Data reported here demonstrate that carambola fruit can be effectively stored for extended periods at 5°C. Furthermore, this temperature maintains fruit quality to a greater extent than previously recommended conditions (6). No chilling injury occurred at 5°C, and normal color development and ripening resumed in fruit transferred to 23°C. Composition of soluble sugars and organic acids, important components of taste, also remained at levels similar to those of freshly-harvested fruit.

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Proc. Fla. State Hort. Soc. 100:275-278. 1987.

CARAMBOLA PRODUCTION IN MALAYSIA AND TAIWAN

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Abstract. **The carambola, *Averrhoa carambola* L. was first introduced to Florida in the 1880's. It was not considered to be a commercially viable crop until the early 1980's. Since that time, carambola acreage in south Florida has shown a dramatic increase, to the current estimate of 300 acres. The carambola is indigenous to Southeast Asia. Concurrently, in Malaysia and Taiwan, acreage is also increasing. Malaysia has 200-300 acres in cultivation. Taiwan has 6900 acres of carambolas. In these countries the average size farm is less than five acres. Little farm machinery is utilized. Much of the labor is supplied by the family. Because of insect problems, fruits are bagged on the trees. Fruits are selectively thinned to produce large size. Sweet fruits are preferred.**

The carambola, *Averrhoa carambola* is thought to be indigenous to Southeast Asia (8). Small sized, tart carambolas were first introduced to Florida in the late 1880s. Later, Dr. H. S. Wolfe sent seeds from Hawaii which resulted in the 'Golden Star' and 'Newcomb' cultivars (2). Some commercial production of carambola, 10 acres or less, was in existance in the 1960's. In 1973, Dr. R. Knight on a Rare Fruit Council sponsored collecting trip, sent back seeds from Malaysia that resulted in the 'Arkin' cultivar, and also grafted 'Fwang Tung' plants. These are sweet, low acid cultivars. The 'Arkin' is the major carambola cultivar being planted in south Florida groves. Acreage is currently expanding (3) to approach 300 acres. The 'Arkin' is a medium size orange-yellow fruit, with high sugar and low acid, having thick fleshy ribs (1).

The introduction and development of superior carambola cultivars was one factor which led to the recent surge in planted carambola acreage. Another factor of equal importance is the immigration of people from tropical countries into the United States who brought their cultural heritage with them (5). Five million oriental people now live in the United States. Since the carambola is thought to be indigenous to Southeast Asia, a significant number of these Asian American people are familiar with this fruit, and provide a ready market. This paper was the result of a fact finding trip to Malaysia and Taiwan in June of 1987. The object was to learn about the carambola industry in a part of the world that has historically appreciated and grown them.

Malaysia and Its Cultivars

In Southeast Asia, carambolas have grown for hundreds of years. These fruit trees were found in the wild, are popular as dooryard trees, or for local consumption (4). In the acid soils and tropical climatic conditions, carambolas grow vigorously. Their leaves are large and deep green, showing little of the micronutrient deficiency so prevalent in south Dade's calcareous soils. Since carambolas grow readily from seed, little cultivar selection was made in Malaysia until the late 1960's or early 1970's, when superior cultivars were identified and numbered.

Malaysia, originally Malaya, is home to 15 million people. This multi-ethnic nation is comprised of peninsular Malaysia (West Malaysia), bordered on the north by Thailand, and to the south by the island nation of Singapore; and across the China Sea, East Malaysia, on the island of Borneo. Malaysia has an equatorial climate influenced by monsoons. Temperatures from 72°-92°F. Mean rainfall amounts are approximately 100 inches a year.

The area considered to have the best quality carambolas is in the state of Selangor in West Malaysia approximately 15 miles south of Kuala Lumpur at 3° N latitude (4). The 4.5 pH of the sandy soils in this area is in the extremely acid range. In Selangor, 200-300 acres of caram-

bolas have been planted, primarily in the last 10 years. The major cultivar is 'B10', a large, high sugar, low acid, non-fibrous carambola with deep ribs. After thinning, which is the common practice, these fruits may weigh as much as 0.7 pounds each. The less sweet 'B2' is used as a pollinator; one branch of 'B2' is grafted on every 5 trees. 'B2' is also a high sugar, low acid fruit, having a more compact rib, more similar to the 'Arkin' cultivar. Rainfall is highest in October-November and March-April. The driest months are June, July, August, December and January. Flowering generally follows times of drought. In the tropics there is no cold weather to induce flowering. Carambolas are harvested most heavily between April and December. During this time, roadside stands along the highway (Fig. 1) offer çarambolas for sale (Othman Yaacob, Univ. Pertanian Malaysia. Personal communication).

Taiwan and Its Cultivars

Taiwan, the Republic of China (known formerly as Formosa), is located 100 miles off the southeast coast of Mainland China. This island has a population of 19 million people. This island is 245 miles long and 90 miles wide. Taiwan straddles the tropical and subtropical zones, having warm summers from March-May and mild winters from November-March. The temperature range is between 40°-90° F; the average temperature in the south is 71° F. Lowland Taiwan is frost free. The mean annual precipitation is 102 inches. Typhoons occur regularly from July-October. The pH of the acid soils 5.5-6.5

There are 6900 acres of carambolas currently grown in Taiwan. These plantings are from 1 to 10 years old, but most of them are 6-8 years old (Tzong-Shyan Lin, Natl. Taiwan Univ. Personal communication). The principle cultivars are 'Meeshi', 'Er-lin', 'Soft sih' and 'Cheng-Tsey'. Their fruiting season seems similar, although may be longer than that of the carambolas grown in south Florida. Fruiting begins in June and continues until March. A third of Taiwan's carambolas are grown in Tainan County, in the southwest at 23° N latitude. Here the 'Cheng-Tsey' ('Chun-Choi') variety of carambola is grown. This is a large fruit about 0.7 pounds after thinning, that has extremely deep, firm rib, high sugar, low acid, and a non-fibrous character (Fig. 2). It has a yellow/orange color. The Erlin variety is used as a pollinator; one shoot is grafted on a limb of each tree. (Ming-Tsong Chang. Tainan Dist. Ag. Improvement Station. Personal communication).

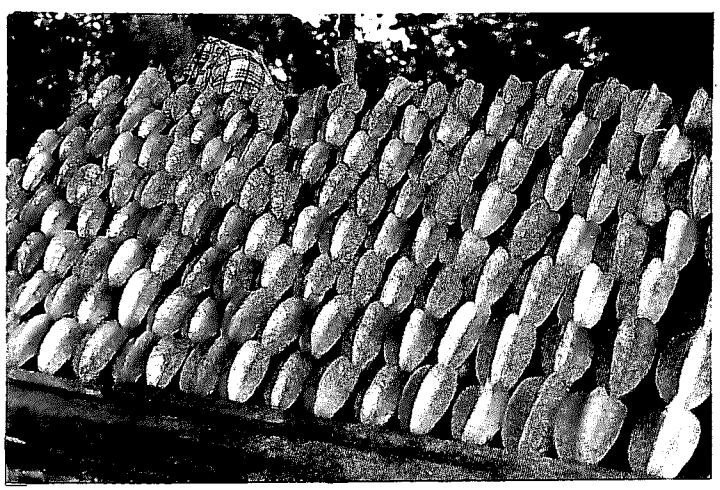

Fig. 1. 'B-10' Carambolas at Roadside Stand in Malaysia.

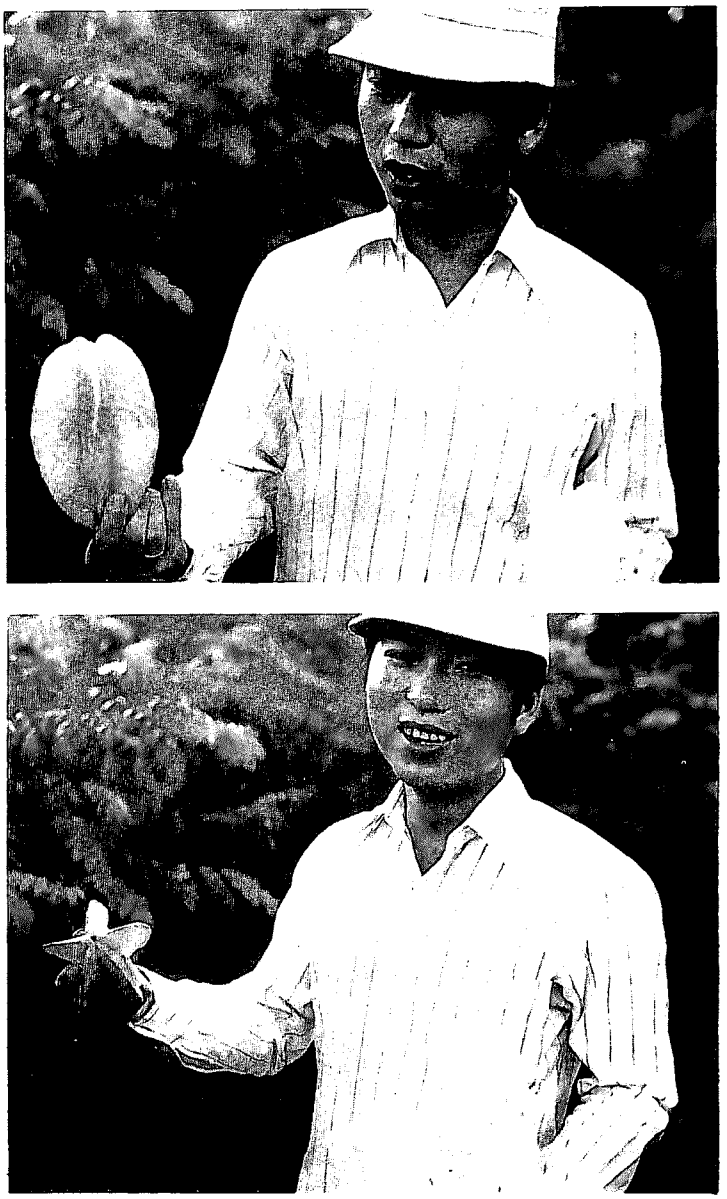

Fig. 2. Farmer in Taiwan with 'Cheng-Tsey' Carambola.

Mechanization

Rarely do the farmers of Malaysia or Taiwan use tractors, or the mechanical implements normally pulled or powered by tractors. In 1985, there were but 9000 tractors in all of Taiwan. Therefore, plantings are not designed to accommodate such equipment. Backpacks and hand pumps may be used, or gas driven sprayers might be mounted on motor scooters.

Planting Design

In Malaysia, the groves are on hilly terrain. Spacing is at 11-12 ft. centers, in what sometimes appears to be a haphazard fashion. At 4-5 years in the ground, the trees were already growing together.

In Taiwan, 80% of the farmers grow carambolas on overhead trellises. (Tzon-Shyan Lin. Natl. Taiwan Univ. Personal communication). These structures are approximately 6 ft. high. They are supported by buttressed concrete posts on each side of every tree row. The trees are planted below the trellises on flat land at 18 to 21 f. centers. Wires run across the top of the post to support and guide the tree canopy. The cost of this structure in US $1500 per acre. It is expected to have a ten year life before repair is needed. The trees are pruned extensively to conform to this trellis. (M-T Chang, Personal communication).

Bagging the Fruit

Farmers of both countries bag their fruit while it develops on the tree, to prevent insect and mechanical damage. These bags are made of glued newspaper, or simple white bags. In Malaysia, fruit fly is a major problem. Although some farmers spray with insecticide, most of them do bag carambolas about a month after flowering. (Anthony, Malaysia Agr. Res. Dept. Personal communication). In Taiwan, there is also some problem with fruit fly, but they are more concerned with a night flying moth that lays its eggs on the fruit. The larvae eat into the fruit. Farmers of both countries thin the fruit during the bagging process. In Malaysia, only 300-400 out of a 1000 fruits are bagged; the rest are thinned. In Taiwan, fruits that hang down below the trellis are thinned gradually until as few as three fruits are left from a cluster. Only those fruit that are straight, with good shape, having no black spots and are attached close to a mature branch are bagged. In Malaysia, fruits are harvested 42-45 days following bagging in the wet season, 45-60 days during the dry season.

Fruits tend to be cleaner when they are bagged. Because of the thinning, the fruits are very large and well shaped. The bags do not solve all insect problems. Some farmers in Taiwan are experimenting with other methods such as large nets to control the night flying moth problem. At times they have a problem with the disease rust, which necessitates spraying. Spraying is very difficult with overhead trellises.

Labor

In Malaysia, Chinese make up about 36% of the population. Most of the carambola farmers are the industrious Chinese. Labor is generally supplied by family members. Since the farms are small, a family can often do all of the necessary work. Additional labor is employed as needed. Some farm workers in Malaysia can earn U.S. $16-$21 per day. Other workers are paid less than one U.S. cent per fruit bagged. A good worker can bag 1000 fruits a day (O. Yaacob, Univ. of Malaysia Pertanian. Personal communictaion). In Taiwan, women earn U.S. $15 per day and men earn $20-$25 for farm work. Because farmers must compete with industry for workers, much of the labor is supplied by the family. Three people may work a two-acre grove.

Fruit Production

According to a July 1, 1987 article in Malayan Business Magazine, production is considered to begin at the second year. A good producing tree can bear as many as 600 fruits (300 lb.) per year. One hundred trees should produce 20,000 wrapped fruits to break even (200 fruits per tree.) Eighty percent of the fruit produced is exported to other countries such as Hong Kong, Singapore, England, Australia or Germany. Twenty percent of the fruit is consumed within Malaysia. Larger fruits are selected for export to far away countries where prices can be significantly higher. Fruits are packed 34-45 lb. per cardboard carton and shipped. Prices that the farmer gets for his fruit range from U.S. $.20-.50 per lb. for fruits consumed in Malaysia to U.S. $1.00-3.00 per lb. for exported fruits. The farmer's production cost per pound is approximately U.S. $.08, once he reaches the break even point. A farmer might expect to make U.S. $8,600 gross or U.S. $3,300 net per acre.

The most successful Taiwan farmers, with mature carambola groves, net approximately $3,000 in U.S. dollars per acre. This is based on a production of 440 lbs. per year per tree or 52,800 lbs. per acre. The price of the fruit to the farmer varies with the season and the quality. Fruits of the Cheng-Tsey cultivar, after thinning, may grow to 15 oz. per fruit. (However, the average carambola in Taiwan weighs around 7 oz.) When there isn't much fruit available and the quality is good, the price to the farmer of a Cheng-Tsey fruit is approximately $.70 per pound or $.50 per fruit.

To the contrary the Taiwan Agricultural Yearbook for 1986 cites yearly production in Taiwan as 38,270 tons or 76,540,000 lbs. and 12,456 lbs. to the acre. The value of the crop is $17,976,400 or $2600 gross per acre. Most of the carambolas grown in Taiwan are consumed fresh within the country. Ten percent or less are processed into juice. A small amount of fruit is exported to other countries such as Japan, Canada, Hong Kong, or Singapore.

In both Malaysia and Taiwan, large amounts of fresh fruits are consumed. People in the tropics like juicy fruits (Tzong-Shyan Lin, Natl. Taiwan Univ. Persona communication). According to the Taiwan Agricultural Yearbook for 1986 the carambolas produced in Taiwan amount to only 1.9% of their total fruit and vegetable production. People in these countries eat a higher percentage of fresh rather than processed foods. A veiwpoint expressed frequently is that carambolas are good for the heart because of the high levels of potassium in the fruit which aids in lowering blood pressure (6).

Future of the Industry

All is not well for the carambola growers in Selangor, Malaysia. Land cost in this area varies from U.S. $62,600-U.S. $83,330 per acre. Since most farmers cannot afford to own land, they lease the land, often from the State. The rental agreement is based on fruit production. Frequently the owner of the land is give 1/2 of the production from the farm for the duration of the lease.

Worse yet, the State, which owns the majority of the carambola growing land, has decided to evict the farmers. This land has been designated for property development. The farmers have no option but to look for other land. They have applied to the government for 1200 acres of agricultural land close to the land they now occupy. They are afraid that their application may not be granted soon enough to keep them in business (6).

The government of Taiwan is responsible for the small size of the farms in that country. In the early 1950's land reform policies provided the vehicle for redistribution of land. With strong cooperation between government agricultural agents and growers, this program has flourished. It allowed more people to own and enjoy the benefits of land that they worked. Land is considered of great value in this country and is generally handed down from generation to generation. Sometimes it is split up among children. The end result being the reduction of farm size. Three quarters of the farms in Taiwan are smaller than 2.4 acres (7). When it becomes available, land is also costly. Land suitable for carambola growing sells for approximately U.S. $75,000 per acre.

The small size of the farms is now considered to be an impediment to further agricultural progress. Since mechanization is not cost effective, farmers often have to diversify into non-farm jobs to support themselves. The number of acres of carambolas, 6900, is remarkable when viewed besides the number of farms that would be necessary to make up that figure. Nonetheless, the carambola industry in Taiwan seems very healthy and is apt to continue to be so in the near future.

Discussion

The leading carambola cultivars in Malaysia and Taiwan are large in size (0.7-0.8 lbs.) due to thinning. They are sweet, low acid, fiberless fruits having extended ribs. These cultivars apparently satisfy their marketing and shipping requirements. It is questionable whether fruits with such large ribs would ship as easily or be as amenable to handling as the 'Arkin'. Then too, there is the question of optimal size for markets. There may be a point at which the fruit is too large to generate the best price per unit of weight.

The methods of growing and marketing carambolas in Malaysia and Taiwan, reflects conditions unique to that part of the world.

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Proc. Fla. State Hort. Soc. 100:278-281. 1987.

THE NATIVE SUBTROPICAL AND TROPICAL FRUITS IN YUNNAN, CHINA

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Additional index words. species, cultivars, distribution, usage.

Abstract. **The background situation of the location, topography, climate, and plant germplasm resources in Yunnan Province of the People's Republic of China is briefly reported. The scientific names, some cultivar names, their distribution and usage of 18 families, 29 genera, and 91 species of subtropical and tropical fruit plants originated from Yunnan and its nearby areas are listed. Of genera and species existing in China, 3 of 4 *Myrica* species, 11 of 17 *Citrus* species, 20 of 42 *Actinidia* species, 8 of 10 *Musa* species, 9 of 11 *Eriobotrya* species, and all 3 species of *Dimocarpus* can be found in the province. There are some specific and important fruits in this area, such as *Citrus hongheensis* Y.L.D.L., *Poncirus polyandra* Ding at al, *Myrica rubra* Sieb., *Eriobotrya bengalensis* (Roxb.) Hook. f., *Actinidia chinensis* Planch., *Dimocarpus logana* Lour., *Dimocarpus yunnanensis* Wu et Ming, *Mangifera persiciforma* Wu et Ming, *Musa acuminata* Colla, and *Musa balbisiana* Colla.**

Yunnan Province is situated in southwestern area of the People's Republic of China. It covers an area of 394,000 square kilometers with mountainous areas, hilly lands, and plains respectively taking up 84%, 10%, and 6% of the province's total land area. Yunnan has a long border line with Burma to its west, and with Laos and Vietnam to its south. There is a population of 33.62 million people of 25 different nationalities.

The province is a part of Yun-Gui Plateau with an average elevation of 2,000 meters above sea level. Its topography slopes from the northwest to the southeast, with the highest point of 6,740 meters (Kagebo Peak of Meili Snow Mountains) and the lowest point of 76 meters (Hekou County). It has a complex terrain and vast altitudinal differences.

The climate in Yunnan is of the subtropical highland monsoon type. There are a variety of climatic types, namely the tropical, subtropical, temperate, and frigid regions. There exists a fairly distinct demarcation of the dry season and rainy season. The former spans from November to April while the latter from May to October. The average annual precipitation is about 1,100 mm, 83% of which occurs in the rainy season. The annual temperature difference is slight (about 10-12°C), but daily temperature range can be relatively large (about 12-16°C). Some