

QUALITY MANAGEMENT IN THE SUPPLY CHAIN OF BABY CORN IN THAILAND

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Abstract. Thailand is the main exporter of baby corn in the world. The production area is approximately 32,000 Hectares. The major importers are the United States of America, Japan, the Netherlands and Taiwan. The demand of baby corn continues to increase. The supply chain and logistics management is very important to maintain the quality and minimize the production cost of baby corn for exporting. In this study, the key members of fresh baby corn supply chains in Kanchanaburi, Ratchaburi, and Nakhon Pathom provinces of Thailand are growers, suppliers, packinghouse and consumers. The issue of baby corn supply chain management for exporting are transportation time, dehusking process time, transportation temperature, storage temperature and also humidity. After harvesting, baby corn must be transported to the packinghouse as soon as possible, then quickly dehusked by workers, packed and kept in cold storage, after that transported to the airport. In the storage period, the temperature and relative humidity are important factors to maintain baby corn qualities. Thus, the storage temperature and relative humidity were studied. It was found that baby corn stored at 4°C at 90-95% RH showed the suitable conditions in reducing weight loss, respiration and in maintaining soluble solids, external appearance including high acceptability for the customers. The storage life of baby corn kept at 4°C at 90-95% RH was 21 days. However, if baby corn was kept at 7°C at 90-95% RH, the storage life was only 18 days. At 25°C and 75-80% RH, the storage life of baby corn was 7 days. Therefore, the cold chain is very important for prolonging the storage life of baby corn.

Keywords: baby corn, quality, supply chain.

Rezumat. Managementul calității în lanțul de aprovizionare cu porumb baby în Tailanda. Tailanda este principalul exportator de porumb baby din lume. Suprafața de producție este de aproximativ 32.000 ha. Cei mai mari importatori sunt Statele Unite ale Americii, Japonia, Olanda și Taiwan. Cererea de porumb baby este în continuă creștere. Managementul lanțului de aprovizionare și logistic este foarte important pentru menținerea calității și minimizarea costurilor de producție a porumbului destinat exportului. În acest studiu, membrii cheie în lanțul de aprovizionare cu porumb baby proaspăt în provinciile Kanchanaburi, Ratchaburi și Nakhon Pathom din Tailanda sunt cultivatorii, furnizorii, procesatorii și consumatorii. Principalele probleme legate de managementul lanțului de aprovizionare sunt timpul necesar transportului, procesului de depănșare, temperatura în timpul transportului, temperatura și umiditatea din depozit. După recoltare, porumbul trebuie transportat pentru ambalare cât de rapid posibil, apoi trebuie depănșat rapid de către muncitori, ambalat și păstrat la rece și, apoi, transportat la aeroport. Pe durata depozitării, temperatura și umiditatea sunt factori foarte importanți pentru menținerea calităților porumbului. Au fost analizate valorile de temperatură și umezeală relativă. Astfel, s-a ajuns la concluzia că porumbul păstrat la o temperatură de 4°C și o umezeală relativă de 90-95% RH a indicat cele mai adecvate condiții în reducerea pierderii în greutate, respirație și în menținerea solidelor solubile, inclusiv a aspectului exterior, un factor esențial pentru clienți. Durata de păstrare la o temperatură de 4°C și o umezeală relativă de 90-95% RH a fost de 21 zile. În cazul unei temperaturi de 7°C și a unei umezele de 90-95 % RH, durata de păstrare a fost de numai 18 zile. La o temperatură de 25°C și o umezeală relativă de 75-80% RH, durata de păstrare a fost de numai 7 zile. Astfel, temperatura este foarte importantă pentru prelungirea duratei de păstrare a porumbului.

Cuvinte cheie: porumb baby, calitate, lanț de aprovizionare.

Baby corn is the ear of maize (*Zea mays* L.) plant harvested young, especially before or just two or three days after the silks has emerged but prior to fertilization. The dehusked ears can be eaten as vegetable. Baby corn provides many food benefits to people. It is a good source of folate and vitamin B. It is also rich in several other nutrients such as potassium, vitamin C and fibre (Food Market Exchange, 2003). Farmers can grow baby corn about four crops a year. The main production areas of baby corn are Kanchanaburi, Ratchaburi and Nakhon Pathom provinces of Thailand.

Baby corn is an important commercial and export crop of Thailand which is the world's largest exporting country. The major importers are the United States of America, Japan, Netherlands and Taiwan. Besides, Thailand also exports baby corn to China, Australia, India and other countries.

The amount of baby corn export in 2009-2010 has been estimated at more than 33 million US dollars and the demand of baby corn continuously increases (Office of Agriculture Economics, 2010). With a short period of cultivation, only 45-60 days, farmers can reap the crop and fetch 12,500-18,750 Baht per ha. Moreover, there are few pests to attack the plant. In addition, parts of baby corn plants such as tassel, young husk, silk and green stalk after harvest can be used as fodder.

The quality of baby corn required by importers/customers refers to shape, size, freshness, limited chemical residues and microorganism, etc. However, the growers' lack of knowledge, low efficiency of management, inappropriate transportation from farms to consumers, all cause produce deterioration leading to a lower price. Therefore postharvest handling, supply chain and logistics management are very important to maintain the quality and minimize losses of baby corn for export.

Quality of baby corn. In all classes, the minimum requirements of the quality of the baby cobs 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;
- free of damage caused by pests;
- free of abnormal external moisture;
- free of any foreign smell and/or taste;
- fresh in appearance;
- practically free of silk.

Note: The cut that is made on base of the cobs should be clean and well defined. A slight discolouration of the cut surface due to storage is acceptable.

The cobs of baby corn are classified in three classes defined below:

1. "Extra" class

The cobs of baby corn in this class must be of superior quality, well-trimmed, free of husk, stalk and silk, perfectly young cob. 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. Class I

The cobs of baby corn in this class must be of good quality, well-trimmed, free of husk and stalk. The following slight defects may be allowed, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package:

(1) slight defects in shape and colour;

(2) slight defects in irregular arrangement of undeveloped ovaries 1;

(3) slight defects on the surface such as rubbing, scratches or other mechanical damage. The total defect area must not exceed 5% per cob;

(4) silk attached to and broken from the cob must be minimal without affecting the appearance of the baby corn supplied to consumers.

3. Class II

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

(1) defects in shape and colour;

(2) defects in irregular arrangement of undeveloped ovaries 1;

(3) defects on the surface due to rubbing, scratches or other mechanical damage. The total defect area must not exceed 10% per cob;

(4) silk attached to and broken from the cob must be minimal without affecting the appearance of the baby corn supplied to consumers. (National Bureau of Agricultural Commodity and Food Standards, 2007).

The quality provisions concerning sizing:

Size is determined by the length of the cobs of baby corn measured from the cut at the base to the tip in accordance with the following:

Size Code 1: cob of baby corn length (cm) > 9.0 to 13.0

Size Code 2: cob of baby corn length (cm) > 7.0 to 9.0

Size Code 3: cob of baby corn length (cm) 4.0 to 9.0

For all sizes, the width must be 1.0 to 2.5 cm (measured at the widest part of the cob of baby corn) (National Bureau of Agricultural Commodity and Food Standards, 2007).

Baby corn production. Baby corn is produced from regular corn plant. However most of the farmers use hybrid seed from the company. Hybrid varieties are more popular than open pollinated varieties in most areas because of the uniformity of cob size, cob height, plant height, flowering and silking date and maturity period. They produce higher and better quality than opened pollinated one. Generally, production practices of baby corn are similar in many growing regions. However, the farmers are not familiar with Good Agricultural Practices (GAP). Training is necessary when farmers want to adopt GAP following the guideline of the Department of Agriculture and Department of Agricultural Extension, Ministry of Agriculture and cooperatives, Thailand (Department of Agriculture, 2002).

When baby corn plants reach 38 days after planting, having 7 pairs of real leaves, masculine buds will come out from clusters of young leaves. It is necessary to get rid of masculine buds. One hand holds a stalk, and the other pluck out a young cluster of leaves surrounding the masculine buds. Plucking masculine buds prevents pollen mixing, which leads to low quality of baby corn. Kernels will swell and become undesirable in the markets. In addition, plucking of masculine buds quickens harvesting and increases productivity. Therefore, this technique should not be overlooked. Baby corn can be harvested 3-4 days after the masculine bud plucking. (AIAMSAANG, 2009; SAKHORNEN, 2009; RATANACHAI, 2011).

Harvest baby corn. Baby corn generally matures very quickly, therefore the harvest of baby corn must be planned carefully to avoid ending up with more mature corn ears. Baby corn is hand-picked as soon as the corn silk

emerges from the ear tips, a few days after. The most appropriate time for harvesting is when baby corn silk comes out 1-2 centimetres from the top end of ears, or when the plant is 45-50 days old. When possible, harvesting should be carried out in the morning period, when the corn moisture content is highest and ambient temperatures are low. Reap baby corn ears on top first, then those below. A baby corn produces 3-4 ears. Harvest crop every day in order to prevent baby corn from being overripe (Food Market Exchange, 2003; AIAMSAANG, 2009; RATTANACHAI, 2011).

Timely harvesting is the most crucial thing in baby corn cultivation. The quality of the produce largely depends on this stage of cultivation. Such as late harvests illustrated by too long silk coming out from ears result in too big baby corn size undesirable to processing plants and traders. As for harvesting methods, farmers should twist of snap ears away. Next, put them in containers like baskets, bags, sacks. The sacks of harvested baby corn should be transported to field packinghouse/collecting place as quickly as possible, then keep on place with good ventilation and should not be piled up and left for days. (Food Market Exchange, 2003; RATTANACHAI, 2011).

Postharvest handling of baby corn. After baby corn is harvested, it should be transported to shady placed or collecting places having good ventilation (Department of Agriculture, 2002), because baby corn has very high rate of respiration (Fig. 1). It should be husked right after harvest, if possible. Do not put baby corn directly on the ground or floor of trucks. It is better to keep it in proper containers such as carton boxes, net plastic baskets facilitating ventilation (Department of Agriculture, 2002).

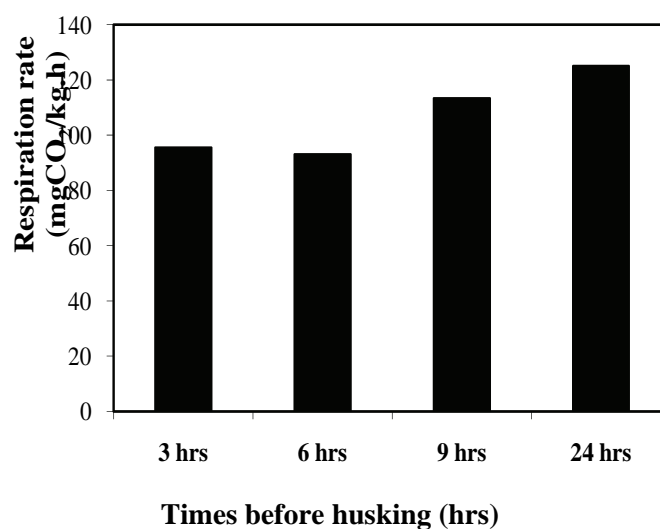


Figure 1. Respiration rate of baby corn before husking.

In husking baby corn, split lengthwise ears, but try not to damage inner spikes. Next, thoroughly get rid of silk. All tools used such as knives, containers must be clean. All tools and containers used from the harvesting stage to the packaging stage need to be well cleaned in order to decrease the amount of microorganisms that can damage baby corn produce. Baby corns are stored at 4°C for about 18 hours. Storage rooms can be cleaned with spraying of 1-2% formaldehyde solution. Sodium hypochlorite is another alternative (RATTANACHAI, 2011)

Baby corn has to be fresh, the length of the cob is between 4 and 13 centimetres, the diameter is between 1 and 2.5 centimetres, straighten cob, kernels is good straight row kernel alignment, no bitten by insects. The kernels should be yellow or cream. If the husk is removed from baby corn, the baby corn must not show any sign of cutting by knife, damage and no silk attached. (National Bureau of Agricultural Commodity and Food Standards, 2007). The process flow in packinghouse to prepare baby corn for exporting starts from sorting, sizing, grading, packing, etc. Then baby corns are transported from packinghouse to the airport. The produces are stored at 5 °C, then transport by air to many countries (RATTANACHAI, 2011).

Time schedule for the supply chain of baby corn. Time schedule of the supply chain of baby corn covers the entire process, from farms to consumers (RATTANACHAI, 2011):

- Baby corn are harvested early in morning (06.00 to 08.00 a.m.) or 2 hours, then packed into sacks and placed in the field (08.00 a.m.)
- Collector picks up baby corn from the field and transport it to the packinghouse (08.00 to 10.00 a.m.) or 2 hours. Temperature during transportation is approximately 27-32 degree C.
- Baby corn is sized, weighted in the packinghouse, then hushing (10.00 a.m. to 01.00 p.m.) or 3 hours.
- Baby corns are stored at 4°C (01.00 p.m. to 07.00 a.m.) or 18 hours.
- Process flow is started, sizing, grading, packing, etc. (07.00 a.m. to 3.00 p.m.) or 8 hours at 15-20 degree C.

- Baby corn are transported from packinghouse to the airport (03.00 p.m. to 05.00 p.m.) or 2 hours at 5°C. The produces are stored at 5°C (05.00 p.m. to 10.35 p.m.) or 5 hours 35 minutes to Japan for the first flight, (05.00 p.m. to 11.50 p.m.) or 6 hours 50 minutes to Japan for the second flight in cargo.
- The produces are transported to partner countries. The first flight from Thailand to Japan time is 10.35 p.m. to 04.10 a.m., the second flight time is 11.50 p.m. to 05.25 a.m., or 5 hours 35 minutes.
- Baby corn is transported from distributors to supermarkets at 5°C, 6 hours.
- Summarising, the total time from baby corn field to consumer is 45 hours 35 minutes (for the first flight to Japan), 47 hours 50 minutes (for the second flight to Japan).

Storage of baby corn. The storage temperature and relative humidity are important to maintain the quality and storage life of baby corn. It was found that baby corn stored at 4°C under 90-95% RH showed the suitable condition to reduce weight loss, respiration and in maintaining soluble solids, external appearance including high acceptability for the customers. The storage life of baby corn kept at 4°C under 90-95% RH was 21 days. However if baby corn was kept at 7°C under 90-95% RH, the storage life was only 18 days (Table 1; Fig. 2). At 25°C and 75-80% RH, the storage life of baby corn was 7 days (SAKHORNEN, 2009). Therefore, the cold chain is very important for prolonging the storage life of baby corn.

Table 1. Respiration rate and weight loss of baby corn storage at 4, 7 and 25°C under 75 and 90% RH.

Treatments	RH (%)	Days of storage	Weight loss (%)	Respiration rate (mg CO ₂ / kg.h)
4 °C	90±5	21	2.05	31.63
7 °C	90±5	18	5.56	36.24
25 °C	75±5	7	10.58	135.12

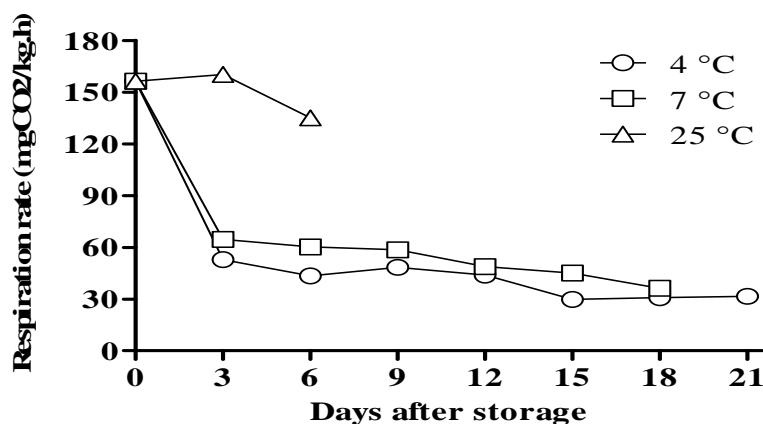


Figure 2. Respiration rate of baby corn during storage at 4, 7 and 25°C (ambient condition) for 21 days.

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