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Loss Investigation in Supply Chain Management Process of Chinese Kale in Chiang Mai Province

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Abstract

Chinese kale (*Brassica oleracea* L. var. *alboglabra*) is an economic vegetable in Thailand. It can be grown all year round on highlands in the northern part of Thailand. A large proportion of Chinese kale is delivered to Bangkok and its vicinity for local consumers and export. The post-harvesting of this produce takes long time due to the long distance between the production area and the market. Chinese kale is sensitive to heat and wind due to its large and thin leaves; therefore, a high percentage of produce loss occurs during postharvesting handling, especially in summer. This research compared two systems of postharvest management of Chinese kale: conventional and cold supply chains. The main objectives were to determine weight loss at each step, analyze the cause of produce damage, and find a proper method to reduce the loss. The results showed that the first major loss was fracture and bruise which occurred during storage at collecting center and during transportation. The second major loss was wilting cause by heat and wind which occurred during transportation in the conventional supply chain. In comparison with the conventional sully chain, the cold supply chain could reduce total weight loss by approximately 45 percent. Proper produce handling could reduce the loss cause by fracture and bruise and low temperature could prevent wilting which was the major loss during transportation. The weight loss cause by fracture and bruise could be reduced by 15 and 26 percent, respectively.

Keywords: loss investigation, chinese kale, postharvest handling

บทคัดย่อ

คะน้า (*Brassica oleracea* L. var. *alboglabra*) เป็นพืชเศรษฐกิจของประเทศไทย สามารถปลูกได้ตลอดทั้งปีในเขตพื้นที่สูงของภาคเหนือตอนบน คะน้าส่วนใหญ่จะถูกส่งไปกรุงเทพและปริมณฑล รวมถึงส่งออก ซึ่งการจัดการหลังการเก็บเกี่ยวต้องใช้เวลามากเนื่องจากผลิตอยู่ห่างจากตลาด อีกทั้ง คะน้าเป็นพืชที่ตอบสนองต่อความร้อนและลมได้ดี เนื่องจากใบมีขนาดใหญ่และบาง ดังนั้นเปอร์เซ็นต์การสูญเสียส่วนใหญ่เกิดขึ้นในกระบวนการจัดการหลังการเก็บเกี่ยว โดยเฉพาะอย่างยิ่ง ในช่วงฤดูร้อน งานวิจัยนี้ได้ทำการศึกษาระบบการจัดการหลังการเก็บเกี่ยวผักคะน้า 2 ระบบ ได้แก่ การจัดการปกติและระบบความเย็น วัตถุประสงค์หลักเพื่อประเมินการสูญเสียแต่ละขั้นตอน วิเคราะห์สาเหตุการสูญเสีย หาแนวทางในการลดการสูญเสีย ผลการวิจัย พบว่า การสูญเสียหลักเกิดจากการหักและการช้ำของผักคะน้าที่เกิดขึ้นในจุดรวบรวมผลิตผล และขั้นตอนการขนส่ง การสูญเสียรองที่พบคืออาการเหี่ยวจากความร้อนและลมที่เกิดขึ้นระหว่างการขนส่งแบบปกติ เปรียบเทียบกับการขนส่งแบบใช้ความเย็นสามารถลดการสูญเสียที่เกิดขึ้นประมาณ 45% และการจัดการผลิตผลอย่างเหมาะสมสามารถลดการสูญเสียที่เกิดจากการหักและการช้ำได้ นอกจากนั้น การใช้อุณหภูมิต่ำสามารถลดการเหี่ยวที่เกิดขึ้นในระหว่างการขนส่งได้ โดยลดการสูญเสียที่เกิดขึ้นจากการหักและการช้ำได้ 15% ในขณะที่ การเหี่ยวสามารถลดลงได้ 26%

คำสำคัญ: การประเมินการสูญเสีย คะน้า การจัดการหลังการเก็บเกี่ยว

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Introduction

Chinese kale (*Brassica oleracea* L. var. *alboglabra*) production in Thailand is about 4-6 million tons a year and its demand tends to increase every year for both domestic and foreign consumers. The study on produce loss provides information that could lend to methods to reduce loss and proper routines to manage vegetable production process. Recent research indicates that major losses of vegetables occur after harvest. The postharvest loss of vegetable is 20 percent by average in the developed countries and 22 percent by average in developing countries. Many types of vegetables are damaged from heat accumulation, vibration and weight compression within the pile of produce. Those factors accelerate some chemical activities, incidence of deceases, and senescence of vegetables (Pichet, 2010). Temperature-control supply chain is an efficient method to reduce produce loss caused by heat. Therefore, the objective of this research was to investigate the effect of cold supply chain on Chinese kale production in northern Thailand.

Research Methodology

The experiments were to laid out compare 2 methods of Chinese kale postharvest management: cold supply chain and conventional supply chain. Weight loss of the product after harvest and during transportation was determined. Chinese kales from 3 production fields are used in the experiments with 2 replications. The initial weight of produce was 20 kilograms for each sample. The weight loss assessment of Chinese kale for the cold supply chain process is shown in Figure 1. The weight loss evaluation for the conventional supply chain process is shown in Figure 2. Four causes of loss include: 1. weight loss cause by deceases such as bacteria and fungi 2. Weight loss cause by insects such as bite marks (Figure 3) 3. Weight loss cause by mechanical damage such as bruise, fracture, and cut 4. Weight loss cause by wilting (Figure 4)

Chinese kale field (CM*) Transport (CM*) Collecting center (CM*) Transport (CM-BKK*) Distribution center (BKK*)

Figure 1 Cold supply chain process

Chinese kale field (CM*) Transport in bucket (CM*) Collecting center (CM*) Transport (CM-PT*) Central market (PT*)

Figure 2 Conventional supply chain process

*CM: Chiang Mai, BKK: Bangkok, PT: Patumthani

Figure 3 Chinese kales are damaged by deceases and insects.

Figure 4 Mechanical Damage and wilting

Results and Discussion

1. **Temperature of Chinese kale after harvest** in cold chain starts at the refrigerated storage at the collecting center after trimming damaged parts. Chinese kales under the cold supply chain had average temperature of 11.3^{O}C. The highest temperature (38.7^{O}C) during the process occurred when the process was moved from the truck to the cold room at the distribution center in Bangkok. The lowest temperature was 3.3^{O}C in the cold room. Average relative humidity was 84.0 percent. Average surrounding temperature during Chiang Mai-Bangkok transportation was 9.4^{O}C. The produce in the conventional supply chain had average temperature of 27.0^{O}C. The highest temperature during the process was 35.6^{O}C and the lowest temperature was 20.1^{O}C. Average relative humidity was 85.5 percent. Average surrounding temperature during Chiang Mai-Pathumthani transportation was 25.8^{O}C.

2. **Comparison of loss occurring in the cold and conventional supply chains** Weight loss at each stage for the cold and conventional supply chains are shown in Figure 5. At harvest, weight loss was determined in the field. The loss data indicate the condition of Chinese kale in the field. The sample for cold supply chain has higher percent weight loss (54.0%) when compared with that for the conventional supply chain (43.3%). Major damage is caused by fracture and insects (Figure 6). The total amount of loss depends on farm management. The weight loss difference between both supply chains becomes significant at the collecting center where Chinese kale undergoes trimming and cleaning (wiping with soft fabric). Weight loss at the collecting center in the cold supply chain is reduced to 10.7 percent while that in the conventional supply chain slightly increases to 44.2 percent, (Figure 5). The hightest reduction of loss is from fracture and bruise (Figure 6). This is because of better handling and storage (Danai and Nitiya, 2005) at the collecting center in the cold supply chain. Percent weight loss cause by deceases and insects also decreases after Chinese kale undergoes sorting and trimming and is then stored in low-temperature environment at the collecting center while weight loss is steady in the conventional supply chain. The difference in weight loss indicates that low temperature and better management can prevent deceases and insects from spreading.

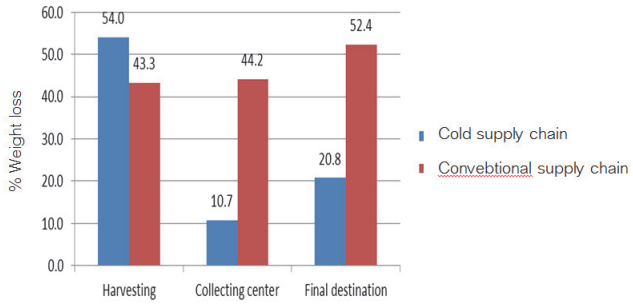

Figure 5 Percent total loss of Chinese kale at each step

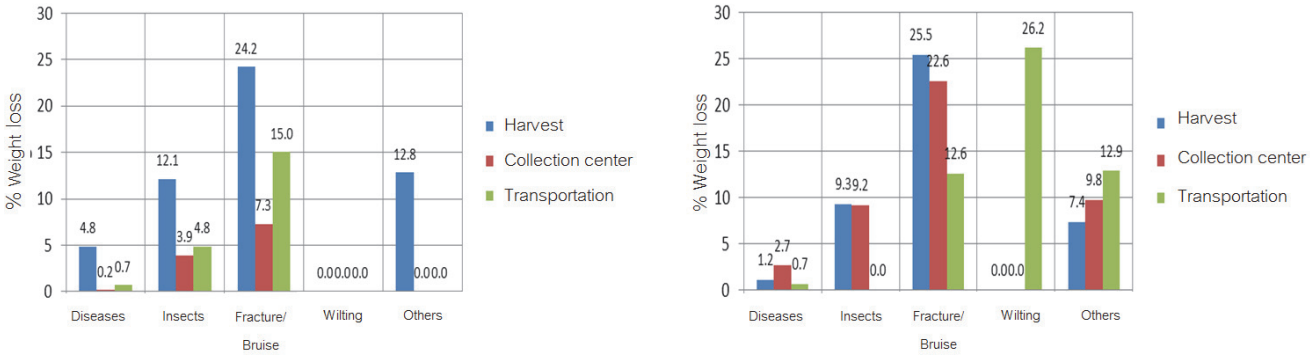

Figure 6 Percent weight loss of Chinese kale in the cold and conventional supply chains

The advantage of cold supply chain was obvious during long transportation from Chiang Mai to Bangkok and Pathumthami. Storing Chinese kale in the refrigerated and enclosed container could lessen wilting which was mainly caused by heat and wind. The refrigerated truck is equipped with refrigeration and the humidifying system which can maintain proper temperature and humidity for the produce. This can minimize transpiration from the leaves which is very essential for leafy vegetables. While in the conventional supply chain, Chinese kale was transported at cooler temperature during the night. Outer leaves were left attached to the stem to protect inner leaves from heat and wind. However, Chinese kale is sensitive to heat and wind due to its wide and thin leaves. The wilting still occurs at high percentage. Low temperature also delays physiological change (Jingtair, 2001). Weight loss in this case did not occur after the produce was exposed to low temperature at the collecting center. Loss cause by fracture and bruise during transport was higher in the cold supply chain because the produce was trimmed. Chinese kale in the conventional supply chain had strong offshoots to absorb impact the fracture and bruise occur less. Another advantage of the conventional supply chain is that weight loss caused by insects was not found.

Conclusion

The first major loss was fracture and bruise which occurred during strange at the collecting center and during transportation. The second major loss was wilting cause by heat and wind which occurred during transportation in the conventional supply chain. In comparison with the conventional supply chain, the cold supply chain could reduce total weight loss by approximately 45 percent. Proper produce handling could reduce the loss cause by fracture and bruise and low temperature could prevent wilting which was the major loss during transportation. Weight loss cause by fracture and bruise could be reduced by 15 and 26 percent, respectively. Low temperature had some minor effects on deceases and insects. However, produce management in the cold supply chain such as sorting and trimming, could reduce the spreading of deceases and insects in downstream processes.

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