of adequate socioeconomic constraints, such as infrastructure for storage and marketing systems should improve to reduce the post-harvest losses and to obtain higher profits for the farmers. Extensive training programs on pre and post-harvest handling of mangos need to be carried out in the area. Furthermore, I. Harvesting of fruits only at the proper maturity, II. Harvesting in the morning time, III. Harvest by hand or using mango - picking poles attached with a pair of clippers and fitted with nets, IV. Washing the fruits soon after harvesting and air - drying before storage or transport, are some recommendation to mitigate the post-harvest losses of mango in the district.

V. REFERENCE

[1]. Ahmed, O.K., and Ahmed, S. E.T. (2014). Determination of Optimum Maturity Index of Mango Fruits (*Mangifera indica*, L.) in Darfur. Agriculture and Biology Journal of North America, Vol 5, No. 2, (pp. 97 – 103).

[2]. Aliasgarian, S., Ghassemzadeh, H. R., Moghaddam, M., and Ghaffari, H. (2015). Mechanical damage of strawberry during harvest and postharvest operations. Acta Technologica Agriculturae, Vol 18, No. 1, (pp. 1 – 5).

[3]. Amin, M., Malik, A. U., Mazhar, M. S., Din, I. U., Khalid, M. S., and Ahmad, S. (2008). Mango Fruit Desapping in Relation to Time of Harvesting. Pakistan Journal of Botany, Vol 40, No. 4, (pp. 1587 – 1593).

[4]. Anazodo, U.G.N, T.O. Abinbola and J.A Dain. (1986). Agricultural Machinery; Type and Condition in Nigeria a National Investigation Survey Report, Federal Department of Agricultural and Natural Resources: Lagos, Nigeria.

[5]. Baloch, M. K., and Bibi, F. (2012). Effect of Harvesting and Storage Conditions on The Postharvest Quality and Shelf Life of Mango (*Mangifera indica* L.) Fruit. South African Journal of Botany, Vol 83, (pp. 109 – 116).

[6]. Dameshwari, S., and Ravindra, M. P. (2017). Defect Identification and Maturity Detection of Mango Fruits Using Image Analysis. American Journal of Artificial Intelligence, Vol 1, No. 1, (pp. 5 – 14).

[7]. De La Cruz Medina, J., and García, H. S. (2002). Mango: Post-harvest Operations. FAO - Post-Harvest Compendium, (pp. 3 – 69).

[8]. Ellong, E. N., Adenet, S., and Rochefort, K. (2015).Physicochemical,Nutritional,Organoleptic Characteristics and Food Applications of Four Mango (*Mangifera indica*) Varieties. Food and Nutrition Sciences, Vol 6, No. 2, (pp. 242 – 253).

[9]. Esguerra, E.B., and Rolle, R. (2018). Post-harvest Management of Mango for Quality and Safety Assurance. Guidance for Horticultural Supply Chain Stakeholders, FAO, Rome, (pp.4 – 20).

[10]. FAO (2018). Food Loss Analysis: Causes and Solutions Case Study on the Mango Value Chain in the Republic Of Trinidad and Tobago, (pp.1 – 29). http://www.fao.org/3/I9569EN/i9569en.pdf.

[11]. Kapilan, R., and Anpalagan, V.C. (2015). Determination of Optimum Maturity of North Sri Lankan Kilichondan Mango Fruits (*Mangifera indica* L.) Based on Their Biochemical Properties. Advances in Applied Science Research, Vol 6, No. 10, (pp. 105 – 113).

[12]. Katoch, P., Katoch, A., and Dangi, B. (2019). An Overview on Mango Malformation and the Potential Approaches to Their Management. Journal of Pharmacognosy and Phytochemistry, Vol 8, No. 4, (pp. 621 – 626).

[13]. Kereth, G.A., Lyimo, M., Mbwana, H.A., Mongi, R.J., and Ruhembe, C.C. (2013).

Assessment of Post – harvest Handling Practices: Knowledge and Losses of Fruits in Bagamoyo District of Tanzania. Food Science and Quality Management, Vol 11, (pp. 8 – 15).

[14]. Kienzle, S., Sruamsiri, P., Carle, R., Sirisakulwat, S., Spreer, W., and Neidhart, S. (2011). Harvest Maturity Specification for Mango Fruit (*Mangifera indica* L. 'Chok Anan') in Regard to Long Supply Chains. Postharvest Biology and Technology, Vol 61, No. 1, (pp. 41 – 55).

[15]. Krishnapillai, N., and Wijeratnam, R. S.W. (2014). First Report of Colletotrichum asianum Causing Anthracnose on Willard Mangoes in Sri Lanka. New Disease Reports, Vol 29, No. 1. https://www.ndrs.org.uk/article.php?id=029001.

[16]. Kuganesan, A., Thiripuranathar, G., Navaratne, A.N., and Paranagama, P.A. (2017). Antioxidant and Anti-Inflammatory Activities of Peels, Pulps and Seed Kernels of Three Common Mango (*Mangifera indica* L.) Varieties in Sri Lanka. International Journal of Pharmaceutical Sciences and Research. Vol 8, No. 1, (pp. 70 –78).

[17]. Lauricella, M., Emanuele, S., Calvaruso, G., Giuliano, M., and D'Anneo, A. (2017). Multifaceted Health Benefits of *Mangifera indica* L. (Mango): The Inestimable Value of Orchards Recently Planted in Sicilian Rural Areas. Nutrients, Vol 9, (pp. 1 –14).

[18]. Lawson, T., Lycett, G. W., Ali, A., and Chin, C. F. (2019). Characterization of Southeast Asia mangoes (*Mangifera indica* L) According to their Physicochemical Attributes. Scientia Horticulturae, Vol 243, (pp. 189 –196).

[19]. Maldonado - Celis, M. E., Yahia, E. M., Bedoya, R., Landázuri, P., Loango, N., Aguillón, J., Restrepo, B., and Guerrero Ospina, J. C. (2019). Chemical Composition of Mango (*Mangifera indica* L.) Fruit: Nutritional and Phytochemical Compounds. Frontiers in Plant Science, Vol 10, (pp.1 – 21).

[20]. Memon, A., Marri, M. Y.K., and Khushk, A.M. (2013). Estimation of Mango Post Harvest Losses in Sindh, Life Science International Journal, Vol 7, No. 1, (pp. 2827 – 2832).

[21]. Murthy, D. S., Gajanana, T. M., Sudha, M., and Dakshinamoorthy, V. (2009). Marketing and Post - Harvest Losses in Fruits: Its Implications on Availability and Economy. Indian Journal of Agricultural Economics, Vol 64, No. 2, (pp. 259 – 275).

[22]. Nunes, M. C. N., Emond, J. P., Brecht, J. K., Dea, S., and Proulx, E. (2007). Quality Curves for Mango Fruit (Cv. Tommy Atkins And Palmer) Stored at Chilling and Nonchilling Temperatures. Journal of Food Quality, Vol 30, No. 1, (pp. 104 – 120).

[23]. Olayemi, F., Adegbola, J., Bamishaiye, E., and Daura, A. (2010). Assessment of post -Harvest Challenges of Small Scale Farm Holders of Tomatoes, Bell and Hot Pepper in Some Local Government Areas of Kano State, Nigeria. Bayero Journal of Pure and Applied Sciences, Vol 3, No. 2, (pp. 39 – 42).

[24]. Opara, U. L., and Pathare, P. B. (2014). Bruise Damage Measurement and Analysis of Fresh Horticultural Produce - A Review. Postharvest Biology and Technology, Vol 91, (pp. 9 – 24).

[25]. Palipane, K. B., and Rolle. R (2008). Good Practice for Assuring the Post-Harvest Quality of Exotic Tree Fruit Crops Produced in Jamaica: A Technical Guide, Food and Agriculture Organization of the United Nations, Rome.

[26]. Parvez, G.M.M. (2016). Pharmacological Activities of Mango (*Mangifera indica*): A Review. Journal of Pharmacognosy and Phytochemistry, Vol 5, No. 3, (pp. 1 – 7).

[27]. Peiris, K. (2016). The Mango in the Democratic Socialist Republic of Sri Lanka. Mango Tree Encyclopaedia, Vol 19, (pp. 337 – 370).

[28]. Ranganathan, K., Ratnasabapathy, T., and Sellan, S. (2015). Determination of Optimum Maturity of Karuthakolumbaan Mango Fruits (*Mangifera indica* L.) to Reduce Post Harvest Loss. Bioscience, Bioengineering and Biotechnology, Vol 2, (pp. 12 – 20).

[29]. Roy, S. K., and Joshi, G. D. (2015). An Approach to Integrated Post - Harvest Handling of Mango. Acta Horticulturae, Vol 231, (pp. 649 – 661).

[30]. Sab, M., Ashok, M. B., and Sudhakara, S. N. (2017). Estimation of Post – Harvest Losses of Mangoes at Different Stages from Harvesting to Consumption. International Journal of Current Microbiology and Applied Sciences, Vol 6, No. 12, (pp.310 – 318).

[31]. San, A. T., Hofman, P. J., Joyce, D. C., Macnish, A. J., Marques, J. R., Webb, R. I., Li, G., and Smyth, H. E. (2019). Diurnal Harvest Cycle and Sap Composition Affect Under-Skin Browning

in 'Honey Gold' Mango Fruit. Frontiers in Plant Science, Vol 10, (pp. 1– 12).

[32]. Septembre - Malaterre, A., Stanislas, G., Douraguia, E., and Gonthier, M. P. (2016). Evaluation of Nutritional and Antioxidant Properties of the Tropical Fruits Banana, Litchi, Mango, Papaya, Passion Fruit and Pineapple Cultivated In Réunion French Island. Food Chemistry, Vol 212, (pp. 225 – 233).

[33]. Shah, K. A., Patel, M. B., Patel, R. J., and Parmar, P. K. (2010). *Mangifera indica* (Mango). Pharmacognosy Reviews, Vol 4, No. 7, (pp.42 – 48).

[34]. Singh, A.K., Charmkar, N.K., and Singh, R. (2019). Mango (*Mangifera indica* L): Morphological and Genetical Diversity in India. International Journal of Pure and Applied Bioscience, Vol 7, No.2, (pp. 382 – 395).

[35]. Singh, Z., Singh, R. K., Sane, V. A., and Nath, P. (2013). Mango – Postharvest Biology and Biotechnology. Critical Reviews in Plant Sciences, Vol 32, No. 4, (pp. 217 – 236).

[36]. Sivakumar, D., Jiang, Y., and Yahia, E. M. (2011). Maintaining Mango (*Mangifera indica* L.) Fruit Quality during the Export Chain. Food Research International, Vol 44, No. 5, (pp.1254 – 1263).

[37]. Vithana, M. D. K., Singh, Z., and Johnson, S. K. (2019). Regulation of the Levels of Health Promoting Compounds: Lupeol, Mangiferin and Phenolic Acids in the Pulp and Peel of Mango Fruit: A Review. Journal of the Science of Food and Agriculture, Vol 99, (pp.3740 – 3751).

[38]. Yahaya, S. M. and Mardiyya, A. Y. (2019). Review of Post-Harvest Losses of Fruits and Vegetables. Biomedical Journals of Scientific and Technical Research, Vol 13, No.4, (pp.1 – 9).

[39]. Yahia, E. M. (2011). Mango (*Mangifera indica* L.). In Yahia E.M (ed.), Postharvest Biology and Technology of Tropical and Subtropical Fruits: Cocona to Mango, England, Woodhead Publishing (pp. 492 – 565). .