While the National Mango Board has funded this research/ literature review, it is not authorized to pursue changes to the Grade Standards.

February 25, 2008

MANGO QUALITY ATTRIBUTES AND GRADE STANDARDS: A REVIEW OF AVAILABLE INFORMATION AND IDENTIFICATION OF FUTURE RESEARCH NEEDS

Adel A. Kader
Postharvest Horticulture Consultant, Kader Consulting Services, P.O.Box 600, Davis, CA 95617-0600, USA

1. Abstract:

A review of available printed and electronic sources of information about mango quality attributes, with emphasis on mango cultivars that are marketed in the U.S. (such as Ataulfo, Haden, Kent, Keitt, and Tommy Atkins), and grade standards was conducted. Based on analysis of this information, possible revisions in the U.S. Standards for Grades of Mangos are proposed including adding objective maturity indices, size categories, and expansion of some of the information about defects. Suggestions for future research needs include identification of sensory and objective quality indices, correlating harvest maturity to flavor quality when ripe, determining the time-temperature combinations that induce chilling injury of mature-green and partially-ripe mangos, and developing a manual for symptoms of mango defects and decay.

2. Mango Quality Attributes

Although consumers may buy fruits on the basis of their appearance and firmness, subsequent purchases depend on their satisfaction with how these fruits taste. Mango flavor quality is influenced by the cultivar, maturity stage at harvest, postharvest

handling procedures and environmental conditions (avoiding mechanical damage and chilling injury), and ripeness stage at the time of eating the mango. Information about postharvest biology and technology of mangos is available in a few books (Litz,1997; Mendoza and Wills,1984; Yahia et al, 2006)), book chapters (Dodd et al,1997; Gomez-Lim,1997; Hulme,1971; Johnson et al,1997; Kader et al,2002; Lakshminarayana,1980; Mitra and Baldwin,1997; Nanjundaswamy,1997; Narain et al,1998; Paull and Chen,2002; Stafford,1983), review articles (Caygill et al,1976; Chaplin,1988; Johnson and Coates,1993; Korsten,2006; Paull and Chen,2004; Subramanyam et al,1975; Wainwright and Burbage,1989; Yahia,2006), and conference proceedings (Drew,2002; Pinto et al,2004; Subhadrabandhu and Pichakum,2000;). However, only a small percentage of the information in the references cited above is about the cultivars marketed in the U.S. (Ataulfo, Haden, Kent, Keitt, and Tommy Atkins). In contrast, 'Kensington',which is the predominant mango cultivar in Australia, has been the subject of extensive studies (Chaplin,1988; Hofman and Ledger,2006; Jobin-Décor,1988; Johnson and Coates,1993; Ledger et al,2003; Loney et al,1992).

Mango quality indices include uniformity of shape and size, freedom from decay and defects, skin color that is characteristic of the cultivar, flesh color, flesh firmness (juiciness, fiber content), and flavor (sweetness, acidity, aroma intensity). Sucrose and citric acid are the main sugar and organic acid, respectively, in mangos. Lactones contribute to preferred mango aroma and 2,5-dimethyl-4-hydroxy-3(2H)-furanone contributes to overripe aroma and flavor (MacLeod and Pieris,1984; MacLeod and Snyder,1985; Malundo et al, 2001). Allergic reaction of some people to mango is related

to the allergen, 3-pentadecyl catechol, which is also found in other members of the family Anacardiaceae, such as cashew and pistachio nuts (Lakshminarayana,1980).

There are large differences in flavor quality and fiber content of mango cultivars, which can be grouped on the basis of fiber content into none to slight (less than 1%), moderate (1-2%), and high (more than 2%). Among the five major cultivars that are marketed in the US, 'Tommy Atkins' is highest in fiber content (2-3%), but it is popular among marketers because of its red skin color. Mango skin's red color (reddish blush) is due to the anthocyanin, peonidin-3-galactoside (Proctor and Creasy, 1969). However, mango producers and marketers should seriously consider gradually replacing 'Tommy Atkins' with cultivars that have better textural and flavor quality and less fiber, such as 'Ataulfo' and 'Keitt'. 'Ataulfo' contains higher concentrations of ascorbic acid (vitamin C) and carotenoids (provitamin A) than "Haden', 'Kent', 'Keitt', and 'Tommy Atkins' (Perkins-Veazie, 2007). In contrast, Ornelas-Paz et al (2007) reported that 'Haden' and 'Ataulfo' had higher amounts of beta-carotenes than 'Kent' and 'Tommy Atkins' mangos. This information is important to consumers who are more interested in flavor and nutritional quality than in appearance quality of fruits.

Mango flavor properties depend on the interactions among volatile compounds and with sugars and acids. From the 150 volatile compounds isolated from mango, it is probable that only a few are critical to characteristic mango flavor (Malundo et al, 1996). Sugars and acids enhance human perception of specific flavor notes in mango, including aromatics (Malundo et al, 2001). When a refractometer is used to measure soluble solids, the results depend on the concentrations of sugars, acids, soluble pectins, and soluble phenolic compounds. Thus, the correlation between soluble solids content and sweetness

is not as high as that between total sugars and sweetness. However, sugars constitute about 90% of the soluble solids in mango.

Mangos are susceptible to many physical, physiological, and pathological defects, including the following (arranged alphabetically within each of the two groups):

A. Defects of Preharvest Origin:

Anthracnose

Insect Damage

Jelly Seed

Lenticel damage

Misshapen

Scab

Scars (russeting)

Skin breaks and cracks

Soft Nose

Stem-end Cavity

Sunburn and sunscald

B. Defects of Harvesting and Postharvest Handling Origin:

Bruising

Decay

Elevated carbon dioxide injury

External (skin) discoloration (due to heat injury or chilling injury)

Immature (poor quality when ripe)

Internal (flesh) discoloration (due to heat injury or chilling injury)

Not well trimmed (stem is longer than 0.5 inch = 12.7mm)

Overripe (too soft)

Sapburn

Shriveling (water loss)

Sunken discolored areas (due to chilling injury)

Sunken shoulder areas (due to heat damage to the flesh below)

Uneven (blotchy) ripening (due to heat injury or chilling injury)

Sapburn (brown to black discoloration of mango skin) results from exudate from the cut stem at harvest (Brown et al,1986; Loney et al,1992). Wainwright and Burbage (1989) reported that large and ripe mango fruit are more prone to physiological disorders, such as flesh breakdown (stem end breakdown, stem end cavity). Raymond et al(1998) described three internal physiological disorders of mangos: jelly seed (disintegration of the flesh around the seed into jelly-like mass), soft nose (partial ripening of the mesocarp at the distal end of the fruit), and stem-end cavity (necrosis of the mesocarp around the cavity). Susceptibility to jelly seed varies among cultivars and 'Tommy Atkins' is among the very susceptible group (Lelyveld and Smith, 1979).

Heat injury results from exceeding the time and/or temperature combinations recommended for decay and/or insect control. Symptoms include skin scald, blotchy coloration, uneven ripening, and void spaces in the flesh due to tissue death. Heat injuries can be reduced by effective monitoring and management of the heat treatment and prompt cooling after the heat treatment.

Chilling injury symptoms include uneven ripening, poor color and flavor, surface pitting, grayish scald-like skin discoloration, increased susceptibility to decay, and, in severe cases, flesh browning. Chilling injury symptoms and severity depend on cultivar, maturity and ripeness stage (riper mangos are less susceptible), and temperature and duration of exposure, which are cumulative.

3. Maturity, Ripeness, and Quality relationships

Harding et al (1954) concluded that specific gravity can not be used as a reliable maturity index. They found that soluble solids content (measured with a refractometer) ranged from 7 to 10% in mature-green 'Haden', 'Keitt', and 'Kent' mangos and increased with maturity and ripeness to 14 to 16%, and was related to flavor quality (determined by the researchers) of the ripe mangos. Meanwhile, titratable acidity declined from 0.55-0.93% in mature-green mangos to 0.09-0.20% in ripe mangos. They also found a good correlation between firmness and ripeness. Soule and Hatton (1955) reported that mango flesh firmness declines with maturation on the tree and that large fruit are more mature and ripen faster than small fruit picked from the same tree. Small and large mature-green 'Haden' and 'Kent' mangos required 8 and 6 days at 27C to ripen, respectively. Small mature-green 'Keitt' mangos required 12 days vs 10 days for large fruit to ripen at 27C. Large fruit had slightly higher soluble solids content and slightly lower titratable acidity than small 'Haden', 'Keitt', and 'Kent' mangos at both the mature-green and ripe stages.

Popenoe and Long (1957) measured increases in starch content (from 5.6 to 7.7% in 'Haden' and from 6.2 to 10.7% in 'Keitt' mangos), specific gravity (from 1.01 to 1.02 in 'Haden' and from 1.00 to 1.02 in 'Keitt' mangos), and scored the mangos for flavor

during maturation. However, they concluded that these indices are not practical because of variability among individual fruit and difficulty of measurement. Popenoe et al (1958) determined changes in specific gravity (from 0.9902 to 1.0265), starch content (from 1.24 to 5.62%), soluble solids content (from 8.0 to 11.0% in hard fruit and from 9.5 to 18.0% in soft fruit) in 'Haden' mangos; they concluded that starch content was the best maturity indicator.

Malevski et al (1977) concluded that the maximum red and maximum yellow color intensities at harvest could serve as a good index of mango maturity in some cultivars. Mitcham and McDonald (1992) described 6 stages of maturity and ripeness of 'Keitt' and 'Tommy Atkins' mangos as follows: (1) Immature-green (underdeveloped shoulders); (2) Mature-green (well-rounded shoulders); (3) Firm (yields slightly under pressure); (4) Fairly-firm (yields significantly under pressure); (5) Soft-ripe (soft fruit); and (6) Over-ripe (extremely soft, mushy).

Baez-Sanudo et al (1997 and 1999) described 5 stages of mango flesh (pulp) color development as follows: (1) Cream (not white); (2) Turning (from cream to yellow with <30% yellow); (3) Yellow (30-60% yellow); (4) Yellow-orange (>60% yellow); and (5) Orange (>90% orange). At stage (1), Baez-Sanudo et al (1999) measured soluble solids contents of 7.3, 6.6, 7.4, and 7.3% and titratable acidity of 1.07, 0.72, 0.60, and 1.20% in 'Haden', 'Keitt', 'Kent', and 'Tommy Atkins' mangos, respectively. These mangos ranged in firmness from 11.0 to 13.2 kg-force (penetration force measured with a 10 mm conical tip) and required 11 to 13 days to ripen at 20C.

Araiza et al (2005) reported that 7.3% soluble solids content is the minimum required for export of mangos from Mexico. They measured increases in soluble solids

contents from mature-green to ripe mangos from 6.9 to 19.2% in 'Ataulfo', 7.6 to 20.0% in 'Kent', and 6.2 to 18.0% in 'Tommy Atkins', while titratable acidity declined from 3.20, 0.81, and 1.88% in mature-green 'Ataulfo', 'Kent', and 'Tommy Atkins', respectively, to about 0.5% or lower in ripe mangos of all three cultivars.

Sugiyama et al (2005) tested sonic and vibration response method as a nondestructive method for evaluating the textural quality of mangos. They found that the most representative part for measuring firmness is along the equatorial diameter and that the transmission velocity of 'Keitt' mangos declined from 70-80 m/s in mature-green fruit to 24-28 m/s in ripe, ready-to-eat fruit. Estimation of dry matter and starch contents by near infrared spectroscopy (NIR) was used to separate immature- from mature-green mangos (Sarawong et al, 2005). NIR was used by Subedi et al (2007) to assess mango maturity on the basis of flesh color or dry matter content. Salim et al (2005) used an electronic nose to separate 'Harumanis' mangos into under-ripe, ripe, and over-ripe group. Jha et al (2006) concluded that mango maturity could be predicted by measuring size, color, and firmness.

Only mature mangos should be harvested to ensure good flavor quality when fully-ripe. A physiologically-mature mango requires 8 to 10 days at 25C to reach the edible ripe stage (Lakshminarayana, 1980). Many maturity indices have been tested, including number of days from full bloom, fruit size, fruit shape, skin color, flesh color, specific gravity, starch content, total solids (dry matter) content, soluble solids, and titratable acidity (Baez-Sanudo et al, 1997 and 1999; El-Azzouni and Salama,1956; Harding et al, 1954;Lakshminarayana, 1980; Malevski et al,1977; Mendoza and Wills, 1984; Popenoe and Long, 1957; Popenoe et al, 1958; Soule and Hatton, 1955; Stafford, 1983;

Subramanyam et al, 1975) . However, due to differences among cultivars, production conditions and locations, there is no consensus on maturity indices (Mitra and Baldwin, 1997).

The change in fruit shape (fullness of the shoulders; shoulders have risen above the stem-end), change in skin color from dark-green to light-green to yellow (in some cultivars) , and extent of yellow color in the flesh are the most commonly-used maturity indices. Red blush on the skin in some cultivars is not a dependable maturity index. Development of a nondestructive method to determine flesh color can provide a useful tool for relating the extent of yellow color in the flesh with some external attributes of a given cultivar in a given production site that can be used in training the harvesting crew on proper selection of mature mangos.

Mangos are picked at the mature-green or breaker stage to withstand the postharvest handling steps required to bring them to the retail markets. They should be ripened at the wholesale, retail, or consumer level. Hatton et al (1965) reported that ripening and softening rates of Florida mango cultivars increased as temperature increased from 16 to 27C, but the best temperature range was 21 to 24C. Mangos ripened at 27C and higher temperatures had strong flavors and molted skin (Soule and Harding, 1956; Hatton et al, 1965). Mangos produce relatively low levels of ethylene, but respond to exogenous ethylene applications. Campbell and Malo (1969) found that ripening of mature-green mangos was accelerated in response to ethylene released from 2-chloroethylphosphonic acid (ethephon). Exposure of Florida mango cultivars picked at the mature-green stage to 20-100 ppm ethylene for 24 hours results in faster and more uniform ripening at 21C and 92-95% relative humidity (Barmore, 1974). Barmore and Mitchell (1977) reported that

having ready-to-eat mangos with better color and aroma at retail stores increased sales. The benefits of ethylene-induced ripening were recently reported for 'Ataulfo' mangos (Montalvo et al, 2007).

The eating quality of mangoes when ripe depends upon maturity at harvest, avoiding physical damage and chilling injury during postharvest handling, and minimizing anthracnose incidence (Kader et al, 2002). Also, there are major differences in flavor quality and fiber content among cultivars. Changes associated with mango ripening (Lizada, 1993) include:

. Skin color changes from dark-green to light-green or yellow (depending on the cultivar),

. Flesh color changes from light-yellow to dark-yellow to orange in all cultivars,

. Increase in carotenoids and decrease in chlorophyll content,

. Decrease in flesh firmness and increased juiciness,

. Increase in respiration and ethylene production rates,

. Conversion of starch to sugars due to amylase activity,

. Increase in soluble solids content,

. Decrease in titratable acidity, and

. Increase in odor-active volatile compounds responsible for characteristic aroma.

4. Factors Affecting Fruit Quality

4.1. Genotype (cultivar or variety, rootstock) is a very important factor in determining mango quality as was stated above in section 2. However, I found no published data on comparing the quality and consumer preferences of the mango cultivars marketed in the USA.

4.2. Cultural practices, such as water and nutrients (especially nitrogen and calcium) supply, integrated pest management procedures, and crop load on the tree influence mango maturity rate, quality at harvest, and postharvest-life potential (related to incidence and severity of physiological disorder and decay). For example, the 'soft nose' disorder in mangos has been related to excess nitrogen and low calcium concentrations (Young and Miner, 1961). Based on my literature review, the effects of preharvest factors on quality at harvest and postharvest life have not been given much attention by researchers working on US-marketed mango cultivars.

4.3. Maturity at harvest is the most important factor in determining eating quality of ripe mangos as was discussed in section 3 above.

4.4. Postharvest handling practices

4.4.1. Preparation for market (washing, heat treatment, waxing, fungicide treatment, packaging, cooling).

Surface coatings mangos with carnauba wax reduced water loss and improved appearance by imparting a subtle shine during storage at 10 or 15C and 90-95% relative humidity for 19 days followed by 4 days at 20C and 56% relative humidity to simulate marketing conditions (Baldwin et al,1999).

Anthracnose (caused by *Colletotrichum gloesporioides*) begins as latent infections in unripe fruit and develops when the mangos begin to ripen. Another important disease is Diplodia stem-end rot, caused by *Lasiodiplodia theobromae*,

grows from the pedicel into a circular black lesion around the pedicel. Fungicide treatment and/or heat treatments can reduce decay incidence and severity (Dodd et al,1997; Hatton and Reeder,1964; Johnson and Coates,1993; Kim et al,2007; McMillan et al,1987; Smoot and Segall,1963; Spalding,1986; Spalding and Reeder,1978 and1986; Spalding et al,1988).

Disinfestation treatments for mangos, including vapor heat treatment, hot water dip, and irradiation at 250 Gy, can have negative effects on quality of mangos if recommended time-temperature combinations or irradiation dose are exceeded (Akamine and Goo,1979; Dennison and Ahmed,1968; Johnson et al,1997; Sharp,1988 and 1993; Sharp et al,1989; Spalding,1986; Spalding et al,1988; Spalding and von Windeguth,1988; von Windeguth,1986). Heating for insect disinfestation elevates respiration 3- to 5-fold and even after cooling the rates remain higher than those of untreated mangos for 4 to 6 days (Mitcham and McDonald, 1993). Irradiation doses above 250 Gy can result in scald-like symptoms on the skin and darkening and development of hollow pockets in the flesh (Spalding and von Windeguth,1988).

4.4.2. Management of temperature and relative humidity (to avoid chilling injury and minimize water loss).

The optimal temperature ranges are 12 to 14C for mature-green mangos and 8 to 12C for partially-ripe and ripe mangos (Kader et al, 2002; Paull and Chen, 2002). The optimal relative humidity range is 85 to 95% for all mangos. Exposure of mangos to lower than optimal temperatures induces chilling injury symptoms that

become more visible after transfer to higher temperatures. Chilling injury symptoms include grayish scald-like discoloration of the skin, pitting, uneven ripening, poor color and flavor, and increased susceptibility to decay (Hatton et al,1965; Kanes et al,1982; Saucedo-Veloz et al,1977; Medicott et al,1990).

4.4.3. Delayed ripening by modified or controlled atmospheres and/or treatment with 1-methylcyclopropene (1-MCP ; Smartfresh).

These treatments can not substitute for keeping mangos at the optimal range of temperature and relative humidity , but can be useful supplemental treatments under conditions when a longer postharvest-life is needed for successful marketing. Based on studies with Florida mango cultivars, the optimal range of oxygen is 3 to 5% and carbon dioxide is 5 to10% in modified or controlled atmospheres (Bender et al, 1994, 1995, 2000, 2000a, 2000b; Hatton and Reeder, 1965; Kim et al, 2007; Spalding and Reeder,1974 and 1977; Yahia,2006). Yahia and Vasquez-Moreno (1993) found that mangos tolerate short exposures to insecticidal atmospheres with very low oxygen and elevated carbon dioxide. However, exposure of mature-green mangos to oxygen levels below 2% and/or carbon dioxide levels above 10% for longer than a few days may induce skin discoloration, grayish or pale flesh color, uneven ripening, and off-flavor development due to fermentative metabolism (accumulation of acetaldehyde and ethanol). Modified atmosphere packaging with or without ethylene absorbers can delay ripening and reduce water loss of mature-green mangos (Miller et al, 1983 and 1986; Yahia, 2006). However, if gas diffusion is restricted to the extent that undesirable levels of oxygen and carbon dioxide

develop, the above-mentioned undesirable effects of low oxygen and elevated carbon dioxide will result.

Exposure of mature-green mangos to 200-300 ppb of the ethylene action inhibitor, 1-methylcyclopropene, for 6 hours at 14 or 20C delays their ripening. However, more research, including cost-benefit analysis is needed before such a treatment is commercialized. Also, the efficacy of the combination of 1-MCP treatment and controlled atmosphere in maintaining quality of mangos during simulated long-distance marine transport should be compared with each of these technologies alone.

4.4.4**.** Ripening initiation with ethylene treatment before retail display or use for fresh-cut processing.

As mentioned in section 3, ethylene induces faster and more uniform ripening. Greater uniformity can be attained if the mangos are sorted according to their maturity stage (as indicated by firmness and ground color) and each group was treated accordingly with.

The less mature mangos receiving longer exposure to ethylene. Once ripening is initiated,

Mangos can be handled at lower temperatures (8 to 10C) to delay further ripening if desired.

4.4.5. Time between harvesting and consumption.

In general, the shorter the time between harvest and consumption of fruits, the better the eating quality because postharvest-life based on flavor quality is generally about 70% of postharvest-life based on appearance quality of fruits. This is because of losses in sugars and organic acids used in respiration, losses of the fruit's capacity to produce its characteristic aroma due to depletion of precursors, and/or development of off-flavors. Future research should include testing this relationship in the US-marketed mango cultivars.

5. Quality Attributes Included in the Standards for Grades

5.1. Maturity Indices

In the US Standards for Grades of Mangos (USDA, 2007), mature means that the mango has reached the stage of development that will ensure the proper completion of the ripening process. It would be much better to include some objective maturity indices in future revisions of these standards. These may include fruit shape (fullness of the shoulders); change from dark-green to light-green to yellow of the skin's background (ground) color, depending on cultivar; flesh color (percent of the flesh showing yellow color); minimum soluble solids content; and/or total solids (dry matter) content.

The definition of mature in the European Standards, both the UN Economic Commission of Europe Standard FFV-45 (UNECE,1991) and the CODEX Standard for Mangoes (CODEX,2005) is as follows: mangoes must be sufficiently developed and display satisfactory ripeness; mangoes must be carefully picked at the stage of physiological development 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 a satisfactory condition at the place of destination. In relation to the evolution of maturing, the colour may vary according to variety. The OECD booklet on mango standards (OECD,1993) includes photographs illustrating flesh color of immature, partially-mature, mature, and over-ripe mangoes, and indicating that the mature mangoes are the only allowable stage (see Appendix, pages 14-15). This booklet also includes the following statements: "Picking at too early a stage of physiological development will result in inferior flavour and aroma" and "harvest at an advanced stage of maturity and ripeness (senescent stage) may result in reduced shelf-life. Such fruit is more susceptible to harvest and post-harvest defect or injury."

Mature in the 1993 Mango Standards of Queensland, Australia (where 'Kensington Pride' is the main cultivar produced) is defined as the fruit has reached such a state of development as to ensure a proper completion of the ripening process and attained a dry matter content of not less than 14% and the fruit is not wilted (shriveled). Dry matter content means the average of dry matter in a minimum of 3 mangoes determined by removing the flesh from both cheeks of a peeled mango, blending the flesh to a fine homogenous pulp, and analyzing a pulp sample of 5-10 g. Another maturity and quality index for 'Kensington Pride' mangoes is a minimum flesh color value of 27 on the Hunter "B" scale (measured by a Hunter Color Difference meter). There are no published data on total solids (dry matter) content or objective flesh color measurements as possible minimum maturity indices for US-marketed cultivars. However, both indices should be included in future studies of flavor quality when ripe vs maturity at harvest.

Minimum maturity in the 1999 Mexican mango Standards (Normas Mexicanas, 1999) is defined as follows:

"Mangos have to present a minimum maturity. Fruit shape, taste, flesh texture, and aroma are factors determining physiological maturity in each variety. Physiological maturity can be evaluated by cutting longitudinally fruits as close to the seed as possible. The seed has to be visible. Mangos have to present the color characterizing the variety. At least 50% of the total fruit's pulp or flesh must be light-yellow, and the remaining pulp has to have a light creamy yellowish color, no white. Varieties Tommy Atkins and Kent do not show pulp color variation between the seed and the fruit cortex during maturity and ripening. All the pulp has to have a light creamy-yellowish color, no white." (Normas Mexicanas, 1999).

I did not find official standards for mangos in Brazil, Ecuador, and Guatemala, but it is my understanding that the mango exporters in these countries use the grade standards of the importing country if required. Voluntary minimum maturity indices based on flesh color and/or soluble solids content may be used by some exporters if required by the importers.

5.2. Fruit Size

Size is not included in the 2007 US Standards for Grades of Mangos in contrast to standards of other countries. Based on discussion among exporters and importers and the results of studies on optimal packaging for mangoes, size categories should be established and included in the US Standards.

Sizing is compulsory for all mangoes marketed in Europe. The minimum weight of mangoes must not be less than 200 g. Mangoes are sized according to their weight into 3 categories as follows:

Size Code	Weight range (g)	Maximum variability within a package (g)
A	200 – 350	75
B	351 – 550	100
C	551 – 800	125

Size tolerances for all classes are 10% by number or weight of mangoes conforming to half of the permissible difference of the related size group above or below the range specified on the package, with a minimum of 180 g in size A and a maximum of 925 g in size C. For cultivars where there is a weak relationship between weight and diameter, weight-graded fruit must also be packed to uniform diameter consistent with the presentation requirement of the class.

The Mexican Mango standards include 13 size categories ranging from 6 to 44 fruits in 4.536-kg (10-lb) box with average fruit weight ranging from 756 to 103 g. The Peruvian Mango Standards (PROMPEX Peru, 2002 and 2006) have 12 size categories ranging from 4 to 20 fruits in 4-kg (8.8-lb) box with average fruit weight ranging from 1000 to 200 g. I recommend evaluating the need for such a large number of size categories on the basis of optimal packaging requirements and preferences of the marketers and consumers. One important factor will be whether mangoes will be sold to consumers by weight or by individual fruit. Selling by weight will most likely facilitate transition from 12 or 13 size categories down to 5 size categories (small, medium, large,

extra-large, and maximum-large). These 5 categories can be set at 200-gram intervals as follows:

Small …….<200 g

Medium…….. 201-400 g

Large…….. 401-600 g

Extra-large……..601-800 g

Maximum large…..> 800 g

5.3. Peduncle size

While the US Standards for Grades of Mangos allow up to one inch (2.54 cm), the European Standards limit peduncle length to 1 cm. It would be useful to conduct a study of the extent of fruit punctures caused by 1-cm vs 2.54-cm long peduncles and on the basis of the results of this study, modify the allowable peduncle length in the US Standards if necessary to reduce potential fruit damage during postharvest handling of mangos.

5.4. Defects

Some of the defects listed in the US Standards for Grades of Mangos can be caused by several conditions. For example, external (surface) discoloration can result from sunburn, sapburn, heat damage, scuffing and abrasions, or chilling injury. Internal discoloration can result from impact bruising, heat damage, chilling injury, or elevated carbon-dioxide injury.

It would be helpful to include such information in future revisions of the standards and to develop an illustrated guide to symptoms of the various defects and decay caused by the major fungi that attack mango fruits.

5.5. Contaminants and Hygiene

The CODEX Standard for Mangoes includes the following two food safety issues that are not covered in the US Standards: (1) Mangoes shall comply with maximum levels of heavy metals and pesticide residues established by the Codex Alimentarias Commission; and (2) Mangoes shall be prepared and handled in accordance with the appropriate sections of the Recommended International Code of Hygienic Practice for Fresh Fruits and Vegetables and other relevant Codex texts such as Codes of Hygienic Practices and Codes of Practice. Also, the produce shall comply with any microbiological criteria established in accordance with the Principles for the Establishment and Application of Microbiological Criteria for Foods. In the US, food safety regulations are the responsibility of the Food and Drug Administration (reducing microbial and heavy metal contamination) and the Environmental Protection Agency (establishing and enforcing pesticide residue limits).

Meanwhile, the focus of the US Standards for Grades is on quality and there is no need to change it.

6. Future Research Needs

6.1. Correlating subjective and objective mango flavor quality indices:

The objectives of this research are to correlate ripe mango composition (sugars, acids, odor-active aroma compounds) and textural attributes (juiciness, fiber content) with flavor acceptability and preference (sensory evaluation by a trained panel) and to identify the objective indices that can be used for good flavor quality of each of the five major mango cultivars marketed in the US (Ataulfo, Haden, Kent, Keitt, and Tommy Atkins). Some of the identified sensory quality indices can be included in future revisions of the US Standards for Grades of Mangos.

6.2. Evaluation of mango harvest maturity indices based on ripe flavor quality:

What are the best mango harvest maturity indices that assure good eating quality when ripe? This will need to be done on all the major cultivars and include flesh color and total solids (dry weight) among the indices to be evaluated. Both objective (sugars, acids, desirable aroma intensity, off-flavor-causing compounds) and subjective (sensory evaluation) flavor quality evaluation should be used. If this study is done after completion of the #1 study above, it would be possible to just use the identified objective indices of good flavor quality, which would reduce the time and cost needed to complete this harvest maturity study. Some of the identified maturity indices can be included in future revisions of the US Standards for Grades of Mangos.

6.3. Management of mango ripening to increase sales:

The objectives of this study are to evaluate the current recommendation for ripening mangos on the major cultivars and the commonly available maturity stages to develop more specific recommendations for optimal ripening of each cultivar and

maturity stage combinations. Another objective of this study is to test the impact of making ready-to-eat, ripe mangos available to consumers on mango sales. The results of this study can help in identifying the minimum harvest maturity for mangos to assure good flavor quality when ripe.

6.4. Time-temperature combinations that induce chilling injury of mangos:

The objectives of this research are to quantify the time-temperature combinations that induce the various symptoms of chilling injury of mangos (loss of flavor, failure to ripen properly, surface pitting, surface discoloration, flesh discoloration, increased susceptibility to decay). This should be done on all the major cultivars and on mature-green and partially-ripe mangos. Based on the results of this research, the recommended temperatures for transport and storage of mature-green and partially-ripe mangoes will either be affirmed as 13 C and 10 C, respectively or changed. Strict adherence to the recommended temperatures and durations (sell by or use by date) by all handlers of mangos can contribute to improved mango quality to the consumers.

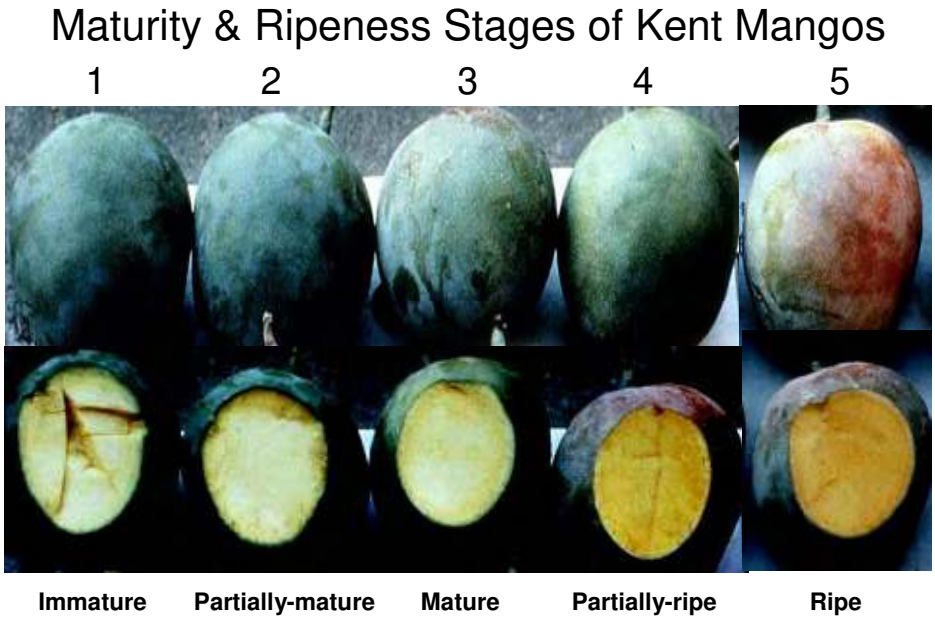
6.5. Developing a Mango Defects and Decay Symptoms Manual:

It would be very useful for all those involved in handling mangos to have a well-illustrated and accurate manual of symptoms of mango defects and decay.

7. Conclusions and Recommendations

7.1. I found a limited number of studies on mango cultivars that are marketed in the USA that focused on the impact of maturity at harvest on flavor quality of mangos when ripe and ready to eat. Thus, I recommend that such studies be given high priority to develop the information needed for selecting the best maturity index or indices for these cultivars. Until such information becomes available, I recommend that flesh color (more

than 75% of the area showing yellow color; stage #3 in the photograph shown below) be used for each cultivar grown in each production area be related to external factors including fruit size, fruit shape (fullness of the shoulders), and skin ground color (change from dark-green to light-green to yellowish-green). Then, the harvest crews should be trained to pick only those mangos that match the maturity indices.



7.2. Future studies on maturity indices should include total solids or dry matter content to find out whether or not such an index is reliable for the US-marketed five major mango cultivars. Total solids is a more reliable index for predicting flavor quality because it includes both the soluble solids (about 90% sugars) and the starch content that will be converted to sugars as the mango ripens.

7.3. I recommend including five size categories (small, medium, large, extra-large, and maximum large) based on ranges of fruit weight in the US Standards for Grades. Establishing a minimum size for mangos will help reduce the problem of immature fruit

reaching the market because within each cultivar and production are, the smaller mangos will likely include a higher percentage of immature fruit. Replacing size classification on the basis of number of mangos per box to fruit weight will provide better opportunities for selecting better shipping containers that provide more protection of the fruit and greater stability of the pallets. Selling mangos at retail by weight will facilitate implementation of this proposal.

7.4. Other potential modifications of the US Standards for Grades include reducing the maximum allowed length of the peduncle from one inch (2.54 cm) to 1 cm to reduce potential punctures to adjacent fruit and focusing the list of defects on those that are most important based on the current NMB-funded survey of mango quality at various steps in the handling chain.

7.5. Publishing a manual showing clear photographs of mango defects and decay symptoms and their causes would be very useful to all those involved in the mango business. The mango experts in Australia are preparing such a manual for their cultivars (Kensington and Calypso) and I am working with Dr. Peter Hofman to use the same terminology for the various mango defects.

8. Selected References (with emphasis on mango cultivars that are currently marketed in the USA) :

Akamine, E.K. and T. Goo. 1979. Effects of ionizing irradiation on 'Haden' mangoes. Univ. Hawaii Res. Rept. 205, 11p.

Araiza, E., T. Osuna, J. Siller, L. Contreras, and E. Sanchez. 2005. Postharvest quality and shelf-life of mango cultivars grown at Sinaloa, Mexico. Acta Hort. 682: 1275-1279.

Baez-Sanudo, R., E. Bringas-Taddei, and C. J. Ojeda. 1997. Mexican fresh mango quality standard grades and application methodology. Acta Hort. 455: 726-731.

Baez-Sanudo, R., E. Bringas-Taddei, and A. Rodriguez-Felix. 1999. Quality standard grades for Mexican mangoes and application methodology. J. Appl. Hort. 1:5-10.

Baldwin, E.A., J.K. Burns, W. Kazokas, J.K. Brecht, R.D. Hagenmaier, R.J. Bender, and E. Pesis. 1999. Effect of two edible coatings with different permeability characteristics on mango (*Mangifera indica* L.) ripening during storage. Postharv. Biol. Technol. 17: 215-226.

Barmore, C.R. 1974. Ripening mangos with ethylene and ethephon. Proc. Fla. State Hort. Soc. 87: 331-334.

Barmore, C.R. and E.F. Mitchell. 1977. Ethylene pre-ripening of mangoes prior to shipment. The Citrus Industry 58: 18-19 & 22-23.

Bender, R.J., J.K. Brecht, E.A. Baldwin, and T.M.M. Malundo. 2000. Aroma volatiles of mature-green and tree-ripe 'Tommy Atkins' mangoes after controlled atmosphere vs. air storage. HortScience 35:684-686.

Bender, R.J., J.K. Brecht, and C.A. Campbell. 1994. Responses of Kent and Tommy Atkins mangoes to reduced O_2 and elevated CO_2. Proc. Fla. State Hort. Soc. 107:274-277.

Bender, R.J., J.K. Brecht, and S.A. Sargent. 1995. Inhibition of ethylene production in mango fruit by elevated CO_2 and recovery during subsequent air storage. Proc. Fla. State Hort. Soc. 108:279-285.

Bender, R.J., J.K. Brecht, S.A. Sargent, and D.J. Huber. 2000a. Mango tolerance to reduced oxygen levels in controlled atmosphere storage. J. Amer. Soc. Hort. Sci. 125:707-713.

Bender, R.J., J.K. Brecht, S.A. Sargent, and D.J. Huber. 2000b. Low temperature controlled atmosphere storage for tree-ripe mangoes (*Mangifera indica* L.). Acta Hort. 509: 447-458.

Brown, B.I., I.A. Wells and C.F. Murray. 1986. Factors affecting the incidence and severity of mango sap-burn and its control. ASEAN Food J. 2:127-132.

Campbell, C.W. and S.E. Malo. 1969. The effect of 2-chloroethylphosphonic acid on ripening of mango fruits. Carib. Reg. Proc. Amer. Soc. Hort. Sci. 13: 221-226.

Carrillo-Lopez,A., F. Ramirez-Bustamante, J.B. Valdez-Torres, R. Rojas-Villegas, and E.M. Yahia. 2000. Ripening and quality changes in mango fruit as affected by coating with an edible film. J. Food Qual. 23:479-486.

Caygill, J.C., R.D. Cooke, D.J. Moore, S.J. Read, and H.C. Passam. 1976. The mango (Mangifera indica L.). Harvesting and subsequent handling and processing: An annotated bibliography. Tropical Products Institute Publ. G 107. Tropical Products Institute, London, 124 p.

Chaplin, G.R. 1988. Advances in postharvest physiology of mango. Acta Hort. 231:639-648.

CODEX. 2005. CODEX Standard for Mangoes. CODEX STAN 184-1993, AMD 1-2005 (http://www.codexalimentarius.net/web/more_info.jsp?id_sta=315)

Comision para la Promocion de Exportaciones (PROMPEX Peru). 2002. Mango.Mango Fresco. Requisitos. Norma Tecnica Peruana NTP 011.010, Comision de Reglamentos Tecnicos y Comerciales-INDECOPI, Lima, Peru, 10p.

Comision para la Promocion de Exportaciones (PROMPEX Peru). 2006. Guia de Interpretación de la Norma de Requisitas del Mango Fresco. Guia Peruana GP 011.024, Comision de Reglamentos Tecnicos y Comerciales-INDECOPI, Lima, Peru, 33p.

Dennison, R.A. and E.M. Ahmed. 1968. Irradiation effects on the ripening of Kent mangos. J. Food Sci. 32: 702-705.

Dodd, J.C., D. Prusky, and P. Jeffries. 1997. Fruit diseases. In: R.E. Litz (ed.). The mango botany, production and uses. CAB International, Wallingford, UK, pp. 257-280.

Drew, R. (editor). 2002. International symposium on tropical and subtropical fruits. Acta Hort. 575:1-879 (2 volumes).

El-Azzouni, M.M. and S.B. Salama. 1956. Studies on the determination of maturity and picking index of the fruits of some varieties of mango. Cairo Univ., Faculty of Agric. Bull 84, 24p.

Gomez-Lim, M.A. 1997. Postharvest physiology. In: R.E. Litz (ed.). The mango, botany, production and uses. CAB International, Wallingford, UK, pp. 425-445.

Harding, P.L., M.J. Soule, and M.B. Sunday. 1954. Quality in mangos. Proc. Florida Mango Forum, 1954, pp. 28-33.

Hatton, T.T. and W.F. Reeder. 1964. Hot water as a commercial control of mango anthracnose. Proc. Carib. Reg. Amer. Soc. Hort. Sci. 8: 76-84.

Hatton, T.T. and W.F. Reeder. 1965. Controlled atmosphere storage of Keitt mangos. Proc. Carib. Reg. Amer. Soc. Hort. Sci. 10: 114-119.

Hatton, T.T., W.F. Reeder, and C.W. Campbell. 1965. Ripening and storage of Florida mangos. Marketing Res. Rep. 725, Agric. Res. Serv., U.S. Dept. Agric., Washington, D.C.

Hoa, T.T., M. Ducamp, M. Lebrun, and E.A. Baldwin. 2002. Effect of different coating treatments on the quality of mango fruit. J. Food Qual. 25:471-486.

Hofman, P.J. and S.N. Ledger. 2006. Using a supply chain approach to guide R&D. Acta Hort. 699: 219-226.

Hulme, A.C. 1971. The mango. In: A.C. Hulme (ed.), The biochemistry of fruits and their products,Vol. 2, Academic Press, NY, pp. 233-254.

Jha, S.N., A.R.P. Kingsly, and S. Chopra. 2006. Physical and mechanical properties of mango during growth and storage for determination of maturity. J. Food Eng. 72: 73-76.

Jobin-Decor, M.P. 1988. Mango ripening guide. Queensland Agric. J. 114:369-371.

Johnson, G.I. and L.M. Coates. 1993. Postharvest diseases of mango. Postharvest News and Information 4:27N-34N.

Johnson, G.I., J.L. Sharp, D.L. Milne, and S.A. Oosthuyse. 1997. Postharvest technology and quarantine treatments, pp. 447-507. In: R.E. Litz (ed.). The mango botany, production and uses. CAB International, Wallingsford, UK.

Kader, A.A., N.F. Sommer, and M.L. Arpaia. 2002. Postharvest handling systems: tropical fruits. In: A.A.Kader (ed), Postharvest technology of horticultural crops, third edition.University of California, Agriculture and Natural Resources, Publication 3311, pp.385-398.

Kanes, O., M. Boulet and F. Costaigne. 1982. Effect of chilling-injury on texture and fungal rot of mangoes (Mangifera indica L.). J. Food Sci. 47:992-995.

Kim, Y., J.K. Brecht, and S.T. Talcott. 2007. Antioxidant phytochemicals and fruit quality changes in mango (*Mangifera indica* L.) following hot water immersion and controlled atmosphere storage. Food Chem. 105: 1327-1334.

Korsten,L. 2006. Advances in control of Postharvest diseases in tropical fresh produce. Int. J. Postharv. Technol. Innov. 1: 48-61.

Lakshminarayana, S. 1980. Mango. In: S. Nagy and P.E. Shaw (eds.). Tropical and subtropical fruits. AVI Publ. Co., Westport, CT, pp. 184-257.

Ledger, S., T. Campbell, and R. Holmes. 2003. Two handling systems deliver acceptable saleable life. Mango Supply Chain/ Communication/ AMIA Conference 03 paper, 10p.

Lelyveld, L.J. van and J.H.E. Smith. 1979. Physiological factors in the maturation and ripening of mango (Mangifera indica L.) fruit in relation to the jelly seed physiological disorder. J. Hort. Sci. 54:283-287.

Litz, R.E. (ed.). 1997. The mango botany, production and uses. CAB International, Wallingford, UK.

Lizada, C. 1993. Mango. In: G.B. Seymour et al. (eds.), Biochemistry of fruit ripening, Chapman and Hall, London, pp. 255-271.

Loney, B.R., S.P. Robinson, J.J. Brophy and E.K. Chacko. 1992. Mango sap-burn, components of the fruit sap and their role in causing skin damage. Austral. J. Plant Physiol. 19:449-457.

MacLeod, A.J. and N.M. Pieris. 1984. Comparison of the volatile components of some mango cultivars. Phytochemistry 23: 361-366.

MacLeod, A.J. and C.H. Snyder. 1985. Volatile components of two cultivars of mango from Florida. J. Agric. Food Chem. 33:380-384.

Malevski, Y., L. Gomez-Brito, M. Peleg, and M. Silberg. 1977. External color as maturity index of mango. J. Food Sci. 42: 1316-1318.

Malundo, T.M.M., E.A. Baldwin, G.O. Ware, and R.L. Shewfelt. 1996. Volatile composition and interaction influence flavor properties of mango (*Mangifera indica* L.). Proc. Fla State Hort. Soc. 109: 264-268.

Malundo, T.M.M., R.L. Shewfelt, G.O. Ware, and E.A. Baldwin. 2001. Sugars and acids influence flavor properties of mango (*Mangifera indica* L.). J. Amer. Soc. Hort. Sci. 126: 115-121.

McMillan, R.T., D.H. Spalding, and W.F. Reeder. 1987. Effectiveness of various postharvest treatments for mango decay control. Proc. Fla. State Hort. Soc. 100: 7-9.

Medlicott, A.P., J.M. M. Sigrist and O. Sy. 1990. Ripening of mangoes following low temperature storage. J. Amer. Soc. Hort. Sci. 115:430-434.

Mendoza, D.B., JR. and R.B.H. Wills (eds.). 1984. Mango: fruit development, Postharvest physiology, and marketing in ASEAN. ASEAN Food Handling Bureau, Kuala Lumpur, Malaysia, 111 p.

Miller, W.R., P.E.Hale, D.H. Spalding, and P. Davis. 1983. Quality and decay of mango fruit wrapped in heat-shrinkable film. HortScience 18: 957-958.

Miller, W.R., D.H. Spalding, and P.W.Hale. 1986. Film-wrapping mangoes at advancing stages of post-harvest ripening. Trop. Sci. 26: 9-17.

Mitcham, E.J. and R.E. McDonald. 1992. Cell wall modification during ripening of 'Keitt' and 'Tommy Atkins' mango fruit. J. Amer. Soc. Hort. Sci. 117: 919-924.

Mitcham, E.J. and R.E. McDonald. 1993. Respiration rate, internal atmosphere, and ethanol and acetaldehyde accumulation in heat-treated mango fruit. Postharv. Biol. Technol. 3: 77-86.

Mitra, S.K. and E.A. Baldwin. 1997. Mango. In: S. Mitra (ed.). Postharvest physiology and storage of tropical and subtropical fruits. CAB International, Wallingford, UK, pp. 85-122.

Montalvo, E., H.S. Garcia, B. Tovar, and M. Mata. 2007. Application of exogenous ethylene on postharvest ripening of refrigerated 'Ataulfo' mangoes. LWT 40: 1466-1472.

Nanjundaswamy, A.M. 1997. Processing. In: R.E. Litz (ed.). The mango botany, production and uses. CAB International, Wallingford, UK, pp. 509-544.

Narain, N., P.S. Bora, R. Narain, and P.E. Shaw. 1998. Mango. In: P.E. Shaw et al (eds.). Tropical and subtropical fruits. Agscience, Inc., Auburndale, FL, pp. 1-77.

OECD. 1993. International Standardisation of Fruit and Vegetables: Mangoes. Organization for Economic Co-operation and Development Publications, Paris, France, 61p. (ISBN 92-64-03893-0-No. 46751)

Normas Mexicanas. 1999. NMX-FF-058-1999, Fresh fruit, Mango (Mangifera indica L), Specifications (in Spanish). Normas Mexicanas, Direccion General de Normas. (http://www.colpos.mx/bancodenormas/nmexicanas/NMX-FF-058-1999.PDF).

Nunes, M.C.N., J.P. Emond, J.K. Brecht, S. Dea, and E. Proulx. 2007. Quality curves for mango fruit (cv. Tommy Atkins and Palmer) stored at chilling and nonchilling temperatures. J. Food Qual. 30: 104-120.

Ornelas-Paz, J.D., E.M. Yahia, and A. Gardea-Bejar. 2007. Identification and quantification of xanthophyll esters, carotenes, and tocopherols in the fruit of seven Mexican mango cultivars by liquid chromatography-atmospheric pressure chemical ionization- time-of-flight mass spectrometry. J. Agric. Food Chem. 55: 6628-6635.

Paull, R.E. and C.C. Chen. 2002. Mango. In: Gross, K., C.Y. Wang, and M.E. Saltveit (editors). 2002. The commercial storage of fruits, vegetables, and florist and nursery stocks. USDA Agr. Handb. 66 (available electronically at: http://www.ba.ars.usda.gov/hb66/index.html).

Paull, R.E. and N.J. Chen. 2004. Tropical fruit postharvest: the impact of biotechnology. Acta Hort. 632: 303-308.

Perkins-Veazie, P. 2007. Carotenoids in watermelon and mango. Acta Hort. 746: 259-264.

Pinto, A.C.Q., M.E.C. Pereira, and R.E. Alves (editors). 2004. VII International Mango Symposium. Acta Hort. 645: 1-695.

Popenoe, J., T.T. Hatton, and P.L. Harding. 1958. Determination of maturity of hard green Haden and Zill mangos. Proc. Amer. Soc. Hort. Sci. 71: 326-329.

Popenoe, J. and W.G. Long. 1957. Evaluation of starch content and specific gravity as measures of maturity of Florida mangos. Proc. Fla. State Hort. Soc. 70: 272-274.

Proctor, J.T.A. and L.L. Creasy. 1969. The anthocyanin of the mango fruit. Phytochemistry 8: 2108.

Raymond, L., B. Schaffer, J.K. Brecht, and J.H. Crane. 1998. Internal breakdown in mango fruit: symptomology and histology of jelly seed, soft nose, and stem-end cavity. Postharv. Biol. Technol. 13: 59-70.

Salim, S.N.M., A.Y.M. Shakaff, M.N. Ahmed, A.H. Adom, and Z. Husin. 2005. Development of electronic nose for fruits ripeness determination. Proc. 1st Int. Conf. Sensing Technol., Palmerston North, New Zealand, 21-23 Nov. 2005, pp. 515-518.

Saranwong, S., S. Kawano, and J. Sornsrivichai. 2005. Advanced technique to predict eating quality of ripe mango at unripe stage using near infrared spectroscopy. Acta Hort. 682: 1427-1433.

Saucedo-Veloz, C., F. Esparza-Torres, and S. Lakshminarayana. 1977. Effect of refrigerated temperatures on the incidence of chilling injury and ripening quality of mango fruit. Proc. Fla. State Hort. Soc. 90: 205-210.

Sharp, J.L. 1988. Status of hot water immersion quarantine treatment for Tephritidae immatures in mango. Proc. Fla. State Hort. Soc. 101: 195-197.

Sharp, J.L. 1993. Quarantine treatments for major mango pests. Acta Hort. 341: 407-414.

Sharp, J.L., M.T. Ouye, W. Hart, S. Ingle, G. Hallman, W. Gould, and V. Chew. 1989. Immersion of Florida mangos in hot water as a quarantine treatment for Caribbean fruit fly (Diptera: Tephritidae). J. Econ. Entomol. 82: 186-188.

Smoot, J.J. and R.H. Segall. 1963. Hot water as a postharvest control of mango anthracnose. Plant Dis. Rep. 47: 739-742.

Soule, M.J. and P.L. Harding. 1956. Changes in physical characters and chemical constituents of Haden mangos during ripening at 80 F. Proc. Fla. Sate Hort. Soc. 69: 282-284.

Soule, M.J.and T.T. Hatton. 1955. Effect of size of fruit and dates of sampling on physical and chemical characters of mangos. Proc. Florida Mango Forum, 1955, pp. 16-21.

Spalding, D.H. 1986. Evaluation of various treatments for control of postharvest decay of Florida mangos. Proc. Fla. State Hort. Soc. 99: 97-99.

Spalding, D.H., J.R. King, and J.L. Sharp. 1988. Quality and decay of mangos treated with hot water for quarantine control of fruit fly. Trop. Sci. 28: 95-101.

Spalding, D.H. and W.F. Reeder. 1974. Current status of controlled atmosphere storage of four tropical fruits. Proc. Fla. State Hort. Soc.87:334-337.

Spalding, D.H. and W.F. Reeder. 1977. Low pressure (hypobaric) storage of mangoes. J. Amer. Soc. Hort. Sci. 102: 367-369.

Spalding, D.H. and W.F. Reeder. 1978. Controlling market diseases of mangos with heated benomyl. Proc. Fla. State Hort. Soc. 91: 186-187.

Spalding, D.H. and W.F. Reeder. 1986. Decay and acceptability of mangos treated with combination of hot water, imazalil, and gamma radiation. Plant Disease 70: 1149-1151.

Spalding, D.H. and D.L. von Windeguth. 1988. Quality and decay of irradiated mangoes. HortScience 23: 187-189.

Stafford, A.E. 1983. Mango. p. 399-431, in: H.T. Chan, Jr. (ed.). Handbook of tropical foods. Marcel Dekker, Inc., New York.

Subedi, P.P., K.B. Walsh, and G. Owens. 2007. Prediction of mango eating quality at harvest using short-wave near infrared spectroscopy. Postharv. Biol. Technol. 43:326-334.

Subhadrabandhu, S. and A. Pichakum (editors). 2000. VI International Symposium on Mango. Acta Hort. 509: 1-558 (2 volumes).

Subramanyam, H., S. Krishnamurthy, and H.A.B. Parpia. 1975. Physiology and biochemistry of mango fruit. Adv. Food Res. 21:223-305.

Sugiyama, J., M.I. Al-Haq, and M. Tsuta. 2005. Application of portable acoustic firmness tester for fruits. Information and Technology for Sustainable Fruit and Vegetable Production, FRUTIC 05, 12-16 September 2005, Montpellier, France.

USDA. 2007. United States Standards for Grades of Mangos. U.S.Dept.Agric., Agric. Mktg. Serv., Fruit and Vegetable Program, Fresh Products Branch, Washington, D.C., 5p. (http://www.ams.usda.gov/standards/MANGOS.pdf).

UNECE. 1991. UNECE Standard FFV-45 concerning the marketing of commercial quality control of mangoes moving in international trade between and to UNECE member countries. United Nations Economic Commission for Europe, Geneva, Switzerland.(http://www.unece.org/trade/agr/standard/fresh/fresh_e/45mang.pdf).

Vodovotz, Y., G.E. Arteaga, and S.Nakai. 1993. Principal component similarity analysis for classification and its application to GC data of mango. Food Res. Int. 26:355-363.

Von Windeguth, D.L. 1986. Gamma irradiation as a quarantine treatment for Caribbean fruit fly infested mango. Proc. Fla. State Hort. Soc. 99: 131-134.

Wainwright, H. and M.B. Burbage. 1989. Physiological disorders in mango (*Mangifera indica* L.) fruit (review article). J. Hort. Sci. 64:125-135.

Yahia, E.M. 2006. Modified and controlled atmospheres for tropical fruits. Stewart Postharvest Review 2006, 5:6, 10pp.

Yahia, E.M., J. O. Paz, and R.A. Flores. 2006. El Mango. Mexico: Trillas, 224p.

Yahia, E.M. and l. Vasquez-Moreno. 1993. Responses of mango to insecticidal oxygen and carbon dioxide atmospheres. Lebersm. Wiss. u. Technol. 26:42-48.

Young, T.W. and J.T. Miner. 1961. Relationship of nitrogen and calcium to 'soft-nose' disorder in mango fruits. J. Amer. Soc. Hort. Sci. 78:201-208.

NORMA DEL CODEX PARA EL MANGO

(CODEX STAN 184-1993, EMD. 1-2005)

1. DEFINICIÓN DEL PRODUCTO

Esta Norma se aplica a las variedades comerciales de mangos obtenidos de *Mangifera indica* L., de la familia *Anacardiaceae*, que habrán de suministrarse frescos al consumidor, después de su acondicionamiento y envasado. Se excluyen los mangos destinados a la elaboración industrial.

2. DISPOCISIONES RELATIVAS A LA CALIDAD

2.1 REQUISITOS MÍNIMOS

En todas las categorías, a reserva de las disposiciones especiales para cada categoría y las tolerancias permitidas, los mangos deberán:

- estar enteros;
- estar sanos, deberán excluirse los productos afectados por podredumbre o deterioro que hagan que no sean aptos para el consumo;
- estar limpios, y prácticamente exentos de cualquier materia extraña visible;
- estar prácticamente exentos de daños causados por plagas;
- estar exentos de humedad externa anormal, salvo la condensación consiguiente a su remoción de una cámara frigorífica;
- estar exentos de cualquier olor y/o sabor extraños;
- ser de consistencia firme;
- tener un aspecto fresco;
- estar exentos de daños causados por bajas temperaturas;
- estar exentos de manchas necróticas negras ó estrías;
- estar exentos de magulladuras marcadas; y
- estar suficientemente desarrollados y presentar un grado de madurez satisfactorio.

Cuando tengan pedúnculo, su longitud no deberá ser superior a 1.0 cm.

2.1.1 El desarrollo y condición de los mangos deberán ser tales que les permitan:

- asegurar la continuidad del proceso de maduración hasta que alcancen el grado de madurez adecuado, de conformidad con las características peculiares de la variedad;
- soportar el transporte y la manipulación; y
- llegar en estado satisfactorio al lugar de destino.

En relación con el proceso de maduración, el color puede diferir según la variedad.

2.2 CLASIFICACIÓN

Los mangos se clasifican en tres categorías, según se definen a continuación:

2.2.1 Categoría "Extra"

Los mangos de esta categoría deberán ser de calidad superior y característicos de la variedad. No deberán tener defectos, salvo defectos superficiales muy leves siempre y cuando no afecten al aspecto general del producto, su calidad, estado de conservación y presentación en el envase.

2.2.2 Categoría I

Los mangos de esta categoría deberán ser de buena calidad y característicos de la variedad. Podrán permitirse, sin embargo, los siguientes defectos leves, siempre y cuando no afecten al aspecto general del producto, su calidad, estado de conservación y presentación en el envase:

- defectos leves de forma;
- defectos leves de la cáscara debidos a rozaduras o quemaduras producidas por el sol, manchas suberizadas debidas a la exudación de resina (incluidas estrías alargadas) y magulladuras ya sanadas que no excedan de 3, 4 y 5 cm² para los grupos de calibres A, B y C, respectivamente.

2.2.3 Categoría II

Esta categoría comprende los mangos que no pueden clasificarse en las categorías superiores, pero satisfacen los requisitos mínimos especificados en la Sección 2.1. Podrán permitirse, sin embargo, los siguientes defectos, siempre y cuando los mangos conserven sus características esenciales en lo que respecta a su calidad, estado de conservación y presentación:

- defectos de forma;
- defectos de la cáscara debidos a rozaduras o quemaduras producidas por el sol, manchas suberizadas debidas a la exudación de resina (incluidas estrías alargadas) y magulladuras ya sanadas que no excedan de 5, 6 y 7 cm² para los grupos de calibres A, B y C, respectivamente.

En las categorías I y II se permite la presencia de lenticelas rojizas suberizadas esparcidas, así como el amarilleamiento de las variedades de color verde, debido a una exposición directa a la luz solar, pero sin que exceda del 40% de la superficie ni se observen señales de necrosis.

3. DISPOSICIONES RELATIVAS A LA CLASIFICACIÓN POR CALIBRES

El calibre se determina por el peso de la fruta, de acuerdo con el siguiente cuadro:

Código de Calibre	**Peso** (en gramos)
A	200-350
B	351-550
C	551-800

La diferencia máxima de peso permisible entre las frutas contenidas en un mismo envase que pertenezcan a uno de los grupos de calibres mencionados anteriormente será de 75, 100 y 125 g respectivamente. El peso mínimo de los mangos no deberá ser inferior a 200 g.

4. DISPOSICIONES RELATIVAS A LAS TOLERANCIAS

En cada envase se permitirán tolerancias de calidad y calibre para los productos que no satisfagan los requisitos de la categoría indicada.

4.1 TOLERANCIAS DE CALIDAD

4.1.1 Categoría "Extra"

El 5%, en número o en peso, de los mangos que no satisfagan los requisitos de esta categoría pero satisfagan los de la Categoría I o, excepcionalmente, que no superen las tolerancias establecidas para esta última.

4.1.2 Categoría I

El 10%, en número o en peso, de los mangos que no satisfagan los requisitos de esta categoría pero satisfagan los de la Categoría II o, excepcionalmente, que no superen las tolerancias establecidas para esta última.

4.1.3 Categoría II

El 10%, en número o en peso, de los mangos que no satisfagan los requisitos de esta categoría ni los requisitos mínimos, con excepción de los productos afectados por podredumbre o cualquier otro tipo de deterioro que haga que no sean aptos para el consumo.

4.2 TOLERANCIAS DE CALIBRE

Para todas las categorías se permite que, como máximo, el 10%, en número o en peso, de los mangos contenidos en cada envase no se ajuste a los límites de calibre del grupo en un 50% de la diferencia máxima permisible para el grupo. Para la categoría de menor calibre, la fruta no debe pesar menos de 180 g, y para la de mayor calibre se aplica un máximo de 925 g, según se indica a continuación:

Grupo de calibre	Límites normales	Límites permisibles (≤ 10% de la fruta/ envase fuera de los límites normales)	Diferencia máxima permisible entre las frutas de cada envase
A	200 - 350	180 - 425	112,5
B	351 - 550	251 - 650	150
C	551 - 800	426 - 925	187,5

5. DISPOSICIONES RELATIVAS A LA PRESENTACIÓN

5.1 HOMOGENEIDAD

El contenido de cada envase deberá ser homogéneo y estar constituido únicamente por mangos del mismo origen, variedad, calidad y calibre. La parte visible del contenido del envase deberá ser representativa de todo el contenido.

5.2 ENVASADO

Los mangos deberán envasarse de tal manera que el producto quede debidamente protegido. Los materiales utilizados en el interior del envase deberán ser nuevos[1], estar limpios y ser de calidad tal que evite cualquier daño externo o interno al producto. Se permite el uso de materiales, en particular papel o sellos, con indicaciones comerciales, siempre y cuando estén impresos o etiquetados con tinta o pegamento no tóxico.

Los mangos deberán disponerse en envases que se ajusten al Código Internacional de Prácticas Recomendado para el Envasado y Transporte de Frutas y Hortalizas Frescas (CAC/RCP 44-1995, Emd. 1-2004).

5.2.1 Descripción de los Envases

Los envases deberán satisfacer las características de calidad, higiene, ventilación y resistencia necesarias para asegurar la manipulación, el transporte y la conservación apropiados de los mangos. Los envases (o lote, para productos presentados a granel) deberán estar exentos de cualquier materia y olor extraños.

[1] Para los fines de esta Norma, esto incluye el material recuperado de calidad alimentaria.

6. MARCADO O ETIQUETADO

6.1 ENVASES DESTINADOS AL CONSUMIDOR

Además de los requisitos de la Norma General del Codex para el Etiquetado de Alimentos Preenvasados (CODEX STAN 1-1985, Rev. 1-1991), se aplicarán las siguientes disposiciones específicas:

6.1.1 Naturaleza del Producto

Si el producto no es visible desde el exterior, cada envase deberá etiquetarse con el nombre del producto y, facultativamente, con el de la variedad.

6.2 ENVASES NO DESTINADOS A LA VENTA AL POR MENOR

Cada envase deberá llevar las siguientes indicaciones en letras agrupadas en el mismo lado, marcadas de forma legible e indeleble y visibles desde el exterior, o bien en los documentos que acompañan el envío. Para los productos transportados a granel, estas indicaciones deberán aparecer en el documento que acompaña a la mercancía.

6.2.1 Identificación

Nombre y dirección del exportador, envasador y/o expedidor. Código de identificación (facultativo)[2].

6.2.2 Naturaleza del Producto

Nombre del producto si el contenido no es visible desde el exterior. Nombre de la variedad o tipo comercial (facultativo).

6.2.3 Origen del Producto

País de origen y, facultativamente, nombre del lugar, distrito o región de producción.

6.2.4 Especificaciones Comerciales

- Categoría;
- Calibre (código de calibre o gama de pesos en gramos);
- Número de unidades (facultativo);
- Peso neto (facultativo).

6.2.5 Marca de Inspección Oficial (facultativa)

7. CONTAMINANTES

7.1 METALES PESADOS

Los mangos deberán cumplir con los niveles máximos para metales pesados establecidos por la Comisión del Codex Alimentarius para este producto.

7.2 RESIDUOS DE PLAGUICIDAS

Los mangos deberán cumplir con los límites máximos para residuos de plaguicidas establecidos por la Comisión del Codex Alimentarius para este producto.

---

[2] La legislación nacional de algunos países requiere una declaración expresa del nombre y la dirección. Sin embargo, en caso de que se utilice una marca en clave, habrá de consignarse muy cerca de ella la referencia al "envasador y/o expedidor" (o a las siglas correspondientes).

8. HIGIENE

8.1 Se recomienda que el producto regulado por las disposiciones de la presente Norma se prepare y manipule de conformidad con las secciones apropiadas del Código Internacional Recomendado de Prácticas - Principios Generales de Higiene de los Alimentos (CAC/RCP 1-1969, Rev. 4-2003), Código de Prácticas de Higiene para Frutas y Hortalizas Frescas (CAC/RCP 53-2003) y otros textos pertinentes del Codex, tales como códigos de prácticas y códigos de prácticas de higiene.

8.2 Los productos deberán ajustarse a los criterios microbiológicos establecidos de conformidad con los Principios para el Establecimiento y la Aplicación de Criterios Microbiológicos a los Alimentos (CAC/GL 21-1997).

February 25, 2008

MANGO QUALITY ATTRIBUTES AND GRADE STANDARDS: A REVIEW OF AVAILABLE INFORMATION AND IDENTIFICATION OF FUTURE RESEARCH NEEDS : APPENDIX

Adel A. Kader
Postharvest Horticulture Consultant, Kader Consulting Services, P.O.Box 600, Davis, CA 95617-0600, USA

9. Appendix: Quality Standards for Mangos:

USDA. 2007. United States Standards for Grades of Mangos. U.S.Dept.Agric., Agric. Mktg. Serv., Fruit and Vegetable Program, Fresh Products Branch, Washington, D.C., 5p. (http://www.ams.usda.gov/standards/MANGOS.pdf)..... pages 2-7.

CODEX. 2005. CODEX Standard for Mangoes. CODEX STAN 184-1993, AMD 1-2005 (http://www.codexalimentarius.net/web/more_info.jsp?id_sta=315)..... Pages 8-11

OECD. 1993. International Standardisation of Fruit and Vegetables: Mangoes. Organization for Economic Co-operation and Development Publications, Paris, France, 61p. (ISBN 92-64-03893-0-No. 46751)…..pages 12-15

UNECE. 1991. UNECE Standard FFV-45 concerning the marketing of commercial quality control of mangoes moving in international trade between and to UNECE member countries. United Nations Economic Commission for Europe, Geneva, Switzerland.(http://www.unece.org/trade/agr/standard/fresh/fresh_e/45mang.pdf)..... very similar to CODEX Standard for Mangoes.

Comision para la Promocion de Exportaciones (PROMPEX Peru). 2006. Guia de Interpretación de la Norma de Requisitas del Mango Fresco. Guia Peruana GP 011.024, Comision de Reglamentos Tecnicos y Comerciales-INDECOPI, Lima, Peru, 33p…..pages 16-18.

Normas Mexicanas. 1999. NMX-FF-058-1999, Fresh fruit, Mango (Mangifera indica L), Specifications (in Spanish). Normas Mexicanas, Direccion General de Normas. (http://www.colpos.mx/bancodenormas/nmexicanas/NMX-FF-058-1999.PDF) ..... pages 19-28.

United States
Department of
Agriculture

Agricultural
Marketing
Service

Fruit and
Vegetable
Programs

Fresh
Products
Branch

United States Standards for Grades of Mangos

Effective August 24, 2007

United States Standards for Grades of Mangos

Effective August 24, 2007

Grades

§51.1043 U.S. Fancy.

"U.S. Fancy" consists of mangos of similar varietal characteristics which are mature, clean, well formed, well trimmed, and which are free from decay, overripe, freezing, internal discoloration, insects, larva, insect or larva feeding, skin breaks which are not healed, and free from injury by healed skin breaks, bruising, scab, shriveling, external (surface) discoloration, sunken discolored areas, scars, russeting, other diseases, mechanical or other means.

(a) Tolerances. In order to allow for variations incident to proper grading and handling, not more than 10 percent, by count, of the mangos in any lot may fail to meet the requirements of this grade, including in this amount not more than 5 percent shall be allowed for defects causing damage, including in this latter amount not more than 2 percent shall be allowed for decay.

§51.1044 U.S. No. 1.

"U.S. No. 1" consists of mangos of similar varietal characteristics which are mature, clean, fairly well formed, well trimmed, and which are free from decay, overripe, freezing, skin breaks which are not healed and extend into the flesh, insects or larva, and free from damage caused by insect or larva feeding, bruising, shriveling, scab, external (surface) discoloration, internal discoloration, sunken discolored areas, scars, russeting, other diseases, mechanical or other means.

(a) Tolerances. In order to allow for variations incident to proper grading and handling, not more than 10 percent, by count, of the mangos in any lot may fail to meet the requirements of this grade, including in this amount not more than 5 percent shall be allowed for defects causing serious damage, including in this latter amount not more than 2 percent shall be allowed for decay.

§51.1045 U.S. No. 2.

"U.S. No. 2" consists of mangos of similar varietal characteristics which are mature, clean, fairly well formed, well trimmed, and which are free from decay, overripe, freezing, skin breaks which are not healed and extend into the flesh, insects or larva, and free from serious damage caused by insect or larva feeding, bruising, shriveling, scab, external (surface) discoloration, internal discoloration, sunken discolored areas, scars, russeting, other diseases, mechanical or other means.

(a) Tolerances. In order to allow for variations incident to proper grading and handling, not more than 10 percent, by count, of the mangos in any lot may fail to meet the requirements of this grade, included in this amount not more than 2 percent shall be allowed for decay.

Application of Tolerances

§51.1046 Application of tolerances.

The contents of individual packages in the lot, based on the sample inspection, are subject to the following limitations:

(a) For a tolerance of 10 percent or more, individual packages shall have not more than 1 1/2 times the tolerance specified, and for a tolerance of less than 10 percent, individual packages shall have not more than double the tolerance specified; *Provided*, that at least one defective specimen may be allowed in any package: *And provided further*, that the averages for the entire lot are within the tolerances specified for the grade.

Definitions

§51.1047 Clean.

"Clean" means that the fruit is practically free from dirt, dust or other foreign material.

§51.1048 Damage.

"Damage" means any defect that materially affects the appearance, or the edible or shipping quality of the mango. Any one of the defects listed in the "Classification of Defects" table (See §51.1059.), or any combination thereof, the seriousness of which exceeds the maximum allowed for any one defect, shall be considered as damage.

§51.1049 Diameter.

"Diameter" means the greatest dimension of the mango measured at right angles to a line from stem to blossom end.

§51.1050 Fairly well formed.

"Fairly well formed" means that the shape of the mango is typical of the variety and is symmetrical with slight irregularities in shape allowed; but, not to an extent where its appearance is materially affected.

§51.1051 Injury.
"Injury" means any injury or defect that slightly affects the appearance, or the edible or shipping quality of the mango. Any one of the following defects listed in the "Classification of Defects" table (See §51.1059.), or any combination thereof, the seriousness of which exceeds the maximum allowed for any one defect, shall be considered as injury.

§51.1052 Mature.
"Mature" means that the mango has reached the stage of development that will ensure the proper completion of the ripening process.

§51.1053 Misshapen.
"Misshapen" means that the shape of the mango is abnormal to an extent that its appearance is materially affected.

§51.1054 Overripe.
"Overripe" means that flesh of the mango yields to slight pressure and is beginning to disintegrate and is past commercial utility.

§51.1055 Serious damage.
"Serious damage" means any defect which seriously affects the appearance, or the edible or shipping quality of the mango. Any one of the following defects listed in the "Classification of Defects" table (See §51.1059.), or any combination thereof, the seriousness of which exceeds the maximum allowed for any one defect, shall be considered as serious damage.

§51.1056 Similar varietal characteristics.
"Similar varietal characteristics" means the fruit in any package is of similar shape and of similar skin and flesh color.

§51.1057 Well formed.
"Well formed" means that the shape of the mango is typical of the variety and is symmetrical without irregularities in shape.

§51.1058 Well trimmed.
"Well trimmed" means the stem is neatly clipped or broken off at a point not more than 1 inch beyond the point of attachment.

§51.1059 Classification of Defects. [1]			
Defects	**Injury**	**Damage**	**Serious Damage**
Bruising	Any slight surface indentation and discoloration of the flesh extending more than 1/8 inch in depth and 1/2 inch in diameter.	Surface indentation and discoloration of the flesh extends deeper than 1/4 inch and causing discoloration exceeding the area of a circle 3/4 inch in diameter.	Surface indentation and discoloration of the flesh extends deeper than 1/2 inch and causing discoloration exceeding the area of a circle 1 inch in diameter.
External (Surface) Discoloration	Discoloration affecting an aggregate area more than 5% of the fruit surface.	Discoloration affecting an aggregate area more than 15% of the fruit surface.	Discoloration affecting an aggregate area more than 25% of the fruit surface.
Insects or Insect or Larva Feeding Injury	When any is present or when any feeding injury is evident on the fruit.	When any is present or when feeding injury aggregates an area that exceeds that of a circle 1/2 inch in diameter.	When any is present or when feeding injury aggregates an area that exceeds that of a circle 1 inch in diameter.
Internal Discoloration	When present in any amount.	When affecting an aggregate area more than 3/4 inch in diameter.	When affecting an aggregate area more than 1 1/2 inch in diameter.
Scab	When cracked, or when the aggregate area exceeds that of a circle 1/4 inch in diameter.	When cracked, or when the aggregate area exceeds that of a circle 1/2 inch in diameter.	When the aggregate area exceeds that of a circle 3/4 inch in diameter.

[1] References to area, aggregate areas, or length are based on fruit 3 inches in diameter. Corresponding smaller or larger areas would be allowed on smaller or larger fruit.

§51.1059 Classification of Defects (continued) [1]			
Defects	**Injury**	**Damage**	**Serious Damage**
Scars or Russeting	When light colored, smooth and affecting an aggregate area more than 5% of the surface, or when dark or rough or scaly and affecting an aggregate area more than 2 1/2% of the surface.	When light colored, smooth and affecting an aggregate area more than 10% of the surface, or when dark or rough or scaly and affecting an aggregate area more than 5% of the surface.	When light colored, smooth and affecting an aggregate area more than 15% of the surface, or when dark or rough or scaly and affecting an aggregate area more than 10% of the surface.
Skin Breaks	When unhealed or when the aggregate area of healed breaks exceeds that of a circle 1/4 inch in diameter or 1/4 inch in length.	When any break is into the flesh or when the aggregate area of healed breaks exceeds that of a circle 1/2 inch in diameter or 1/2 inch in length.	When any break is into the flesh or when the aggregate area of healed breaks exceeds that of a circle 1 inch in diameter or 1 inch in length.
Shriveling	When affecting an aggregate area more than 5% of the surface.	When affecting an aggregate area more than 15% of the surface.	When affecting an aggregate area more than 25% of the surface.
Sunken Discolored Areas	When more than 5% of the surface has a distinct sunken area with discoloration.	When more than 10% of the surface has a distinct sunken area with discoloration.	When more than 15% of the surface has a distinct sunken area with discoloration.

[1] References to area, aggregate areas, or length are based on fruit 3 inches in diameter. Corresponding smaller or larger areas would be allowed on smaller or larger fruit.

CODEX STANDARD FOR MANGOES

(CODEX STAN 184-1993, AMD. 1-2005)

1. DEFINITION OF PRODUCE

This Standard applies to commercial varieties of mangoes grown from *Mangifera indica* L., of the *Anacardiaceae* family, to be supplied fresh to the consumer, after preparation and packaging. Mangoes for industrial processing are excluded.

2. PROVISIONS CONCERNING QUALITY

2.1 MINIMUM REQUIREMENTS

In all classes, subject to the special provisions for each class and the tolerances allowed, the mangoes must be:

- whole;
- sound, produce affected by rotting or deterioration such as to make it unfit for consumption is excluded;
- clean, practically free of any visible foreign matter;
- practically free of damage caused by pests;
- free of abnormal external moisture, excluding condensation following removal from cold storage;
- free of any foreign smell and/or taste;
- firm;
- fresh in appearance;
- free of damage caused by low temperatures;
- free of black necrotic stains or trails;
- free of marked bruising; and
- sufficiently developed and display satisfactory ripeness.

When a peduncle is present, it shall be no longer than 1.0 cm.

2.1.1 The development and condition of the mangoes must be such as to enable them:

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

In relation to the evolution of maturing, the colour may vary according to variety.

2.2 CLASSIFICATION

Mangoes are classified in three classes defined below:

2.2.1 "Extra" Class

Mangoes in this class must be of superior quality. They must be characteristic of the variety. They must be free of defects, with the exception of very slight superficial defects, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package.

2.2.2 Class I

Mangoes in this class must be of good quality. They must be characteristic of the variety. The following slight defects, however, may be allowed, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package:

- slight defects in shape;
- slight skin defects due to rubbing or sunburn, suberized stains due to resin exudation (elongated trails included) and healed bruises not exceeding 3, 4, 5 cm^2 for size groups A, B, C respectively.

2.2.3 Class II

This class includes mangoes which do not qualify for inclusion in the higher classes, but satisfy the minimum requirements specified in Section 2.1 above. The following defects, however, may be allowed, provided the mangoes retain their essential characteristics as regards the quality, the keeping quality and presentation:

- defects in shape;
- skin defects due to rubbing or sunburn, suberized stains due to resin exudation (elongated trails included) and healed bruises not exceeding 5, 6, 7 cm^2 for size groups A, B, C respectively.

In Classes I and II, scattered suberized rusty lenticels, as well as yellowing of green varieties due to exposure to direct sunlight, not exceeding 40 per cent of the surface and not showing any signs of necrosis are allowed.

3. PROVISIONS CONCERNING SIZING

Size is determined by the weight of the fruit, in accordance with the following table:

Size Code	Weight (in grams)
A	200 - 350
B	351 - 550
C	551 - 800

The maximum permissible difference between fruit in the same package belonging to one of the above mentioned size groups shall be 75, 100 and 125 g respectively. The minimum weight of mangoes must not be less than 200 g.

4. PROVISIONS CONCERNING TOLERANCES

Tolerances in respect of quality and size shall be allowed in each package for produce not satisfying the requirements of the class indicated.

4.1 QUALITY TOLERANCES

4.1.1 "Extra" Class

Five percent by number or weight of mangoes not satisfying the requirements of the class, but meeting those of Class I or, exceptionally, coming within the tolerances of that class.

4.1.2 Class I

Ten percent by number or weight of mangoes not satisfying the requirements of the class, but meeting those of Class II or, exceptionally, coming within the tolerances of that class.

4.1.3 Class II

Ten percent by number or weight of mangoes satisfying neither the requirements of the class nor the minimum requirements, with the exception of produce affected by rotting, marked bruising or any other deterioration rendering it unfit for consumption.

4.2 SIZE TOLERANCES

For all classes, 10% by number or weight of mangoes in each package are permitted to be outside (above or below) the group size range by 50% of the maximum permissible difference for the group. In the smallest size range, mangoes must not be less than 180 g and for those in the largest size range a maximum of 925 g applies, as follows:

Size Code	Normal Size Range	Permissible Size Range (≤ 10% of fruit/package exceeding the normal size range)	Max. Permissible Difference between fruit in each package
A	200 – 350	180 – 425	112.5
B	351 – 550	251 – 650	150
C	551 – 800	426 – 925	187.5

5. PROVISIONS CONCERNING PRESENTATION

5.1 UNIFORMITY

The contents of each package must be uniform and contain only mangoes of the same origin, variety, quality and size. The visible part of the contents of the package must be representative of the entire

5.2 PACKAGING

Mangoes must be packed in such a way as to protect the produce properly. The materials used inside the package must be new[1], clean, and of a quality such as to avoid causing any external or internal damage to the produce. The use of materials, particularly of paper or stamps bearing trade specifications is allowed, provided the printing or labelling has been done with non-toxic ink or glue.

Mangoes shall be packed in each container in compliance with the Recommended International Code of Practice for Packaging and Transport of Fresh Fruits and Vegetables (CAC/RCP 44-1995, Amd. 1-2004).

5.2.1 Description of Containers

The containers shall meet the quality, hygiene, ventilation and resistance characteristics to ensure suitable handling, shipping and preserving of the mangoes. Packages (or lot for produce presented in bulk) must be free of all foreign matter and smell.

6. MARKING OR LABELLING

6.1 CONSUMER PACKAGES

In addition to the requirements of the Codex General Standard for the Labelling of Prepackaged Foods (CODEX STAN 1-1985, Rev. 1-1991), the following specific provisions apply:

6.1.1 Nature of Produce

If the produce is not visible from the outside, each package shall be labelled as to the name of the produce and may be labelled as to name of the variety.

[1] For the purposes of this Standard, this includes recycled material of food-grade quality.

6.2 NON-RETAIL CONTAINERS

Each package must bear the following particulars, in letters grouped on the same side, legibly and indelibly marked, and visible from the outside, or in the documents accompanying the shipment. For produce transported in bulk these particulars must appear on a document accompanying the goods.

6.2.1 Identification

Name and address of exporter, packer and/or dispatcher. Identification code (optional)[2].

6.2.2 Nature of Produce

Name of the produce if the contents are not visible from the outside. Name of the variety or commercial type (optional).

6.2.3 Origin of Produce

Country of origin and, optionally, district where grown or national, regional or local place name.

6.2.4 Commercial Identification

- Class;
- Size (size code or weight range in grams);
- Number of units (optional);
- Net weight (optional).

6.2.5 Official Inspection Mark (optional)

7. CONTAMINANTS

7.1 HEAVY METALS

Mangoes shall comply with those maximum levels for heavy metals established by the Codex Alimentarius Commission for this commodity.

7.2 PESTICIDE RESIDUES

Mangoes shall comply with those maximum pesticide residue limits established by the Codex Alimentarius Commission for this commodity.

8. HYGIENE

8.1 It is recommended that the produce covered by the provisions of this Standard be prepared and handled in accordance with the appropriate sections of the Recommended International Code of Practice – General Principles of Food Hygiene (CAC/RCP 1-1969, Rev. 4-2003), Code of Hygienic Practice for Fresh Fruits and Vegetables (CAC/RCP 53-2003), and other relevant Codex texts such as Codes of Hygienic Practice and Codes of Practice.

8.2 The produce should comply with any microbiological criteria established in accordance with the Principles for the Establishment and Application of Microbiological Criteria for Foods (CAC/GL 21-1997).

---

[2] The national legislation of a number of countries requires the explicit declaration of the name and address. However, in the case where a code mark is used, the reference "packer and/or dispatcher (or equivalent abbreviations)" has to be indicated in close connection with the code mark.

COMPARATIVE SUMMARY TABLE OF REQUIREMENTS LAID DOWN BY THE STANDARD

REQUIREMENTS	CLASSES		
	"Extra"	I	II
Market quality	Superior quality	Good quality	Marketable quality
I. Definition of produce *(all classes)*	— all varieties (cultivars) of *Mangifera indica L.*		
II. Minimum requirements *(all classes)*	— intact — firm — fresh in appearance — sound — clean, practically free of any visible foreign matter — free from: • black stains or trails which extend under the skin • marked bruising • damage caused by low temperature — free of • abnormal external moisture • any foreign smell and/or taste — practically free from: • pests • damage caused by pests — sufficiently developed and display satisfactory ripeness — carefully picked at the stage of physiological development to allow: • continuation of ripening process to appropriate degree of corresponding varietal characteristics • to withstand transport and handling • to arrive in satisfactory condition at place of destination		
III. Quality requirements			
— Appearance	characteristic of the variety	characteristic of the variety	in keeping with minimum requirements
— Shape	characteristic of the variety	slight defects allowed	defects allowed
— Colouring	characteristic of the variety	characteristic of the variety	
— Defects	very slight superficial skin defects allowed	slight skin defects allowed Limits: group A: 3 cm^2 group B: 4 cm^2 group C: 5 cm^2	skin defects allowed Limits: group A: 5 cm^2 group B: 6 cm^2 group C: 7 cm^2
	For classes I and II are allowed: — scattered rusty lenticels — yellowing of green varieties due to exposure to direct sunlight. Limit: not to exceed 40% of the fruit surface area		

COMPARATIVE SUMMARY TABLE OF REQUIREMENTS LAID DOWN BY THE STANDARD *(cont'd)*

REQUIREMENTS	CLASSES		
	"Extra"	I	II
Market quality	Superior quality	Good quality	Marketable quality
IV. Sizing			
— By fruit weight	compulsory		
— Size group	A: 200-350 g B: 351-550 g C: 551-800 g		
— Maximum permissible differences between fruit within the same package	A: 75 g B: 100 g C: 125 g		
— Minimum weight	200 g		
V. Tolerances (number or weight)			
— Quality	5%	10%	10%
— Size	10% conforming to half of permissible difference of related size group above or below (all classes) Minimum of 180 g for group A Maximum of 925 g for group C		
VI. Presentation (all classes)			
— Uniformity	— origin — variety — quality — size — visible fruit must be representative of the entire contents		
— Packaging	— protects produce properly — materials inside the package new and clean and of a quality to avoid causing external damage — non toxic ink or glue on printing or labelling — free of all foreign matter		
VII. Marking (all classes)	— identification of packer and/or dispatcher — "mangoes" where contents are not visible from outside — variety — country of origin (region optional) — classification — size (weight range) — size group (optional) — number of fruit — official control mark (optional)		

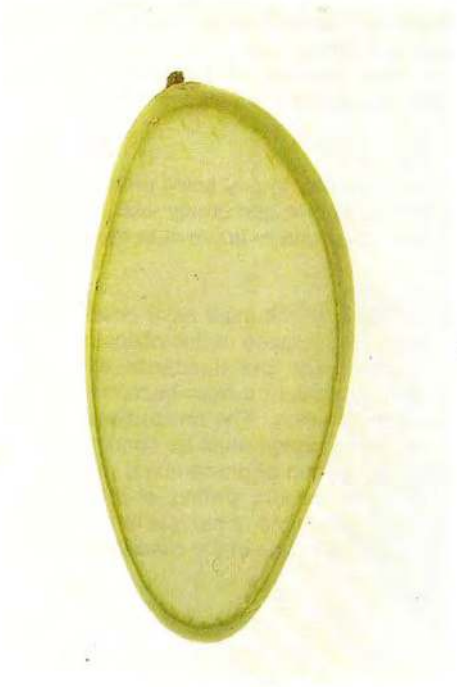
Texte interprétatif de la norme

a) *Développement et maturité*

Une cueillette effectuée à un stade trop précoce de développement physiologique se traduira par une perte de saveur et de parfum.

Fruit insuffisamment développé, non mûr

Underdeveloped, immature fruit



Exclu — Not allowed

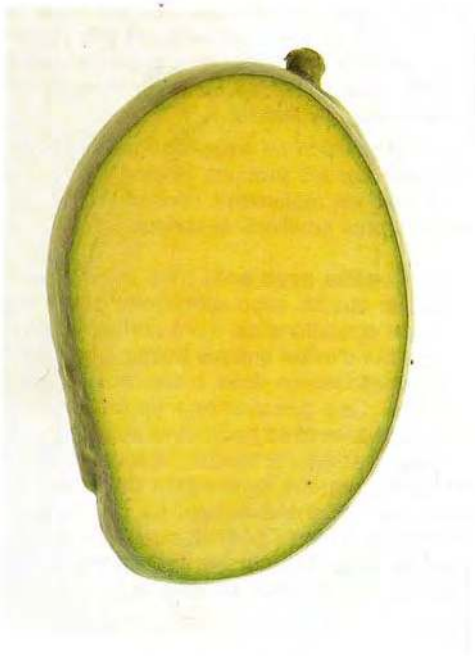
Interpretation of the standard

a) *Development and ripeness*

Picking at too early a stage of physiological development will result in inferior flavour and aroma.

Fruit insuffisamment mûr devant poursuivre le processus de maturation

Fruit not sufficiently mature to continue the ripening process

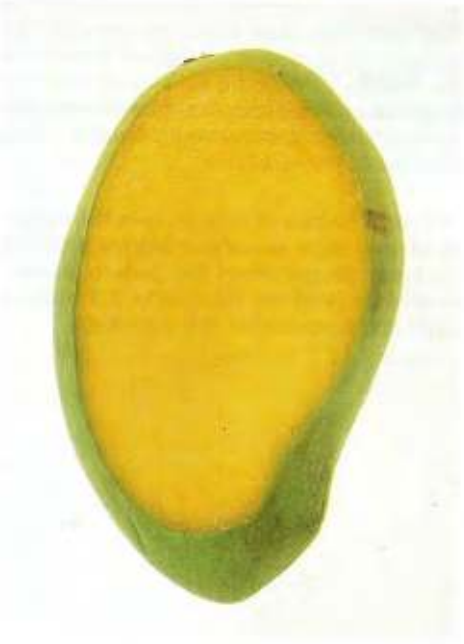


Exclu — Not allowed

Texte interprétatif de la norme

Interpretation of the standard

Fruit mûr — Mature fruit



Fruit en état de surmaturité — Over-ripe fruit

Exclu — Not allowed

b) *Capacité de supporter le transport et la manutention*

Une cueillette effectuée à un stade avancé de développement et de maturité (stade de sénescence) peut se traduire par une moindre durée de conservation. Sur de tels fruits, les défauts ou les lésions risquent davantage de se produire au moment de la récolte ou après celle-ci.

b) *Withstand transport and handling*

Harvest at an advanced stage of maturity and ripeness (senescent stage) may result in reduced shelf life. Such fruit is more susceptible to harvest and post-harvest defect or injury.

ANEXO A
(INFORMATIVO)

TABLA 1 – COMPARATIVO DE LOS REQUISITOS DE LA NORMA

REQUISITOS	CATEGORIAS		
	"Extra"	I	II
Calidad comercial	Calidad superior	Buena calidad	No clasificados en las categorías anteriores pero cumplen los requisitos mínimos de calidad.
I. Definición del producto	Todas las variedades comerciales de mangos obtenidos de *Mangífera índica L.*, de la familia de las Anacardiáceas.		
II. Requisitos mínimos *(todas las categorías)*	Los mangos deben: a. Estar enteros. b. Ser de consistencia firme. c. Tener aspecto fresco. d. Estar sanos; excluyendo los productos afectados por pudrición o deterioro que impidan su consumo. e. Estar limpios y prácticamente exentos de materias extrañas visibles. f. Estar prácticamente exentos de secreción de látex. g. Estar exentos de manchas necróticas. h. Estar prácticamente exentos de quemaduras producidas por látex. i. Estar prácticamente exentos de daños por quemaduras de sol. j. Estar prácticamente exentos de defectos en la cáscara producidos por rozaduras. k. Estar exentos de magulladuras profundas. l. Estar exentos de daños causados por plagas. m. Estar exentos de daños causados por temperaturas bajas. n. Estar exentos de humedad externa anormal, salvo la condensación siguiente a su remoción de una cámara frigorífica. o. Estar exentos de cualquier olor y/o sabor extraños. p. Estar suficientemente desarrollados y presentar un grado de madurez satisfactorio según la naturaleza del producto. q. Presentar forma característica de la variedad. r. Tener pedúnculo no inferior a 0,5 cm de longitud y el corte deberá ser transversal. s. Cumplir con las especificaciones fitosanitarias establecidas.		
III.Requisitos de calidad			
– *Aspecto*	característico de la variedad	característico de la variedad	conforme con los requisitos mínimos
– *Forma*	característica de la variedad	defectos leves permitidos	defectos leves permitidos
– *Coloración*	característico de la	característico de la	

<table>
<tr><td></td><td>variedad</td><td>variedad</td><td></td></tr>
<tr><td>– Defectos</td><td>defectos superficiales muy leves permitidos</td><td>defectos leves en la cáscara permitidos, no exceden de 1 cm^2 del mango</td><td>defectos en la cáscara permitidos, no exceden de 3 cm^2 del mango.
Se permite presencia de lenticelas rojizas suberizadas esparcidas, así como el amarillamiento de las variedades de color verde, debido a una exposición directa a la luz solar, pero sin exceder el 10% de la superficie.</td></tr>
<tr><td>IV. Clasificación por calibres
Determinado por el peso de la fruta</td><td colspan="3">Calibres
Peso unitario promedio (g)
Rango de pesos (g)
<table><tr><th>Calibres</th><th>Peso unitario promedio (g)</th><th>Rango de pesos (g)</th></tr><tr><td>4</td><td>1000</td><td>900 – 1100</td></tr><tr><td>5</td><td>800</td><td>720 – 880</td></tr><tr><td>6</td><td>667</td><td>600 – 730</td></tr><tr><td>7</td><td>571</td><td>515 – 625</td></tr><tr><td>8</td><td>500</td><td>450 – 550</td></tr><tr><td>9</td><td>444</td><td>400 – 485</td></tr><tr><td>10</td><td>400</td><td>360 – 440</td></tr><tr><td>12</td><td>333</td><td>300 – 365</td></tr><tr><td>14</td><td>286</td><td>260 – 315</td></tr><tr><td>16</td><td>250</td><td>225 – 275</td></tr><tr><td>18</td><td>222</td><td>200 – 240</td></tr><tr><td>20</td><td>200</td><td>180 – 220</td></tr></table></td></tr>
<tr><td>V. Tolerancias de Calidad</td><td>5%</td><td>10%</td><td>10%</td></tr>
<tr><td>VI. Presentación (todas las categorías)

– Homogeneidad

– Envasado</td><td colspan="3">

– variedad
– calidad
– calibre
– las frutas visibles deben ser representativas de todo el contenido

– asegurar una protección adecuada del producto
– materiales utilizados en el interior del envase nuevos, limpios y de una calidad tal que permita evitar daños internos o externos</td></tr>
</table>

	– tinta o pegamento utilizados para impresión o etiquetado no deben ser tóxicos
VII. ***Marcado o etiquetado*** *(todas las categorías)*	– identificación del exportador, envasador y/o expedidor – nombre del producto: "mangos" – variedad – país de origen (indicación de la región opcional) – categoría de calidad – calibre – peso neto – marca oficial de inspección (opcional)

NMX-FF-058-1999. PRODUCTOS ALIMENTICIOS NO INDUSTRIALIZADOS PARA CONSUMO HUMANO. FRUTA FRESCA. MANGO (*MANGIFERA INDICA* L.). ESPECIFICACIONES. NON INDUSTRIALIZED FOOD PRODUCTS FOR HUMAN CONSUMPTION. FRESH FRUIT. MANGO (*MANGIFERA INDICA* L.). SPECIFICATIONS. NORMAS MEXICANAS. DIRECCIÓN GENERAL DE NORMAS.

PREFACIO

En la elaboración de la presente Norma Mexicana participaron las siguientes Empresas e Instituciones:

Asociación Agrícola Regional de Productores Rurales y Empresarios del Mango en Michoácan (ARPEMMICH)
Banco Nacional de Comercio Exterior
Colegio de Postgraduados
Comité Técnico de Normalización Nacional de Productos Agrícolas, Pecuarios y Forestales
Confederación Nacional Campesina (CNC)
Consejo Nacional Agropecuario (CNA)
Confederación Nacional de Agrupaciones de Comerciantes de Centros de Abasto, A.C. (CONACA)
Empacadoras de Mango de Exportación, A.C. (EMEX)
Fideicomiso de Centrales de Abasto de la Ciudad de México, S.A.
Instituto Mexicano de Normalización y Certificación (IMNC)
Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP)
Procuraduría Federal del Consumidor
Representantes de Productores y Empacadores del Estado de Chiapas
Representantes de Productores y Empacadores del Estado de Jalisco
Representantes de Productores y Empacadores del Estado de Michoacán
Representantes de Productores, Empacadores y Sistema-Producto del Estado de Veracruz
Secretaría de Agricultura, Ganadería y Desarrollo Rural (SAGAR)
Dirección General de Agricultura;
Dirección General de Asuntos Internacionales;
Dirección General de Desarrollo Agropecuario;
Dirección General de Sanidad Vegetal;
Apoyos y Servicios a la Comercialización Agropecuaria (ASERCA);
Delegación Federal del Estado de Chiapas;
Delegación Federal del Estado de Colima;
Delegación Federal del Estado de Jalisco;
Delegación Federal del Estado de Michoacán;
Delegación Federal del Estado de Nayarit;
Delegación Federal del Estado de Oaxaca;
Delegación Federal del Estado de Sinaloa;
Delegación Federal del Estado de Veracruz.
Secretaría de Comercio y Fomento Industrial
Dirección General de Normas
Servicio Nacional de Información de Mercados (SNIM)
Unión Agrícola Estatal de Michoacán (UAEMICH)Universidad Autónoma de Chapingo

1. OBJETIVO Y CAMPO DE APLICACIÓN

Esta Norma Mexicana establece las especificaciones mínimas de calidad que debe cumplir el mango (*Mangifera indica* L.), de la familia Anacardiáceae, para las variedades de los grupos indostano y mulgova, para ser consumido en estado fresco y comercializado en territorio nacional, después de su acondicionamiento y envasado. Se excluye el mango para procesamiento industrial.

2. REFERENCIAS

Para la correcta aplicación de la presente Norma se deben consultar las siguientes Normas Oficiales Mexicanas y Normas Mexicanas vigentes o las que las sustituyan:

NOM-075-FITO-1997	Por la que se establecen los requisitos y especificaciones fitosanitarias para la movilización de frutos hospederos de moscas de la fruta, publicada en el Diario Oficial de la Federación el 23 de abril de 1998.
NOM-129-SCFI-1998	Información comercial - Etiquetado de productos agrícolas – Mango, publicada en el Diario Oficial de la Federación el 31 de agosto de 1998.
NMX-FF-006-1982	Productos alimenticios no industrializados para consumo humano - fruta fresca - Terminología. Declaratoria de vigencia publicada en el Diario Oficial de la Federación el 10 de junio de 1982.
NMX-FF-008-1982	Productos alimenticios no industrializados para consumo humano - fruta fresca - Determinación del tamaño con base al peso unitario. Declaratoria de vigencia publicada en el Diario Oficial de la Federación el 10 de junio de 1982.
NMX-Z-012/1-1987	Muestreo para la inspección por atributos - Parte 1: Información general y aplicaciones. Declaratoria de vigencia publicada en el Diario Oficial de la Federación el 28 de octubre de 1987.
NMX-Z-012/2-1987	Muestreo para la inspección por atributos - Parte 2: Métodos de muestreo, tablas y gráficas. Declaratoria de vigencia publicada en el Diario Oficial de la Federación el 28 de octubre de 1987.
NMX-Z-012/3-1987	Muestreo para la inspección por atributos - Parte 3: Regla de cálculo para determinación de planes de muestreo. Declaratoria de vigencia publicada en el Diario Oficial de la Federación el 31 de julio de 1987.

3. DEFINICIONES

Para los efectos de esta Norma deben consultarse las definiciones establecidas en la Norma Mexicana NMX-FF-006 (véase 2 Referencias), además de complementarse con lo indicado a continuación:

3.1 Mango niño

Son aquellos frutos de las variedades del grupo mulgova de flores no polinizadas; por esta razón son pequeños. No presentan semilla, solo endocarpio.

3.2 Mango variedades del grupo indostano

Son aquellos frutos de forma ovalada, cáscara correosa, de color verde con chapeo, pulpa de color amarillo, ligeramente fibrosos, aromáticos y de sabor agradable. Variedades: Haden, Keitt, Kent, Tommy Atkins, Irwin, Zill, Sensation, Oro, Vandycke, Vishis (Manzanillo) y otras del mismo fenotipo.

3.3 Mango variedades del grupo mulgova

Son aquellos frutos de forma alargada, con cáscara suave, de color amarillo; pulpa amarilla, ligeramente fibrosa; aromáticos y de sabor agradable. Dichas variedades son: Manila, Ataulfo, Diplomático, Panameño, Obo, Criollo y otras del mismo fenotipo.

3.4 Mango de calidad

Es aquel que satisface las especificaciones mínimas enunciadas en el inciso 5.1.

4. CLASIFICACIÓN DEL PRODUCTO

4.1 El producto objeto de esta Norma se clasifica en las categorías de calidad siguientes:

Extra
Primera
Segunda
Mango Niño (Categoría Única)

5. ESPECIFICACIONES

El mango objeto de esta Norma debe cumplir con las especificaciones siguientes:

5.1 Especificaciones mínimas

En todas las categorías y tipos, sin perjuicio de las disposiciones especiales establecidas para cada una de las tolerancias admitidas, los mangos deben cumplir las siguientes especificaciones, las cuales se verifican sensorialmente:

a) Estar enteros y bien desarrollados;
b) Ser de consistencia firme;
c) Tener aspecto fresco;
d) Estar sanos; excluyendo todo producto afectado por pudrición o deterioro que impida su consumo;
e) Estar limpios, exentos de materia extraña, visible (tierra, manchas o residuos de materia orgánica);
f) Estar exentos de olor y sabor anormal o extraño;
g) Estar exentos de magulladuras profundas;
h) Estar exentos de daños causados por plagas;
i) Presentar tamaño, forma y color característicos de la variedad (excepto para el mango niño);
j) Estar suficientemente desarrollados y haber alcanzado su madurez fisiológica;
k) Presentar un desarrollo y condición que les permita soportar el transporte y manejo para llegar a su destino en estado satisfactorio;
l) Estar exentos de daños por refrigeración;

m) Estar exentos de humedad externa anormal, salvo la condensación consiguiente a su remoción de una cámara frigorífica;
n) Cuando tengan pedúnculo, su longitud no deber ser superior a 1,0 cm y el corte deberá ser transversal y perpendicular, y
o) Cumplir con las especificaciones fitosanitarias establecidas en la Norma Oficial Mexicana NOM-075-FITO (véase 2 Referencias).

5.2 Madurez y color al momento del corte

5.2.1 Madurez

Los mangos deben presentar un punto de madurez mínimo. El punto, sazón o grado de madurez fisiológico se presenta en la forma, sabor, textura de la pulpa y aroma característicos de la variedad. Los cortes para verificar la madurez deben ser hechos a lo largo del lado plano del mango tan cercano al hueso como sea posible. El hueso debe ser visible. Lo anterior se verifica sensorialmente.

5.2.2 Color al momento del corte

Los mangos deben presentar la coloración característica de la variedad o tipo. Al momento del corte deben tener aproximadamente un 50 % del grosor de la pulpa de color amarillo pálido, la pulpa restante debe tener un color amarillo crema claro, no blanco.

En las variedades Tommy Atkins y Kent la maduración no muestra una variación de color desde el hueso hasta la corteza. Toda la pulpa debe tener un color amarillo crema claro, no blanco.

5.3 Especificaciones de categorías

Las especificaciones de los mangos para su clasificación en categorías se verifican sensorialmente, excepto aquellos en que se indique otro método de prueba específico, siendo las siguientes:

5.3.1 Categoría extra

El mango de esta categoría debe cumplir y presentar la forma, el desarrollo y coloración típicas o propias de la variedad.

Debe ser uniforme en cuanto a la coloración y tamaño a excepción del mango niño, debiendo cumplir con las especificaciones señaladas en el inciso 5.1.

No debe tener defectos, salvo aquellos superficiales muy leves, siempre y cuando no afecten: el aspecto general del producto, su calidad, conservación y presentación en el envase. Esto se verifica visualmente.

5.3.2 Categoría primera

El mango de esta categoría debe cumplir con las especificaciones señaladas en el inciso 5.1 y presentar la forma, desarrollo y coloración típicas o propias de la variedad.

Se permiten los siguientes defectos leves, siempre y cuando no afecten el aspecto general del producto, su calidad, conservación y presentación en el envase:

- Defectos leves de forma, y
- Defectos leves en la cáscara como: rozaduras, costras, cicatrices y manchas de látex que no excedan de 3,0 cm^2 para mangos con códigos de calibre del 22 al 14; de 4,0 cm^2 para mangos con códigos de calibre del 12 al 9 y de 5 cm^2 para mangos con códigos de calibre del 8 al 6 (véase tabla 1).

NOTA 1.- Estas áreas se verifican mediante una escala milimétrica.

5.3.3 Categoría segunda

El mango de esta categoría debe presentar la forma, desarrollo y coloración típicas o propias de la variedad.

Esta categoría comprende los mangos que no puedan clasificarse en los grados superiores, pero satisfacen las especificaciones sensoriales mínimas detalladas en el inciso 5.1.

Se permiten los siguientes defectos, siempre y cuando los mangos conserven las características esenciales respecto a la calidad, estado de conservación y presentación en el envase.

- Defectos leves de forma;
- Defectos de color tales como las quemaduras de sol o daños por calor; siempre y cuando el producto conserve las características comunes de la variedad y
- Defectos en la cáscara debido a rozaduras, costras, cicatrices y manchas de látex que cubran un área no mayor de 5,0 cm^2 para mangos con códigos de calibre del 22 al 14; de 6,0 cm^2 para mangos con códigos de calibre del 12 al 9 y de 7 cm^2 para mangos con códigos de calibre del 8 al 6. Estas áreas se verifican mediante escala milimétrica.

NOTA 2.- Para todas las categorías, en ningún caso los defectos deben afectar la pulpa del mango.

5.3.4 Mango niño

El mango niño se debe presentar en el mercado con las especificaciones de calidad de la categoría extra, a excepción de la especificación relativa al tamaño.

5.4 Especificaciones de tamaño

El tamaño del mango se determina por su peso unitario (masa unitaria), en base a la Norma Mexicana NMX-FF-008 (véase 2 Referencias).

5.4.1 Tamaño mínimo

El tamaño mínimo para los mangos del grupo indostano en todas sus variedades, es de 150 g, código de tamaño 22, según la tabla 1.

El tamaño mínimo para los mangos del grupo mulgova en todas sus variedades, es de 100 g, código de tamaño 106, conforme a la tabla 1 (excepto para mango niño).

5.4.2 Intervalos de tamaños

Los mangos se calibran según la escala siguiente:

TABLA 1.
Clasificación por tamaño en función del peso unitario (masa unitaria) para todas las variedades

Código de calibre	Peso unitario (g)	Intervalo (g) (rangos redondeados)	
6	756	mayor de	701
7	648	610	700
8	567	535	609
9	504	480	534
10	454	415	479
12	378	350	414
14	324	305	349
16	284	270	304
18	252	240	269
20	227	290	239
26	174	155	189
34	133	120	154
44	103	85	119

NOTA 3
- El código de calibre indica el número de frutos que se pueden colocar en un envase de 4,536 kg, equivalente a 10 libras de peso.
- La tabla 1, no incluye al mango "niño".

5.5 Especificaciones de tolerancia

Las tolerancias con respecto a la calidad y el tamaño de los mangos que no cumplen con las especificaciones de las categorías de tamaño indicadas en la tabla 2, se determinan en porcentajes de unidades o por peso de los mismos respecto al envase, admitiéndose las indicadas en dicha sección.

5.5.1 Tolerancias de calidad

5.5.1.1 Categoría extra

En cada lote o envase se permite una tolerancia del 5 % en número o en peso (masa) de mangos que no reúnan todos los requisitos para esta categoría, pero que satisfacen los de la categoría primera.

5.5.1.2 Categoría primera

En cada lote o envase se permite una tolerancia del 10 %, en número o en peso de mangos que no reúnen todos los requisitos de esta categoría pero que satisfacen los de la categoría segunda.

5.5.1.3 Categoría segunda

Se permite hasta 10 % en número de mangos que no reúnen los requisitos de la categoría, ni los requisitos mínimos a excepción de los mangos afectados por pudrición, deterioro, marcas superficiales, severas o cualquier otro defecto que altere notablemente la calidad y que hace inadecuado su consumo.

5.5.2 Tolerancias de tamaño

5.5.2.1 Categoría extra

Se permite hasta 5 % en número o en peso (masa) de mangos que no satisfacen las exigencias respecto al calibrado, siempre que se ajuste al tamaño inmediatamente inferior o superior del código mencionado en el envase.

5.5.2.2 Categoría primera y segunda

Se permite hasta 10 % en número o en peso (masa), de mangos que no satisfacen las exigencias respecto a los calibrados, siempre y cuando entren en el tamaño inmediato inferior o superior al código mencionado en el envase.

TABLA 2
Tolerancia en número o en peso (masa)

Categoría	Tolerancia de calidad en %	Tolerancia de tamaño en %
Extra	5	5
Primera	10	10
Segunda	10	10

6. MUESTREO

Para efectuar la verificación de las especificaciones de calidad, tamaño y color del producto objeto de esta Norma, se debe aplicar un muestreo de común acuerdo entre el proveedor y el comprador, se recomienda la aplicación con base en uno de los sistemas de muestreo contemplados en las Normas Mexicanas NMX-Z-012/1, NMX-Z-012/2 y/o NMX-Z-012/3 (véase 2 Referencias).

7. MÉTODOS DE PRUEBA

Para verificar la calidad del producto objeto de esta Norma deben aplicarse los métodos de prueba indicados en la Norma Mexicana NMX-FF-008 (véase 2 Referencias), así como lo indicado a continuación.

7.1 Cálculo de porcentajes

Cuando se conoce el número de unidades contenidas en el envase, el cálculo de porcentajes se debe determinar con base a un conteo de los frutos. Cuando las unidades contenidas en el envase se desconocen, el cálculo se debe determinar con base al peso neto (masa neta) del envase o por otro método equivalente.

8 MARCADO, ETIQUETADO, ENVASE Y EMBALAJE

La información comercial indicada en el presente capítulo debe ser veraz y describirse de forma tal que no induzca a error con respecto a la naturaleza y características del producto, con caracteres ostensibles, legibles e indelebles. La información señalada en el presente capítulo debe expresarse en idioma español, sin perjuicio de presentarse además en otros idiomas, conforme a lo establecido en la Norma Oficial Mexicana NOM-129-SCFI (véase 2 Referencias).

8.1 Información en el envase

8.1.1 La información comercial que deben ostentar los envases que contiene al mango debe constar de los siguientes datos:

- Nombre o razón social y domicilio del productor o empacador y, en su caso, del importador;
- Nombre genérico del producto: "Mango";
- Variedad del producto;
- Contenido promedio en kilogramos, pudiéndose expresar además en otras unidades de medida;
- Grado de clasificación, y
- Nombre del país y región de origen.

8.1.2 La etiqueta debe ir adherida o impresa en la parte frontal del envase, conocida comúnmente como cabecera o superficie principal de exhibición, la cual debe ser siempre visible al estibarse.

8.1.3 Cuando la información comercial contenida en la etiqueta venga en un idioma distinto al español, debe colocarse otra etiqueta del mismo tamaño y proporción tipográfica, conteniendo únicamente la información que establece esta Norma en idioma español.

8.2 Envase

8.2.1 El contenido de cada envase debe ser homogéneo, compuesto por mangos del mismo origen, categoría, tamaño, variedad y/o tipo comercial.

- En categoría extra, el contenido de cada envase debe ser también homogéneo en madurez o color.

8.2.2 La parte visible del contenido del envase debe ser representativo de todo el contenido.

8.2.3 Los mangos deben envasarse de modo que se les asegure una protección conveniente.

8.2.4 Los envases deben estar exentos de cualquier material y olor extraño.

8.2.5 Los envases deben satisfacer las características de calidad, higiene y ventilación para asegurar la manipulación, el transporte y la conservación adecuada del producto.

8.2.6 Los materiales usados en el interior del envase deben ser nuevos, limpios y de calidad que evite daños externos o internos al producto.

8.2.7 El uso de materiales, especialmente papel o sellos, que lleven especificaciones comerciales está permitido, siempre y cuando la impresión o el etiquetado se realice con tintas o pegamentos no tóxicos.

8.3 Embalaje

8.3.1 El embalaje debe ser de un material que garantice el buen manejo y conservación del producto.

9. CONTAMINANTES

9.1 Metales pesados

Los mangos deben estar exentos de metales pesados en cantidades que puedan representar un peligro para la salud.

9.2 Residuos de plaguicidas

Los mangos deben ajustarse a los límites máximos para residuos de plaguicidas establecidos por el Comité del Codex sobre Residuos de Plaguicidas aplicable para este producto.

10. HIGIENE

10.1 Se recomienda que el producto objeto de la aplicación de esta Norma sea elaborado y manipulado de acuerdo a lo establecido en el Código Internacional Recomendado de Prácticas Principios Generales de Higiene de los Alimentos (CAC/RCP 1-1969, Rev. 2 - 1985), así como de otros Códigos de Prácticas Recomendados por la Comisión del Codex Alimentarius que sean aplicables a este producto.

10.2 En la medida de lo posible, de acuerdo con las buenas prácticas de producción, el producto debe estar exento de sustancias objetables.

10.3 Cuando se analice siguiendo los métodos apropiados de muestreo y examen, el producto:

- Debe estar exento de microorganismos en cantidades que puedan representar un peligro para la salud;
- Debe estar exento de parásitos que puedan representar un peligro para la salud, y
- No debe contener ninguna sustancia generada por microorganismos en cantidades que puedan representar un peligro para la salud.

11. BIBLIOGRAFÍA

NOM-008-SCFI-1993	Sistema General de Unidades de Medida, publicada en el Diario Oficial de la Federación el 14 de octubre de 1993.
NMX-FF-058-1995-SCFI	Productos Alimenticios no Industrializados para uso Humano - Fruta Fresca - Mango (*Mangifera indica*

	L.) - Especificaciones. Declaratoria de vigencia publicada en el Diario Oficial de la Federación el 12 de abril de 1996.
NMX-Z-013/01-1977	Guía para la presentación, redacción y estructuración de las Normas Mexicanas. Declaratoria de vigencia publicada en el Diario Oficial de la Federación el 31 de octubre de 1977.
CODEX STAN 184/1993	World Codex standard for mangoes.

Comisión Nacional de Fruticultura - Secretaría de Agricultura y Ganadería - "Empaque e industrialización del mango en México, México 1975".

Comisión Nacional de Fruticultura - Departamento de Normalización e Inspección de Calidad Frutícola - "Aspectos técnicos del mango, México 1980".

12 CONCORDANCIA CON NORMAS INTERNACIONALES

Esta Norma Mexicana equivale parcialmente a la Norma internacional Codex Stan 184/1993 (véase 11 Bibliografía) y difiere de la misma en el punto 3 relativo a la clasificación por calibres.