Quarantine and Quality Issues of Exporting Pakistani Mangoes to Japan

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Abstract

Pakistan produces good quality mangoes. Since last many years efforts are being done to reduce the postharvest losses and government has established even exclusive research institutes for this purpose. Pakistani mangoes are being exported to Middle East and few other countries, but not to Japan that has strict quarantine regulations. About 50-years ago, even the mangoes produced in the Okinawa Islands of Japan had to be hot water treated to enter into mainland (Tokyo and surrounding areas); then they eradicated the diseases and their causes from the mango producing areas. Now, mangoes produced in Japan can be transported anywhere in the country without heat treatment. Japan is importing mangoes from Mexico, Philippines, Thailand, etc. and had asked India, Pakistan and other countries to provide 3-years data pertaining to *Bacterocera dorsalis* and *B. cucurbitae*. India has provided data to the Japanese government and in the year 2006 people have seen Indian mangoes being sold in the Japanese market. Pakistani authorities have yet to carry out research and satisfy the Japanese authorities to allow the entry of Pakistani mangoes into Japan. There is an urgent need that research institutions carry out research on eradication of *Bacterocera* spp. and processing of mangoes with vapor heat treatment, universities should assign projects to masters' or doctoral students to strengthen the data requirements, and government has to take serious steps to communicate with the Japanese authorities to satisfy them that Pakistani mangoes are safe.

1. Introduction

Mango (*Mangifera indica*) is found in nearly all over the tropical regions of the World, and known as “The King of all fruits”. It comes in market early in May and remains in market till August/September. There are more than 1300 varieties of the mango, which are cultivated in the Indo-Pak sub-continent. In Sindh, there are more than hundred varieties of mango. Although we get mangoes from Balochistan and NWFP, but the main source are Sindh and Punjab. In Pakistan we get more than 1 million tons production, out of which Sindh provides 50%. Multan and Mirpurkhas are the main regions, where we get mangoes in large quantity. The maximum production, we get from Rahim Yar Khan, where mangoes are cultivated on more than 26 thousand acres.

The mango is mainly obtained from Districts of Rahim Yar Khan, Hyderabad, Tandojam, Tando Allahyar, Tando Jan Muhammad, Digri, Nawab Shah, Naushero Feroz, Khairpur Mirus, Ghotki, Bahawalpur, Shuja Abad, MuzzaffarGarh, Koat Addu, Khanewal, Sahiwal, Vehari, Okara, Faisalabad, Jhang, and Toba Tek Singh.

There are many varieties, which are famous in Pakistan, but some varieties which are very common, e.g., *Sindhri, Langra, Chaunsa, Fajri, Samar Bahist, Anwar Ratole, Dasehri, Saroli, Tuta Pari, Neelam, Maldah, Collector, Bengan Phali, etc.*

As mango is named as "the King of all fruits" similarly, Sindhri is said to be "The King of Mango", because this variety is on the top in Pakistan. Sindhri is yellow in colour, and its taste is very sweet. Sindhri mangoes were first brought by father of late Prime Minister Muhammad Khan Junejo from Bombay and then cultivated at Sindhri and it was named by his father Din Muhammad Junejo as "Sindhri". Since 1996-97, Pakistan was on 4th position, but according to Jang Midweek Magazine dated 12th July 2000, Pakistan is on 5th rank. India is still on top on the production of 12 million tons.

The data regarding the area on which the mango was cultivated in 2005 in the top 12 mango producing countries is given in Table 1 that shows India is on the top and Pakistan ranks seventh.

Table 1. World Mango production in 2005

Top 12 Mango Producers - 2005 (hectares)	
India	1,600,000
China	433,600
Thailand	285,000
Indonesia	273,440
Mexico	173,837
Philippines	160,000
Pakistan	151,500
Nigeria	125,000
Guinea	82,000
Brazil	68,000
Vietnam	53,000
Bangladesh	51,000
World Total	**3,870,200**

Source:FAO (2005)

The point of concern for Pakistan is that the yield per hectare (10 tons) is not increasing. This yield is about one-third, when compared to other mango growing countries.

In Japan, the mango market is dominated by the cultivar 'Irwin', which is a red colored mango. However, the mango imported by Philippines is mainly of 'Pelican' cultivar that has yellow color and smaller size. The mangoes received from Mexico and Brazil is of medium size and mainly of red color.

2. Mango Pests and Diseases

Mango suffers from diseases at all stages of its life. All the parts of the plant, namely, trunk, branches, twigs, petioles, flowers, leaves and fruits are attacked by fungi, bacteria and algae. They cause several kinds of rot, die back, anthracnose, scab, necrosis, blotch, spots, mildew, etc. Some of these diseases like powdery mildew, midge, are of great economic importance as they cause heavy losses in mango production. Major diseases of mango and their control measures are discussed below:

It is important to make careful examination of trees for pest because the conditions change each year and necessary change in spraying program is required. Pakistani mangoes are typically monoembryonic (single embryo) seeds, highly colored fruit and are subject to anthracnose disease.

a) The largest problem of mango is anthracnose because it attacks all parts of the tree and is probably most damaging to the flower panicles.

b) Powdery mildew can be a serious problem under conditions of high humidity and rainfall during bloom because the disease would limit fruit set.

c) Mites and scale insects can attack mango trees, but they rarely limit growth or production unless populations build to high levels. Populations of Pink mealybug are building up in cotton and kinnow and are threat to mango trees in Pakistan.

d) Anthracnose (*Colletotrichum* state of *Glomerella cingulata* Ston, Spaull and Schrenk) is of widespread occurrence. The disease causes serious losses to young shoots, flowers and fruits under favorable climatic conditions of high humidity, frequent rains and at temperature of 24 to 32°C. It also affects fruits during storage. In humid, high-rainfall areas, anthracnose disease often damages or destroys both flowers and developing fruits. Repeated applications of systemic fungicides are the only effective treatment for anthracnose in the field. Depending on the prevailing weather conditions blossom blight may vary in severity from slight to a heavy infection of the panicles. Black spots develop on panicles as well as on fruits. Severe infection destroys the entire inflorescence resulting in no setting of fruits. Young infected fruits develop black spots, shrivel and drop off. Fruits infected at mature stage carry the fungus into storage and cause considerable loss during storage, transit and marketing. The fungus perpetuates on twigs and leaves of mango or other hosts. Varietal differences in susceptibility have been noted at Multan, maximum damage was observed on *Chaunsa*. Since the fungus has long saprophytic survival ability on dead twigs, the diseased twigs should be pruned and burnt along with fallen leaves for reducing the inoculum potential.

For the control of Anthracnose the following practices are recommended:

a) Check for some new affected fungicide available in local market,

b) Trees may be sprayed twice with Bavistin (0.1%) at 15-days interval during flowering to control blossom infection. Spraying of copper fungicides (0.3%) is recommended for the control of foliar infection.

c) Hot water immersion or vapor heat treatment be done before exporting as it is the only acceptable quarantine treatment by the Japanese authorities to allow entry of mangoes in Japan.

3. Mango in Japanese Market

Although mango has been grown in Japan for more than a century; but it was not a popular fruit in the mainland of Japan. It is mainly grown in the Okinawa Island followed by Miyazaki, Okayama and Aichi prefectures (Al-Haq & Sugiyama, 2004). In these regions, mango is grown in plastic greenhouses because the weather conditions can cause inflorescence damage

and make the crop susceptible to anthracnose (*Colletotrichum gleospoiroides*).

Approved quarantine methods demands treatment of mangoes either with hot water immersion or vapor heat treatment. Japan International Cooperation Agency (JICA) provided a pilot plant to Pakistan and that remained unattended at the Karachi port for about three years; and after interventions by the Asian Productivity Organization (APO), Tokyo; Ministry of Food, Agriculture & Livestock (MINFAL), Islamabad, Embassy of Pakistan, Tokyo, the pilot plant had been installed at the Karachi airport for quarantine purposes (Siddiqui, 2006). The Government of Japan had asked the MINFAL to provide three-year data to satisfy them that Pakistani mangoes are free from two pests; namely, *Bactrocera cucurbitae* and *B. dorsalis*. The third commonly found species is *B. zonata*. Following is a short account for these flies.

4. Mango and *Bactrocera*

Following is a brief account of three species of *Bactrocera* mentioned in the above section:

***Taxonomic position*:** Insecta, Diptera, Tephritidae

***Geographical distribution*:** Found in Asia, Africa, North America, Oceania while absent in European Union. In Asia, it is found in the following countries: Afghanistan, Bangladesh, China, Hong Kong, India, Indonesia, Iran, Japan, Lao, Malaysia, Myanmar, Nepal, Oman, Pakistan, Philippines, Saudi Arabia, Singapore, Sri Lanka, Taiwan, Thailand, United Arab Emirates, and Viet Nam.

***Biology*:** Eggs are laid below the skin of the host fruit. These hatch within 1-3 days and the larvae feed for another 4-7 days at 21°C. Purpariation is in the soil under the host plant and adults emerge after 1-2 weeks (longer in cool conditions) and adults occur throughout the year (Christensen & Foote, 1960). For most *Bactrocera* spp., it is the adults that are best able to survive low temperatures, with a normal torpor threshold of 7°C, dropping as low as 2°C in winter. *B. zonata* however, overwinters in the larval and pupal stage (Fletcher, 1987). Regression models have been developed in Pakistan to predict population density (Inayatullah et al., 1991a) and levels of fruit infestation (Inayatullah et al., 1991b). Qureshi et al. (1993), investigating development of *B. zonata* at different temperatures, showed that no stages developed at temperatures of 15°C or under, the optimum being at 25~30°C.

4.1 *Bactrocera dorsalis* (Hendel)

***Common name*:** Oriental fruit fly

***Taxonomy and nomenclature*:** *B. dorsalis* forms part of a species complex, within which over 50 species have been described in Asia. Many earlier records of *B. dorsalis* from southern India, Indonesia, Malaysia, Philippines and Sri Lanka are based on misidentifications of what are now (Drew & Hancock, 1994) known to be other species. Seven of these pests are also recognized to be pests of cultivated plants.

***Hosts*:** *B. dorsalis* occurs on a wide range of fruit crops, for example in China and Japan on apples, bananas, Capsicum, guavas, mangoes, oranges, pawpaws, peaches, plums and tomatoes (Clausen et al., 1965; Koyama, 1989).

***Eradication examples*:** Outbreaks in USA (California, Florida) eradicated (FAO, 1987) but found again in California in 1989. Reported in Hawaii since about 1945. An outbreak on Northern Mariana Islands (Rota), Oceania, was eradicated (Nakagawa et al., 1968). Similarly, it was eradicated in Ryuku Archipelago, Japan in 1985.

***Detection and inspection methods*:** *B. dorsalis* can be monitored by traps baited with male lures. Methyl eugenol (O-methyl eugenol) attracts *B. dorsalis* flies at very low concentrations and is believed to attract over a range of up to 1 km. The lure is usually placed on a cotton-wool wick suspended in the middle of the plastic trap that has small openings at both ends; Drew (1982) describes the Steiner trap. Lure can either be mixed with an insecticide (malathion or dichlorvos) or a piece of paper dipped in dichlorvos can be placed in the trap. Traps are usually placed in fruit trees at a height of about 2m above ground and should be emptied regularly as it is possible to catch hundreds of flies in a single trap left for just a few days, although the lure may remain effective for at least two weeks. A review of the biological aspects of male lure was presented by Cunningham (1989a) and the use of lures is described in more details by Draw (1982). A trapping system used to monitor for possible introductions of *B. dorsalis* into New Zealand has been described by Somerfield (1989).

4.2 *Bactrocera cucurbitae* (Coquillett)

***Common names*:** Melon fly, melon fruit fly

***Hosts*:** Recorded almost exclusively on Cucurbitaceae (Weems, 1964), both tropical species and temperate species. Cucumber and melons are typical hosts but found on other fruits as well.

***Eradication examples*:** In Solomon Islands (Oceania), it has been subjected to an eradication campaign using a combination of bait spraying and male annihilation with cue-lure traps (Eta, 1996). In North Mariana Islands (Oceania), it was eradicated using the sterile insect technique, but re-established in 1981. In Japan, Ryuku Archipelago: progressively eradicated using the sterile insect technique (Iwahashi, 1997; Anon, 1987) from, strategy from the west (adjoining Taiwan), the Yaeyama group (1993); the Miyako group (1987), Kumejuma (1978), the rest of the Okinawa group (1990), the

Amami group (1989). Ryuku Archipelago: progressively eradicated using the sterile insect technique (Iwahashi, 1997) Anon, 1987) from, strategy from the west (adjoining Taiwan), the Yaeyama group (1993); the Miyako group (1987), Kumejuma (1978), the rest of the Okinawa group (1990), the Amami group (1989)

Detection and inspection methods: *B. cucurbitae* can be monitored by traps baited with male lures. Cue lure (4-(p-acetoxyphenyl)-2-butanone) attracts flies at very low concentrations and is believed to attract over a range of up to 1 km, like *B. dorsalis*. The rest of the method is the same as quoted for *B. dorsalis.*

Economic impact of the pest: *B. cucurbitae* is a very serious pest of the fruits and flowers of cucurbits, and sometime attacks non-cucurbit hosts. Waterhouse (1993) identifies it as one of the five most important pests of agriculture in South East Asia.

Control: Same as mentioned for *B. dorsalis*.

4.3 *Bactrocera zonata* (Saunders)

***Common names*:** Peach fruit fly, guava fruit fly

***Taxonomy and nomenclature*:** *B. maculingera* Doleschall was previously listed as a synonym of *B. zonata*. White & Evenhuis (1999) have shown that it is unrelated.

***Hosts*:** The main hosts are guava, mango and peach. Secondary hosts include apricot, fig and citrus. *B. zonata* has been recorded on over 50 cultivated and wild plant species, mainly those with fleshy fruits.

***Detection and inspection methods*:** *B. zonata* can be monitored by traps (Jackson or Steiner traps, though Jackson traps are preferable) baited with the male lure methyl eugenol (O-methyl eugenol), which attracts male flies at very low concentrations (Qureshi et al., 1992). In Jackson traps, a cotton wick impregnated with about 6 ml of a mixture methyl-eugenol:insecticide (3:1) is placed inside the trap. Malathion or dichlovros is generally used as the killing agent.

***Eradication examples*:** *B. zonata* was trapped in USA (California) (Carey & Dowell, 1989), but eradicated (Spaugy, 1988). Similarly, in 2001 in Santa Clara county and is under eradication program.

4.4 Control of *Bactrocera spp.*

When detected, it is important to gather all fallen and infested host fruits, and destroy them (Liquido, 1991). Those sepecies whose males are attracted to lures should be monitored using bait traps (Bateman, 1982). Insecticidal protection is possible by using a cover spray or a bait spray. Malathion is the usual choice of insecticide for fruit fly control and this is usually combined with protein hydrolysate to form a bait spray (Roessler, 1989); practical details are given by Bateman (1982). Bait sprays work on the principle that both male and female tephritids are strongly attracted to a protein source from which ammonia emanates. Bait sprays have the advantage over cover sprays in that they can be applied as a spot treatment so that the flies are attracted to the insecticide and there is a minimal impact on natural enemies. Biological control has been tried against *B. dorsalis, B. cucurbitae*, but introduced parasitoides have had little impact (Wharton, 1989). The techniques of male annihilation and sterile insect release have been used to eradicate some populations of *B. dorsalis* from the northern Ryuku Islands, Japan (Cunninghan, 1981b), and *B. cucurbitae*. Male annihilations utilize the attraction of males to chemical lures (cue lure). The sterile insect technique (SIT) requires the release of millions of sterile flies into the wild population so that there is a strong likelihood of wild females mating with sterile males (Gilmore, 1989). SIT was used to eradicate *B. dorsalis* from Ogasawara Island, Japan (Shiga, 1989) and the same technique was used to eradicate *B. cucurbitae* from Kume Island, Japan (Shiga, 1989).

5. Sanitation

Consignments of fruits of especially *Annona, Averrhoa carambola, Citrus, Fortunella, malus, Mangifera indica, Prunus domestica, Prunus persica, Psidium guajava* and *Pyrus* from countries where *B. dorsalis* occurs should be inspected for symptoms of infestation and those suspected should be cut open in order to look for larvae. Countries having strict quarantine regulations sought that fruits should come into their countries from an area where *Bactrocera* does not occur, or from a place of production found free from the pest by regular inspection for 3 months before harvest. Fruits may also be treated in transit by

- cold treatment (e.g. 11, 12 or 14 days at 0.5, 1.0 or 1.5°C, respectively or 19, 25 or 25 days at 5, 6 or 7°C, respectively) for temperature sensitive fruits like mangosteens; Burikam et al., 1992), or
- for mango and certain other types of fruits by
  - vapor heat (e.g. keeping at 43°C for 4-6 h) (USDA, 1994).
  - Hot-water treatment (46°C for 65-90 min), according to size and shape of fruits; USDA 1994), or
- forced hot-air treatment (Armstrong et al., 1995).

Ethylene dibromide was previously widely used as a fumigant but is now generally withdrawn because of its carcinogenicity; methyl bromide is less satisfactory, damaging many fruits and reducing their shelf-life although treatment schedules are available for specific cases (e.g. for cucumbers at 21~16°C, 32 g/m^3 for 2 h; USDA, 1994).

Until the true pest status of the potential pest species

of the *Bactrocera* complex has been established, the quarantine measures says it would be reasonable to continue making these requirements for consignments from areas where any of them occur.

Not only the fruits, but plants of host species transported with roots from countries where *Bactrocera* spp. occurs should be free from soil, or the soil should be treated against puparia. The plants should not carry fruits. Such plants may indeed be prohibited importation.

6. Export of Pakistani Mangoes

Since last few years, unfortunately, the export of this fruit is facing problems on account of tough competition from other Asian countries, mainly India. Latin American countries like Brazil having now also come into the field and Pakistan has lost market. There could be many reasons for this downward exports, like:

* the traditional manner of crop production
* halfhearted efforts at research,
* pests and diseases of mangoes, and
* improper postharvest treatment and packaging.

The Pakistani shippers should also give due importance to the following facts:

* never forget that the buyers in the world market are not just interested in prices; they also want good presentation. We have to constantly watch for trends, choices and preferences of the buyers in the world market;
* processing should be made with the latest machines and packing should not only be fancy and eye catching but durable.
* ensure that the fruit would not rot in transit and that the quality would not diminish in the process.

According to the study conducted by International Trade Centre in Geneva, Switzerland about 30 % of the food export of all over developing countries, Pakistan is one of them, perishes, before it reaches to the foreign market. This is because of the defective packing. Therefore, we have to improve it by all means to get more foreign exchange from other countries by exporting the good quality of mangoes.

The Government of Pakistan has launched a "Special Financial Support" on export of mangoes to Europe since July 2006. It will be provided @ Rs.15 per kg by air and Rs.10 per kg by sea shipments to Europe only (for all airlines and shipping lines). The period of export for the purpose of foresaid financial support was from 1st July to 15th October 2006. Such schemes should be continued in future or if possible be made permanent.

The Government of Pakistan has also issued the minimum grades and quality standards for pre-shipment inspection of mangoes for export to Europe under Special Financial Support Scheme. These are applicable to only fresh produce and industrial processing has been excluded. The purpose of the standards is to define minimum quality requirements of mangoes at the export control stage, during preparation and packing for export to Europe under the special financial support scheme.

6.1 Minimum requirements

a) Mangoes must be intact; firm; fresh in appearance; sound; produce affected by rotting or deterioration such as to make it unfit for consumption is excluded; clean, practically free from any visible foreign matter; free from pests; practically free from damage caused by pests; free from black stains or trails which extend under the skin; free from marked bruising; free from damage caused by low temperature; free from abnormal external moisture; and free from any foreign smell and/or taste.

b) Mangoes must be fully developed and display satisfactory ripeness and characters of variety.

c) Mangoes must be carefully picked at the stage of physiological development and maturity so as to enable them:

* to ensure a continuation of the ripening process until they reach the appropriate degree of ripeness corresponding to the varietal characteristics;
* to withstand transport and handling; and
* to arrive in satisfactory condition at the place of destination.

d) In relation to the development of the ripening process, the coloring may vary according to variety.

6.2 Tolerances

Tolerance in respect of quality and weight are allowed up to 5% in each package for produce not conforming to the minimum standards indicated.

6.3 Presentation

Following are the requirements for presentation:

6.3.1 Uniformity: The contents of each package must be uniform and contain only mangoes of the same origin, variety, quality and size.

6.3.2 Packaging: Mangoes must be packed in such a way as to protect the produce properly. The materials used inside the package must be new; clean; of a good quality; such as, not to cause any external or internal damage to the produce. The use of materials and particularly paper or stamps bearing trade specifications is allowed provided the printing or labeling has been done with non-toxic ink or glue. Each carton must have holes on two sides for proper ventilation. Individual fruit wrapping with tissue paper or foam padding is encouraged. Packages must be free from all foreign matter.

6.3.3 Weight: The exporters are encouraged to maintain and indicate weight standards 2, 3, 4, 5, 6 or 7 kg on the box.

6.3.4 Labeling: Each package must bear the following

particulars, in letters grouped on the same side, legibly and indelibly marked, and visible from the outside.
a) Identification of Packer and/or dispatcher: Name and address of an officially issued or accepted code/trade mark
b) Nature of the Produce: "Mangoes" if the contents are not visible from the outside; and name of the variety
c) Origin of the produce: Country of origin and optionally, district where grown or national, regional or local place/farm name.
d) Official control mark: Official mark of the national official quality certifying agency; additional information, if desired by importer

6.3.5 Phyto-Sanitary Certification: It must be obtained from the Department of Plant Protection to the effect that the fruit described above have been inspected and found free from quarantine pests and substantially free from other injurious pests; and that they are considered to conform with phytosanitary regulations of the importing country. Inspection Criteria of each carton by an Inspector is shown in Table 3.

Table 3
Inspection Criteria of each carton by an Inspector

(A) Weight
Gross Weight
Net Weight
(B) Defects in Minimum Criteria & General Characteristics
Not sound/Dirty/ Damaged/Bruised
Under/ Over-ripe
Diseased/Infested/Stained
(C) Quality Defects affecting the Fruit Expressed in % of Carton Net Weight (Tolerance Limit, 5%)
Shape Defects
Color Defects
Skin Defects
Healed Skin Defect
(D) Average Total Defects for the Batch (sum of averages): % Defects in Presentation (Tolerance Limit, 5%)
Uniformity
Contents of package
Weight of Package (2,3,4,5 0r 7 kg)
(E) CONCLUSION FOR THE BATCH:
Conforms to minimum quality standards
Does Not Conform to Minimum Quality Standards
Reason/s of non conformity :
Signature of the Inspector

7. Summary

In this manuscript, an attempt has been made to highlight the quarantine and quality issue of Pakistani mangoes. We have also tried to explain why Japanese are strict in quarantine regulations-obviously they didn't want to see re-occurance of Bactrocera spp. in Japan. It has also been proposed that Pakistani authorities should take serious steps to launch R&D projects for eradication of Bactrocera spp. from Pakistan, and provide more facilities to carry on R&D for use of sanitation treatment (e.g., vapor heat treatment or hot-water immersion or forced hot-air treatment), and initiate projects for using emerging technologies (e.g., electrolyzed oxidized water, high-pulse treatment, acoustic technology, etc.) to ensure quality of Pakistani mangoes.

8. Recommendations

Pakistan has to take strong measures to resolve the issue of entry of Pakistani mangoes into Japanese market as this is the right time to enter into Japanese market:
a) launch *Bactrocera* Eradication Program,
b) MINFAL should involve HEC and agricultural universities to conduct research work on this hot issue,
(c) R&D projects be initiated to have data about quality of Pakistani mangoes, e.g. texture of various Pakistani mango cultivars (like the study, Al-Haq & Sugiyama, 2004a,b);
(d) carry out research on emerging technologies, e.g.,
- hot water immersion (Al-Haq et al., 2003)
- electrolyzed oxidized water (Al-Haq et al., 2001, 2002),
- electric pulse treatment as pre-treatment for ripening (Shivashankara et al., 2004),
- acoustic technology to judge quality of fruit (Al-Haq & Sugiyama, 2004; Al-Haq et al., 2004b);

(e) provide pilot vapor heat treatment (VHT) plants to universities and research institute for research, and commercial VHT plants to packers and shippers;
(f) improvement in packaging-it should conform with the international standards,
(g) take such measure that ensure quality of exported fruits; and
(h) efficient communication between two governments be ensured.

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