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Production, Post-Harvest and Marketing of Kaffir Lime (*Citrus hystrix* DC) In Tulungagung, Indonesia

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Abstract

Kaffir lime (*Citrus hystrix* DC) is one of the *Citrus* species that is popular as food spices in Indonesia. This study was aimed at describing the production system, post-harvest handling, marketing and evaluating the product variation of kaffir lime cultivated in the Tulungagung district, East Java Province, Indonesia. Data was collected through a survey by interviewing kaffir lime farmers, distributors and customers in June 2018. Kaffir lime is cultivated by local farmers using traditional and conventional agriculture practices. The farmer used good quality seedlings as planting materials and applies animal manure or compost to the trees. Kaffir lime is grown on rain-fed land; fertilizers and pesticides are applied sparingly. The kaffir lime leaves could be harvested twice a year in different seasons. Better leaf quality can be obtained during the rainy seasons. The leaf production per tree is estimated at about 100 gram per plant per season. Post-harvest handling involved sorting, packing and marketing without any cooling treatment. The standard gate price of kaffir lime leaf in June 2019 was IDR 6,000-7,000, IDR 9,000-10,000 at the collector level, IDR 11,000-12,000 at wholesaler, and IDR 14,000-16,000 at small retailers. Leaves were distributed to traditional market in Tulungagung, neighbouring districts such as Kediri, Trenggalek and Blitar, and also capital cities such Jakarta. The main product of kaffir lime is the fresh leaves for food seasoning and as a raw material to produce essential oil and dry leaf powder. The stems have been used for fuel in home industries. The fruits of kaffir lime are rarely found in the market and have great potentials for essential oil production and recently, a promising commodity for export.

Keywords: essential oil, food spices, supply chain, traditional market.

Introduction

Citrus is known to have originated from the southeast foothills of the Himalayas ranging from the eastern area of Assam, northern Myanmar and western Yunnan prior to its spread over the world by various human activities (Gmitter and Hu, 1990; Wu et al., 2018). One of the citrus species that is widely distributed in the tropical climate of Southeast Asia is kaffir lime (*Citrus hystrix* DC). The term 'kaffir' was used to place this lime as one of the inferior citrus crops prior to the discoveries of its potential uses for human life (Wongpornchai et al., 2012). The previous name of this lime was 'Mauritius Papeda' since De Candolle (DC) brought the seeds from Mauritius and then classified this lime as the first citrus species in Papeda sub genus due to its unpalatable fruits (Swingle and Reece, 1967).

Nowadays, kaffir lime leaves are widely used as spices in numerous Asian dishes, including Indonesian cuisines. Kaffir lime leaves can be easily distinguished from other citrus leaves due to the presence of winged petiole forming a bifoliate leaf type (Budiarto, 2018). In the international market, the leaves have been marketed in various forms such as fresh, frozen or dried (Wongpornchai et al., 2012). Additionally, the leaves are a source of essential oil (Setiadi and Parimin, 2004) and can potentially be marketed as a preservative agent for pharmacy, aromatherapy and cosmetics (Murni et al., 2017). In the past, kaffir lime was used as herbal drink for coughing, as hair shampoo and sweets (Heyne, 1950; Irsyam, 2015).

Although kaffir lime has a lot of benefits, the development of this citrus in Indonesia is still limited. The Research Institute for Citrus and Subtropical Fruits (Balitjestro) have acknowledged the lack of study in kaffir lime production in Indonesia (Balitjestro, 2011). Most of the demands for kaffir lime fresh leaves in domestic market is supplied by non-intensive kaffir

lime producers who grow the trees in their home backyards (Setiadi and Parmin, 2004). At the same time, the demand of kaffir lime product worldwide continues to increase due to the rapid growth in population and the recent pursue for healthy lifestyles. Indonesia's position is still lagging behind compared to Thailand as the top producer of kaffir lime product in the international market (Wongpornchai et al., 2012).

To increase domestic production the kaffir lime business should be managed more properly, including through agricultural intensification. The only one production center of kaffir lime that has semi-intensive kaffir lime production system in Indonesia is the Tulungagung district in the East Java province (Balitjestro, 2011; Balitjestro, 2014). Various documents issued by local statistic offices were the basic reference to trace the existence of kaffir lime business in this study in Tulungagung. This study was aimed at collecting and recording preliminary information about production, post-harvest handling and marketing of kaffir lime, and the development of its market in Tulungagung, East Java, Indonesia.

Methods

This study was conducted in June 2018 in the Tulungagung district, particularly in Ngunut, Sumbergempol and Rejotangan sub-district, East Java province, Indonesia, using a baseline survey. The respondents were 50 people in total, consisting of 10 farmers, 10 collectors, 10 wholesalers, 10 small retailers and 10 customers. Interviews were conducted to collect information regarding the process and problems in term of crop cultivation, post-harvest handling, marketing and product variation of kaffir lime in Tulungagung. The results were discussed descriptively.

Results and Discussion

Production and Post-Harvest

The production area of kaffir lime in Tulungagung is estimated to be about 2080 ha, which is distributed to be highly concentrated in the Ngunut sub-district covering an area of about 1020 ha, Sumbergempol and Rejotangan (760 and 300 ha, respectively) (Balitjestro, 2011; Balitjestro, 2014). Tulungagung has an altitude of 90 m above the sea level, daily temperature of 25.5 ^{0}C, and annual rainfall of 1717 mm per year (Climate-data, 2019).

Kaffir lime is cultivated by local farmers in Tulungagung using traditional and conventional agriculture practices, which include hand weeding, application of compost and rely on rain as source of water. Conventional practices are represented by the application of chemical fertilizer and pesticide. With limited capital, farmers usually used their own land to grow lime rather than renting lands for production. The cultivation of Kaffir lime is slightly different to other common citrus like tangerine, mandarin, oranges, pummelo, lemon, citron, and lime, due to the different market orientation of the product. For citrus trees grown for fruit production, the culture practices and production system is more complex and costly; irrigation has to be provided and flowering is usually regulated. For kaffir lime which is grown for their leaves, the production system is less intensive in terms of input and labour requirements.

Propagation

Kaffir lime seedlings are produced through grafting techniques using "Rough Lemon" (RL) or "Japansche Citroen" (JC) as rootstocks. With all the farmers interviewed, there was none who grew seedlings from seeds. The farmers purchased grafted seedlings from Indonesian Research Institute for Citrus and Subtropical Fruits which costs IDR 5,000-9,000 per seedling. Seedlings are ready to be marketed at around five month after grafting, having height of 25-30 cm, have normal growth, and disease-free.

Planting

The planting of kaffir lime was started by land clearing from previous plant debris; farmers prefer to do manual weeding. Soil tillage is also done manually using hoe instead of tractors, and by watering of dry land to ease the tillage. The irrigation usually relies on the nearby water sources such as rivers or ditches. Water was carried in buckets from the river to the field, even though some farmers use water pump to distribute the water. There has no irrigation tunnels facility in this area; kaffir lime cultivation mostly depends upon the surface water from rain. Some farmers may add animal manure compost and dolomite during the tillage. Planting was conducted three days after soil tillage and the commonly used planting distance is 50 cm within the row, and 50 cm between rows.

Tree Maintenance

If compared to other species of citrus for fruit production, the maintenance of kaffir lime trees is relatively simpler, because there is no need to give a repeated fertilizer, regulate the flowering, or provide irrigation to support the fruit loading. Most of the kaffir lime in the area is in rain-fed fields. Most of the farmers apply fertilizer once after planting with government-

subsidized fertilizer such as NPK Phonska, Urea, ZA and SP-36. If farmers have additional capital, they may fertilizer the second time during the third month after planting. There is no standard fertilizer dosage among farmers; however, the fertilizer dosage suggested by Balitjestro (2009) is 20 gram N, 10 gram P_2O_5, 5 gram K_2O per tree. Manual weeding is conducted regularly once a month. The field is monitored for pests and disease infestation, and unless pest populations exceed the economic threshold, the use of pesticides is not warranted.

The various pests and diseases associated with the citrus agribusiness includes leaf miner (*Phyllocnistis citrella*), *Tetranycidae, Toxoptera sp*, thrips (*Thysanoptera*), lime butterfly (Papilio demolion), blendok (*Botryodiplodia theobromae* Pat), citrus powdery mildew (*Oidium tingitanium*), citrus canker (*Xanthomonas axonopodis* pv. Citri), scooty mold (*Capnodium citri* Berkl & Desm), scab (*Spaceloma Fawcettii* Jenkins). The most threatening disease is citrus vein phloem degeneration (CVPD) which is transmitted by an insect vector *Diaphorina citri* Kuw (Balitjestro, 2010). A good quality kaffir lime seedling obtained from Balitjestro help the kaffir lime farmers to prevent the infection of CVPD.

Kaffir lime leaf harvest

The harvesting of kaffir lime leaves can start fourth month after planting, but most farmers prefer to harvest twice a year for labour efficiency. Farmers may delay the harvesting schedule up to two months to get profitable price. Harvesting time is usually arranged in the morning or evening, and is done manually with a sickle to cut the lime canopy. The cutting point on the stem ranges from 10 to 30 cm above the ground. This practice allows the plant to completely rejuvenate before subsequent harvestings which may be a recurring process for another period of six years.

Plant population is usually 40,000 trees per ha with leaf production of about 100 gram per tree, so the leaf production in one ha is equivalent to 4 tons. Kaffir lime growers could obtain >10 ton.ha^{-1} from two harvesting seasons per year (Balitjestro 2011). Citrus leaves produced during the dry season, which is during June-July, is usually of lower quality than those produced in rainy seasons, and indicated by the smaller, thinner and smuttier leaf, perhaps due to more pest incidence.

Postharvest handling of kaffir lime leaves

During the harvesting period there will be collectors coming to the farmer to negotiate for the price. Some collectors may offer a hand in the harvesting activities by providing labours, but some farmers may refuse the offer to maximize their income. There are two types of labour involved, the man group for field harvesting and distribution, and the women group for stripping the leaves from the spiky stems which is traditionally called *mitil*. The daily pay of a man labour to do harvest in the field is around IDR 30,000 per day, whereas the wage for woman workers depends on the amount of the harvested leaves, i.e. IDR 600 to 1,000 per 100 g of fresh leaves. *Mitil* is usually done by women working in groups of three to five people. The leaf pickers usually wear gloves made of old clothing, or sometimes they used their bare hands. The harvested leaves are pooled into 10 kg packs and stored in pink polypropylene woven sacks to ease the transportation. Later, the sacks will be weighed at the collector's house to calculate the total yield, and subsequently the farmers will receive their payments for the produce.

Marketing

The marketing chain of kaffir lime leaves in Tulungagung is described in Figure 1. Kaffir lime growers are spread in three sub-districts of Tulungagung, Ngunut, Sumergempol and Rejotangan. Farmers sell kaffir lime leaves to collectors at a price of about IDR 6000-7000 per kg. Kaffir lime leaves have to be marketed as soon as possible to avoid moisture loss which may reduce the weight. A collector is a first-hand distributor that sells the kaffir lime leaves to the traditional market, or sending them to essential oil producers. The postharvest life of kaffir lime leaves stored in the collector's houses is only 24 hours. The selling price at the collector level varies greatly from IDR 9,000 to 10,000 per kg.

The kaffir lime leaves are marketed to the local markets at Tulungagung including Ngemplak Ngunut, Rejotangan and Sumbergempol, and to capital cities including Jakarta. For small scale distribution (≤30 kg) the collector uses a motorbike to distribute the produce to the local markets. Distribution to the neighbouring districts such as Ngronggo market of

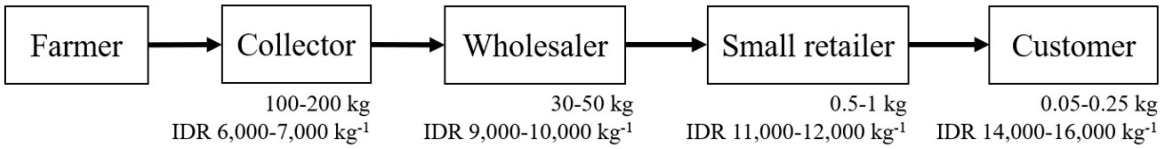

Figure 1. Marketing channel of kaffir lime leaves in Tulungagung

Kediri, Wlingi market of Blitar, Kepanjen market of Malang and market of Mojokerto, used a small truck or bus, with the delivery volumes ranging from 50-100 kg per day. Deliveries to the capital cities was carried out every three days or once a week using a mini truck, with the delivery volume ranging from 500 kg to 1 ton.

The second-hand distributor is a wholesaler in the traditional market. A wholesaler is a large reseller that can be easily found in big markets, such as the Ngemplak market. Each day a wholesaler could sell 30 kg of kaffir lime leaves per day. The customer of the wholesale are small retailers from the same market or other markets nearby. Prior to selling, the wholesaler repacks the leaves in smaller packs with a clear plastic bag of 0.5 kg per pack. The selling price at the wholesale level ranges from IDR 12,000-13,000 per kg.

The third-hand distributors are small retailers that distribute the produce in large and small markets, including the Sumberdadi village market and Sumbergempol sub-district market. Small retailers sell the kaffir lime leaves along with other foods such as vegetables, herbs and spices, and they could sell on average 0.5 kg of kaffir lime leaves per day. At festive seasons such as Eid and during the fasting month they may be able to sell up to 1 kg leaves per day. The selling price at the small retailer level ranges from IDR 14,000-16,000 per kg.

At the end of the supply chain of kaffir lime leaves are the consumers who are the local residents, food store owners, or housewives who purchases kaffir lime leaves in a small amount. A food store owner usually buy on average 250 g kaffir leaves at IDR 5,000, while a housewife buys a smaller amount ranging from 100-250 g with the price of about IDR 1,000-2,000. The local refineries and food companies are also customers of the kaffir lime leaves, but they are in a shorter supply chains as they directly get their supplies from the collector. The selling price from collector to food factories in Malang ranges from IDR 8,000-10,000 per kg depending on their agreement. The advantage of supplying kaffir leaves to food factories is that it is competitive, stable selling price, with the challenge of always ensuring product quality is achieved according to the contractual agreement.

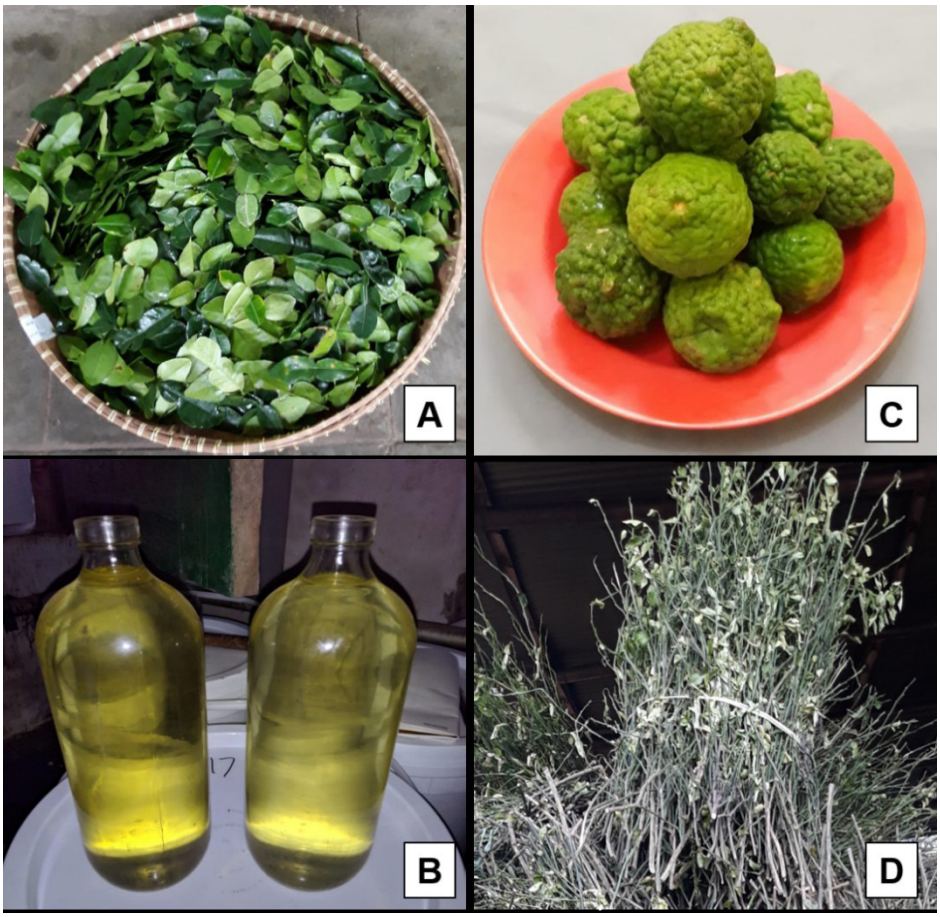

Figure 2. Fresh and processed products from kaffir lime at Tulungagung market: fresh leaves (A); essential oil (B); fruits (C); stems after stripping the leaves (D).

Product Variation

The main product of Kaffir lime is fresh leaves that are used as a food spice (Figure 2A). The selling price of fresh leaf of kaffir lime varies depending on the level in the supply chain. The closer the market from the production centre, the lower the price. In June 2018, the price of kaffir lime in Tulungagung such as the Ngemplak traditional market located in the city centre ranged from IDR 14,000-16,000 per kg, while at the same time the price in Bogor in the Gunung Batu and Cibereum traditional markets reached IDR 40,000 per kg.

Although kaffir lime leaves are mostly sold fresh, some derivative products are increasingly popular, e.g. leaf flour and leaf essential oil. The emerging demand of those products is seen as the reason behind the increasing demand for fresh kaffir lime leaves. The leaf flour is produced by certain collectors using the sun drying method, where the leaves are dried out in the sun for two days. Dried leaves will give a rustling sound when squeezed. The dried leaves were then pooled and powdered using a blender. The price of kaffir lime leaf flour in Tulungagung in June 2019 was IDR 30,000 kg^{-1} and this product is mainly bought by food manufacturers in large cities, such as Malang, Surabaya and Jakarta.

The leaf essential oil (Figure 2B) is produced by certain collectors using distillation method at a home industry scale. Some collectors may have 1 to 3 sets of refining furnaces with the capacity of 400 kg of leaves. The popular method to extract leaf essential oils of kaffir lime is steam distillation. The distillation process is started by placing the leaf into the furnace and then let the leaves be exposed to hot steam to release the aromatic compounds, which then pass into a cooling system for condensation. Due to the different specific gravity, the essential oil floats above the water layer. The distillation process lasts for 6-7 hours. The leaf essential oil yield of kaffir lime ranged from 0.5-0.6 %. The price of leaf essential oil of kaffir lime in Tulungagung is IDR 700,000 per kg or IDR 1,750 per ml.

There are two marketing strategies of leaf essential oil, online marketing through the social media, and off-line marketing through the channel of big oil collectors in the capital cities prior to export to the international markets. There are various names of kaffir lime essential oil in international market, such as leech lime oil, makrut oil, combava petit oil, mauritius papeda oil (Wongpornchai et al., 2012).

The fruits of kaffir lime (Figure 2C) are often collected during the harvesting of kaffir leaves in the dry season (June to July). The fruits are less popular compared to the leaves and becomes the side product of lime cultivation because the fruits do not have the commercial value as yet. The more fruits that emerge, the less leaves produced in a tree. When the harvested fruits is below 5 kg, the leaf collectors usually get free fruits as the bonus from the farmer. Above the 5 kg, the leaf collector usually buys fruits at a price of about IDR 10,000 per kg. The leaf collectors send the fruit to the middle man in capital cities. The fruit peel of kaffir lime is believed to be rich in essential oils.

Another side product of kaffir lime cultivation in Tulungagung is the harvested stems that have gone through the '*mitil*' (stripping off the leaves) process (Figure 2D). The collector has an advantage by having the harvested stem for free from the farmers. The collector may sell the stems to other collectors who have essential oils business since the stem could be used as wood fuel for operation of the refining furnace. The price of the stem ranges from IDR 500-1000 per kg depending on the wood fuel stock of the essential oils home industry. The ashes from the wood which are waste products of the refining industry can be pooled and applied to the agricultural field as soil amendment.

Conclusion

Kaffir lime production in Tulungagung is operated by local farmers in three sub-districts, Ngunut, Sumbergempol and Rejotangan, using a combination of the traditional and conventional agriculture practices. The leaves could be harvested twice a year; Kaffir lime is mainly sold for their leaves; leaf productivity was estimated to be up to 100 gram per plant per season. There are other products resulting from the kaffir lime business, i.e. leaf flour, leaf essential oils, fruit and stem. Postharvest handling consisted of leaf stripping (*mitil*) and packing without any cooling treatment. The gate price of kaffir lime leaf per kg in June 2018 was IDR 6,000-7,000, IDR 9,000-10,000 at collector level, IDR 11,000-12,000 at the wholesale level, and IDR 14,000-16,000 at small retailer level. Kaffir lime leaves have been distributed to the local markets of Tulungagung and to the capital city Jakarta.

Acknowledgement

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