A Survey of Mango Seed Waste Management in the Thai Food Industry

Pitchaon Maisuthisakul and Sirikarn Phasuk

http://eprints.utcc.ac.th/id/eprint/642
Survey of Mango Seed Waste Management in the Thai Food Industry

การสำรวจการจัดการของเสียจากเนื้อในผลิตภัณฑ์ของอุตสาหกรรมอาหารของไทย

บทคัดย่อ

มะวง (Mangifera indica Linn.) เป็นผลไม้เมืองร้อนของไทยที่มีการนำมาแปรรูปเป็นจำนวนมากโดยพบว่า เนื้อม่วงคัตเตอร์เป็นร้อยละ 60 ของน้ำมากผลทั้งหมด ส่วนที่เหลือเป็นของเสียในรูปเปลือกผลและเมล็ด การศึกษาข้อมูลมีวัตถุประสงค์เพื่อศึกษาความเป็นไปได้ในการนำผลมะวงจากทางโรงงานมาใช้ประโยชน์ โดยสำรวจพฤติกรรมของผู้ประกอบการธุรกิจอาหารของไทยเกี่ยวกับการจัดการของเสียของผลมะวง โดยใช้แบบสอบถามเก็บข้อมูลทั่วไปและการจัดการของเสียของผลมะวงระหว่างผู้ผลิตแบบสุ่ม พบว่า โรงงานที่คัดเลือกจำนวน 103 โรงงาน ซึ่งมีจำนวนที่ได้ระบายว่าโรงงานแปรรูปมะวงของประเทศไทยเป็นโรงงานขนาดกลางถึงขนาดเล็กที่มีคนงานจำนวน 51-100 คนอยู่ร้อยละ 42.1 โดยมะวงที่นิยมนำมาแปรรูปเป็นมะวงพันธุ์เก้าและโรคนั้นคือ ร้อยละ 29.5 และ 27.9 ตามลำดับ ทั้งนี้มีผลเสียที่เป็นมลพิษม่วงอยู่ประมาณ 1,063 กิโลกรัมต่อสิบตัน ซึ่งจากจำนวนโรงงานทั้งหมดที่ตอบแบบสอบถามระบาย มีการแยกกลุ่มมะวงที่ตาม สามเหลี่ยมที่สูงร้อยละ 73.7 และมีจำนวนงานที่มีความประสงค์จะขายของเสียเมล็ดมะวงเหล่านี้ในราคามา 100-500 บาทต่อตันร้อยละ 47.4 จากผลการศึกษาที่นี้ให้เห็นว่ามีความเป็นไปได้สูงในการนำผลมะวงนี้มาใช้ประโยชน์ เนื่องจากมีปริมาณมาก และราคาถูก

คำสำคัญ: มะวง เมล็ด ของเสีย การจัดการ
Abstract

The mango (*Mangifera indica* Linn.) is one of the most important tropical fruits in Thailand. Approximately 60% are processed for edible mango products. During processing of the mango, by products such as peel and kernel are generated. As seed kernel is not currently utilized for any commercial purposes, it is discarded as waste. The aim of this survey study was to examine the behavior of Thai food manufacturers regarding mango seed (MS) waste management for feasibility of MS utilization. Questionnaires were used with 103 randomly selected factories. Detailed investigations on the general information and management of mango waste in the experimental factories revealed that 42.1% of mango processing factories in Thailand are small and medium enterprises which have 51-100 employees. The most common varieties of mango used in the industry are Kaew and Choke Anan varieties, which accounted for 29.5% and 27.9%, respectively. The mean rate of MS waste generation was 1,063 kgs. per week. About 73.7% of the mango waste generated (measured by weight) is well managed to separate the waste by variety. About 47.4% of manufacturers proposed that the cost of mango seed kernel (MSK) waste separated according to variety was 100-500 baht per ton. Based on this investigation, mango seed may be a cost-effective and high volume source to utilize as a raw material.

Keywords: Mango, Seed, Waste, Management

Introduction

Thailand is a major producer of mangoes. After consumption or industrial processing of the fruit, considerable amounts of mango seeds are discarded as waste. The mango flesh is only 60% of the total weight of the fruit. The seed represents between 10% and 25% of the whole fruit weight of different mango varieties (Pitchaon Maisuthisakul, Sirikarn Pasuk and Pitiporn Ritthiruangdej, 2007). The kernel inside the seed represents between 45% and 75% of the seed and about 20% of the whole fruit (Arogba, 1997). However, more than ten million tons of mango seeds are being produced annually as waste. Although the waste is mainly composed of biodegradable constituents, their disposal causes serious environmental problems, including water pollution, unpleasant odours, explosions and combustion, asphyxiation and greenhouse gas emissions. Many investigations on their use of wastes have been aimed at converting
the waste materials into food ingredients, bio-fuels, and other value-added applications (Makris, Boskou and Andrikopoulos, 2007). In Europe, agricultural wastes, such as grape seed and olive waste extracts have been applied successfully for industrial production of natural antioxidants from a large quantity of plant residues (Peschel, et al., 2006).

Gallotannins and condensed tannin-related polyphenols detected by thin-layer chromatography were reported to be present in mango seed kernel (MSK) (Arogba, 1997). In addition, tannins from dry MSK meal were reported to contain tannic acid, gallic acid, and epicatechin in the ratio 17: 10: 1, respectively (Arogba, 2000). Abdalla, et al. (2006) has recently characterized the phenolic compounds in Egyptian mango seed kernels. They are tannins, gallic acid, coumarin, caffeic acid, vanillin, mangiferin, ferulic acid, cinammic acid and unknown compounds. These data show that MSK contains various phenolic compounds so that it can be a good source of natural antioxidants (Abdalla, et al., 2006; Puravankara, Bohgra, and Sharma, 2000).

The present study was undertaken to assess the current situation in mango processing factories in Thailand. The study was limited in its scope as constrained by availability of funds; hence, only a sample survey was attempted. Current practice of MSK waste management in 103 selected factories in Thailand was studied.

Materials and Methods

A list of fruit processing factories obtained from the National Food Institute (NFI) was prepared. Factories involved in processing different fruits were randomly selected from the list. After that, the factories were screened by a pre-questionnaire about the types of fruit that they processed. We selected factories using mangoes as a raw material. Some employees refused to answer the questionnaire. At the screening step, we selected 103 factories from the 1,018 factories on the list.

Data were collected by means of a structured questionnaire administered by telephone interviews in September 2007 to February 2008. This method was used because some of the employees did not have formal education and many of those who had some education might not be familiar with the terminology used in the questionnaire. The questionnaire contained three parts: (1) general information (2) fruit processing and waste management details, including fruit type used, varieties of fruits, type of waste generated, volume of waste per week, methods of waste collection, reuse, recycling and on-site waste processing and common
manufacturing practices for disposal of fruit waste after use and (3) possible cost of MSK waste. In particular, manufacturers were presented with a number of multiple choice tests and were asked to choose the answer which they thought best described their attitude in each particular case. The questions and the possible alternative answers were read to interviewees by the interviewers who ticked the given answer(s). The interviews were conducted in a friendly way and there was very good cooperation without any refusals.

The raw data from the questionnaires were coded and entered into specially designed databases. Once the data had been initially entered, they were carefully checked for entry errors. Relative frequencies of answers were calculated for each question. Data were transferred to appropriate spreadsheets (Microsoft Excel) and SPSS (version 10) for statistical analysis. Relative frequencies were compared using the chi-square test to determine significant differences in the proportions of given answers. Mean differences were declared significant at a 95% confidence level. The observations were summarized in the form of tables and graphs.

Results and Discussion

1. General Information

Food factories were classified according to general information regarding numbers of employees and types of processed fruits presented in Table 1. The data showed that they included responses in relation to products of factories and numbers of employees. The data showed that most of the mango processing factories in Thailand were small and medium enterprises which had 51-100 employees (42.1%). We found that factories with 21-50 employees were equal in number to those with more than 100 employees (21.1%). Moreover, the factories processed many types of fruits (Table 1). The proportion using of mangoes and the other fruits was approximate 40: 60. The others (100%) were rambutan; Nephelium lappaceum L. (35%), longan; Dimocarpus longan Lour. (25%), tamarind; Tamarindus indica L. (20%), Santol; Sandoricum koetjape (Burm.f.) Merr. and Lychee; Litchi chinensis Sonn. including Madan; Garcinia schomburgkiana Pierre. (10%), pineapple; Ananas comosus Merr. and star gooseberry; Phyllanthus acidus Skeels. including grape; Vitis Vinifera L. (5%) and chinese date; Ziziyphus mauritiana Lam. (5%).
A Survey of Mango Seed Waste Management in the Thai Food Industry

2. Physical Composition of MSK Wastes

The composition of the varieties of mango waste in the surveyed factories is given in Figure 1. It is clear that Kaew and Choke Anan variety make up a high proportion at 29.51% and 27.87%, respectively, followed by Num Dok Mai, Rad, Hua Chang, Fa Lun, Aok Rong and Pim Sen.

3. Generation of MSK Waste

The mean rate of generation of MSK waste can be expressed as kg per week. The rate must be known in order to decide on a feasible way to develop a new product from MSK waste. The mean generation rate of MSK waste was 1,063 kgs. per week. Some factory owners were unaware of the quantity and characteristics of the waste generated by their factories.

Table 1 General information from the random population survey fruit processing factories (n=20)

<table>
<thead>
<tr>
<th>General Information</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers of Employees</td>
<td></td>
</tr>
<tr>
<td>10-20 employees</td>
<td>15.8</td>
</tr>
<tr>
<td>21-50 employees</td>
<td>21.1</td>
</tr>
<tr>
<td>51-100 employees</td>
<td>42.1</td>
</tr>
<tr>
<td>More than 100 employees</td>
<td>21.1</td>
</tr>
<tr>
<td>Types of Fruits</td>
<td></td>
</tr>
<tr>
<td>1 type</td>
<td>5.3</td>
</tr>
<tr>
<td>2 types</td>
<td>36.8</td>
</tr>
<tr>
<td>3 types</td>
<td>31.6</td>
</tr>
<tr>
<td>More than 3 fruits</td>
<td>26.3</td>
</tr>
</tbody>
</table>
4. MSK Waste Management

Results of the questionnaire survey showed that factories who stated that they always separated wastes by types of fruits accounted for 68.4%, while the percentage of factories who stated they never separated fruit waste was 31.64%. Many fruit factories who did not separate wastes were able to separate each type of fruit waste if they were contacted by suppliers and this could increase the fruit factories who separated fruit waste to 83.3%.

About 73.7% of the mango waste generated (measured by weight) was well managed to separate the waste from other fruits, while the other 26.3% had various management problems. In the first case, 47.4% were managed to separate by part of the mango such as peel and seed; 84.2% of these companies were able to separate the fruit waste by part, and deliver them for sale.

There is a relatively large number of factories that are interested in selling MSK waste. About 84.2% of factories proposed a price for MSK waste (non-separated by a variety of mangoes) of 100-500 baht per ton and the other 15.8% proposed a price of 501-1000 baht per ton. MSK waste separated into each mango variety would cost about 100-500 baht per ton (47.4%) and 501-1000 baht per ton (42.1%) and 1001-1500 baht per ton (10.5%). It can, therefore, be concluded that it is feasible to use MSK waste from industrial production as raw material because it is available and low cost.

![Figure. 1 Mango varieties of MSR waste from surveyed factories](image-url)
The data in Figure 2 shows that small factories do not normally separate mango seeds from the other mango waste. Separated mango seed management is found mainly in medium factories (21-100 employees) who also separate mango waste according to variety (Figure 3). Thus, medium size industries manage MSK waste better than larger ones.

Figure 2 Percentage of factories with various numbers of employees found to separate mango seeds from other mango waste

Figure 3 Percentage of factories with various numbers of employee found to separate mango seed waste according to a variety of mangos
Conclusions

The use of questionnaires to obtain data regarding the production, characterization and management of mango seed waste should be accompanied by other studies concerning the quality of mango seeds (such as bioactivity, chemical composition) in the area of production. However, this study allows us to obtain the approximate knowledge of waste management practices in the area. The data collected has provided the basis of an on-site mango seed waste management plan that will soon be implemented. Moreover, the producers are interested in selling mango seeds. This means that in the future the application of mango seeds as raw material for new products may develop with a purpose of profiting from economies of scale.

Acknowledgements

This research would not have been possible without the University of the Thai Chamber of Commerce Fund. We also would like to acknowledge the company factories for all information obtained. Last but not least, we gratefully acknowledge Prof. Michael H. Gordon for his valuable suggestions.

References


Asst. Prof. Dr. Pitchaon Maisuthisakul received her Doctor of Philosophy in Agro-Industry Product Development from Kasetsart University. She is currently working at the University of the Thai Chamber of Commerce, Bangkok. Her main interest is in food antioxidant, consumer concept development and sensory analysis.

Asst. Prof. Dr. Sirikarn Phasuk received her Doctor of Philosophy in Science Education from Srinakharinwirot University. She is currently working at Valaya Alongkorn Rajabhat University Under the Royal Patronage. Her Main interest is in bioactivity of herbs.