

Chapter 1

Introduction

Mango (*Mangifera indica* L.) is one of the most important fruits in tropical zones and can be classified into two groups, Indian and Indo-Chinese types. The classification is based on the mode of their reproductive feature. The Indian type has monoembryonic seeds, each of which contains a single zygotic embryo and only one seedling grows per seed. The Indo-Chinese type has polyembryonic seeds which contain one or more embryos, one of which is usually zygotic. Adventitious embryos develop from the nucellus, a maternal tissue surrounding the embryo sac, and the nucellar seedlings of the mangoes are usually very similar to the maternal parent.

Moreover the Indian type are highly colored fruits with mixes of reds, purples and yellows and tend to be susceptible to anthracnose caused by *Collectotrichum gloeosporioides* Penz., whereas the Indo-Chinese ones are not highly colored fruit, green to light green to yellow, and tend to be more resistant to anthracnose. Mango selection has occurred in many production areas throughout the world, and locally selected and developed cultivars have their own characteristics adopting to each production region. Although there are hundreds of mango cultivars, the number of cultivars

grown commercially is relatively small. A mango cultivar grown in a different production area may behave and produce differently.

Mango is one of the important economic fruit crops in Thailand and Thailand is one of the major producers and exporters of mangoes. In 1997 Thailand exported around 14,515 metric tons of mangoes per year as fresh and canned fruits, earning US\$ 8,951,621. Mango plantations are found in many provinces but the large-scale plantations are located mainly on the east and the west coasts of the Gulf of Thailand, having an average production of 11,332 metric tons per year (1993-1997) (Arthachinda, 2000).

However, Thai mango production is confronted with the problems of quality and productivity to compete in the world market. The quantity of domestic and export mango has been limited by the mango's highly perishable nature; short storage life and susceptibility to postharvest disease, storage temperature and physiological disorders. These problems have seriously limited its export to distant markets. The relative importance of quality depends upon several factors such as maturity at harvest, ripening before marketing, and pre-harvest condition such as mineral nutrition, which can determine storage life and final fruit quality.

Factors affecting fruit quality and storability

1. Maturity

Maturity at harvest is the most important factor which determines storage life and fruit quality for the oversea market. Any fruit harvested either too early or too late is lower in fruit quality, more susceptible to disease and physiological disorders and has shorter storage life than fruit harvested at proper maturity. If fruits in a carton show uneven maturity, it is impossible to find an effective storage regime to ensure good quality on arrival. One fruit of more advanced maturity in a box may accelerate the ripening of all the other fruits, which may then arrive at a market with disease symptoms and/or short shelf life. Variable maturity within the treatment lots can also adversely affect product quality after heat disinfestations (Jacobi et al., 1995). The recommended stage of maturity for mango harvesting is different among cultivars. Methods for assessing fruit maturity may be on the basis of dry matter, flesh color, fruit shape, Brix, specific gravity or days from flowering. Thai mango cultivars such as 'Nam Dok Mai' can be harvested 100 days after full bloom or a specific gravity between 1.03-1.04 (Nanthachai, 1982). For 'Carabao' mango from The Philippines, the maturity of the fruit can be determined by a harvesting stage 82-88 days after full bloom (Mendoza, 1981) or by floatation in salt solution for specific gravity. The fruits which float in a 1% salt solution, are considered immature. On the other hand, fruits which sink in the same solution can be characterized as mature since they can be ripened (Esguerra and Lizada, 1990).

2. Ripening stage

Ripening consists of the composite processes that occur from the later stage of growth and development through to the early stage of senescence. Mango can be harvested at mature and unripe stages, and can withstand the postharvest handling system when shipped to long distance markets. Once fruits ripen they have to be consumed immediately. If they need to be delayed, the ripe fruit should be cooled at a safe temperature and kept until ready for market (Kader, 1999).

Mango was divided into groups based on ripening behavior; those harvested at mature stage and ripened off the tree produce much higher ethylene for their ripening, for example 'Carabao'. The skin color changes in relation to the ripening process after harvesting, and some need to be treated or exposed to ethylene to initiate ripening and to accelerate uniform ripening such as 'Nam Dok Mai' mango, because the vital problem of this variety is non uniformity in the development of skin color (Mendoza and Wills, 1984).

3. Storage temperature

Low temperature storage after harvest is a common technique used to extend the storage life of fruit. In practice, the minimum

temperature for storage of most tropical fruit is determined by their susceptibility to chilling injury (CI). A temperature of 12-13°C is considered suitable for Thai mango storage for 2-3 weeks, while Philippine mango such as 'Carabao' can be stored at 7-10 °C for 15 days (Mendoza and Wills, 1984). However, there are variations in reports about the optimal temperatures, which may be attributed to the characteristic of cultivar and/or the stage of maturity and ripeness when kept in low temperature storage.

4. Heat treatment

Regarding mango for export, it is known that vapor heat treatment (VHT) can be used against fruit fly as a quarantine treatment before fresh market shipment. This system has been commercially operated in many countries, mainly for tropical and subtropical fruits such as mango and papaya (Paull, 1995). The treatment consists of a period of warming and a holding period when the temperature of the interior reaches the desired temperature (47 °C) for the length of time required to kill the insect (20 min), and then a cooling down period until the temperature reaches 37 °C. However, quality changes have occurred during storage: such as physiological and biochemical response, and internal damage such as abnormal ripening and development of internal cavities.

5. Preharvest condition

Preharvest factors such as climate, pest management, irrigation and plant nutrition affect postharvest fruit quality. Environmental conditions during fruit growth and maturation also influence fruit quality by either hastening or delaying horticultural maturity and susceptibility to internal flesh breakdown (IFB). An early season cultivar, the 'Sensation' mango shows no IFB, whereas the incidence in late season mangoes was 80% (Van Lelyvel and Smith, 1979). It is common though that the temperature during production affects growth and development. Temperature has a direct influence on metabolism affects cellular structure such as the firmness of apple (Blanpied et al., 1978), the heat sensitivity of papaya fruit (Paull, 1995) and the incidence of chilling injury of avocado (Woolf et al., 1999). Ca is the plant nutrition mostly associated with fruit quality. In mango, Ca influenced the development of internal breakdown (Mercado, 1979) and soft nose (Raymond et al., 1998). The severity of these disorders varies from season to season. The lowest levels of Ca were found in pulp where soft nose occurs (Burdon et al., 1991).

To solve the problems mentioned above, this study was conducted on the following general objectives.

General objectives

1. A study on the changes of physiological and biochemical characterization of imported mango fruit and quality problem such as chilling injury with and without VHT.

2. A study on the heat treatment designed for disinfestation of imported mango from tropical countries and the response of mango to low temperature storage condition in terms of physiological and biochemical changes as well as ultrastructural changes in tissues observed by scanning electron microscope (SEM).

3. A study on the factors of ripening stages affecting physiological and biochemical changes such as the changes in electrolyte leakage, ACC (1-aminocyclopropane-1-carboxylic acid) content, and polyamines which may relate with chilling injury during low temperature storage and after being transferred to ripen at 25°C.

4. A study on the effect of different fruit maturity on quality and physiological changes of fruits, such as changes in coloration, fruit texture, chemical constituent, polyamines content, and occurrence of disorders after VHT when stored at three different

temperatures. Ultrastructural observation of different regions of mesocarp which showed different symptoms of chilling injury and internal breakdown.

5. A study on preharvest factors, such as location and soil composition where mango had been grown, in relation to fruit quality, including structural observation and microelement analysis of fruits by low temperature scanning electron microscope (LTSEM) and x-ray probe microanalyzer.

This information will be useful for mango exporting countries for successful postharvest handling where mango fruits are subjected to insect disinfestation treatment and long transport times to market, and will provide more understanding of the factors which cause inconsistencies in postharvest fruit performances.