Proceedings of the Second Asia-Pacific Conference on Global Business, Economics, Finance and Social Sciences (AP15Vietnam Conference) ISBN: 978-1-63415-833-6
Danang-Vietnam, 10-12 July, 2015 Paper ID: V512

Food Safety Management Diagnosis and Product Quality Assessment of Small-Scale Muscovado Processing Companies

Karen Luz Y. Teves,
Central Philippines State University, Philippines.
kartevs@yahoo.ca

Aldwin M. Teves,
Central Philippines State University, Philippines.

Abstract

Food Safety Management System (FSMS) of three selected small-scale muscovado were diagnosed using FSMS diagnostic tool and results revealed that company operating in core control and assurance activities based mostly on ad hoc had high context risks and poor food safety performance whereas muscovado company with at least GMP had moderate level FSMS activities with moderate risk in its context factors and eventually resulted to moderate performance. With HACCP, small-scale company was obliged to upgrade its plant including its core control and assurance activities, and had moderate risk in its context factors, thus obtained good food safety performance. The ad hoc system of low performing company positively affects the product quality and if at least GMP is fully implemented in its system and work out gradually towards HACCP implementation, greater chance that product may conform to ICUMSA standards.

Key word: *Food Safety Management System, muscovado, HACCP, small-scale.*

1. Introduction

Muscovado is a non-centrifugal brown sugar commonly called *gur, jaggery, khandsari* in South Asia, *panela, dulce* in Latin America, *desi* in Pakistan, *khandasari* in India, *chancaca* in Colombia, *demirara*, and *turbinado* in the Carribean and Central America, and black sugar in Japan and Taiwan (ITDI-DOST, 2007). Due to its natural goodness, sticky texture and distinct aroma, developed countries are willing to pay high prices for muscovado if quality requirements such as sucrose content, color, moisture, pH, brix, sediment contents and other physico-chemical and microbial properties are met (PDAP, 2005).

Of the 258 muscovado mills surveyed by Philippine Development Assistance Program (PDAP), very few used upgraded technology, 11 mills are still using extractors drawn by carabaos and 247 mills are motor-driven (ITDI-DOST, 2007). This traditional method of muscovado processing is one of the hindrances why the product cannot compete in the global market. The use of outdated equipment and lack of hygiene and sanitation during processing hampers the food safety and quality of muscovado (PDAP, 2005). Contamination, presence of sediments and high microbial count in the product are prime reasons for Philippine made muscovado's failure to pass the foreign standards (Latiza, 2004).

Recently, only two muscovado mills passed the strict global market requirements in the Philippines. Upgrading of mills is very expensive, thus, small scale producers hold on to traditional production (PDAP, 2005). To address these issues the implementation of a system based on technical and scientific principles, such as HACCP, is crucial. HACCP implementation is still voluntary for small scale food companies in the Philippines and certification difficulties in these companies are due to a number of internal and external factors such as lack of management commitment, hygienic practices, awareness and expertise, proper mindset and behavioral outlook, limited financial and lack of governmental infrastructure and support (FAO, 2014).

The objective of this study is to analyze the food safety issues, gaps and HACCP implementation problems in small-scale muscovado processing companies in the Philippines, diagnose the food the food safety management systems of selected small-scale muscovado companies and evaluate and compare the product quality to ICUMSA standards.

2. Present Scenario of Small-scale Muscovado Processing

Though muscovado production offers clear opportunities of poverty reduction and enhancing rural enterprises, the use of antiquated equipment and machine hampers the efficiency in juice extraction and product quality is sacrificed (PDAP, 2005). Majority of muscovado mills still used traditional way of juice extraction, such as carabao-drawn extractors and motor-driven mills (ITDI-DOST, 2007). The high insoluble solid content in

muscovado is due to incidental extraneous matter extracted by the crushing and washing operations of the extractor (Honig, 1968).

Table 1: Major problems of small-scale muscovado companies

	Problem
1.	Low product quality – high insolubles/sediments
2.	Poor raw material- sugarcane was harvested several days prior to delivery to the company and have undergone sugar inversion
3.	Factory workers lack knowledge of hygiene, sanitation and HACCP
4.	Lack of analytical laboratory and apparatus in the company to monitor product quality
5.	High contamination in the juice due to traditional juice extractor used
6.	Antiquated and unhygienic equipment used
7.	Hygienic practices among employees is not strictly implemented
8.	Lack of hygiene and sanitation in the plant
9.	Documentation and record-keeping is based on ad hoc and no electronic back up
10.	GMP (Good Manufacturing Practices) not fully implemented

Impurities present in muscovado significantly lowers the quality of the product, hence affecting its marketability (Latiza, 2004). Moreover, a number of small-scale companies cannot implement HACCP because of financial incapability, lack of management commitment, hygienic practices, technical expertise and other factors. These constraints added to low product quality are the reasons why small-scale muscovado sugar is not marketable in the international market. The major problems of small-scale muscovado companies are outlined in Table 1 while Table 2 presents the HACCP implementation problems of these companies.

Table 2: HACCP implementation problems of small-scale muscovado companies

	HACCP implementation Problem
1.	Lack of good hygienic practices as prerequisite program due to inadequate plant layout and non-cleanable equipment and structures
2.	Lack of proper HACCP training and expertise
3.	Financial constraints- assistance provided by governments and trade associations is not adequate
4.	Human resource problem- management lacks commitment to invest in staff training due to cost
5.	Legality of requirements- companies are not persuaded to implement HACCP because it is not a legal requirement

2.1. Food Safety Management System Diagnosis of Selected Small-scale Muscovado Processing Companies

Three small-scale muscovado companies in the Negros province, Philippines was being studied and the selection of these companies in the study was based on the type of food safety management they have adopted. Company A is still working towards full implementation of GMP and majority of processing procedures are based on ad hoc, company B is a GMP compliant while Company C is a HACCP certified company exporting to Korea and Japan. The comparison of food safety system diagnosis of these companies will give an insight as to the importance of putting food safety system in place.

Table 3: Characteristics of small-scale muscovado companies

Company	Food Safety Quality Implemented	&Number ofFactory MgtEmployees	size	Production capacity	Market
A	None	6	500 m^2	15 tons/ mo or 500 kg/day	Local
B	GMP	20	800 m^2	40 tons or 467 kg/day	Local/Korea
C	HACCP	40	12000 m^2	90 tons/mo or 3000 kg/day	Local/Korea /Japan

2.2. The Food Safety Management System Diagnostic Instrument

To contribute to the improvement of small scale muscovado processing companies, the FSMI-DI developed by Jacxsens, et al. Luning et al. (2008, 2011, 2009) and Jacxsens et al. (2011) was used. Quality Assurance (QA) and production managers were interviewed using the structured questionnaire and required to choose the level in each indicator which most represents their companies' situation. The instrument has four parts; contextual factors, core control, assurance activities and performance to a total of 51 indicators. To obtain an overall indication, overall scores were assigned. For this purpose, mean scores for the whole set of indicators representing respectively context and FSMS activities were first calculated. Mean scores were transformed to assigned scores as previously described by Luning, et al (2011), which represent the range wherein the mean scores fall and interpretation per category was included to discuss results (Table 4).

Table 4: Conversion of mean scores into assigned scores with interpretation per FSMS category

Mean score	Assigned score	Interpretation of Assigned Score per FSMS category			
		Context	Control Activities	Assurance	System output
0-0.2	0	Low risk	Not performed	Not performed	Poor performance
0.3-1.2	1	Low risk	Basic level	Basic level	Poor performance
1.3-1.7	1-2	Low-moderate	Basic- average	Basic- average	Poor to moderate
1.8-2.2	2	Moderate risk	Average level	Average level	Moderate performance
2.3-2.7	2-3	Moderate -high	Average-advanced	Average- advanced	Moderate- Good
2.8-3.0	3	High risk	Advanced level	Advanced level	Good performance

2.3. Context Factors

Context factors such as the product and process, organization and chain environment characteristics relates to the riskiness in context and can influence the food safety output of an FSMS (Luning et al., 2011). Based on the FSMS results found in Figure 1, Company C which is HACCP certified had moderate to low risk in product and process, organization and chain environment context factors with mean scores of 1.5, 1.7 and 1.3, respectively (Fig. 1). With HACCP, this company operated with moderate to low risk because it has the baseline to manufacture muscovado efficiently compared to company B having only GMP, which had moderate to high risk having mean scores of 2.0, 2.2 and 1.5, respectively. Among the

companies, A which is operating based on ad hoc or traditional way obtained the highest mean scores in all context factors (2.3, 2.9 and 2.6) implying that the company had high risks in terms raw material, product, process, organizational and chain environment due to absence of a food safety system. Compared to A and B, C which is HACCP certified, followed food safety system procedure such as raw material specification for sugarcane planters/suppliers, good packaging material to prevent product risk, juice heating monitoring like installation of built in thermometers to inactivate microorganisms to acceptable level and trained personnel in the QA Department who is HACCP expert, resulted to moderate risk in the three context factors. In addition with HACCP, company C are obliged to impose food safety competence requirement upon hiring of employees/laborers, have clear food safety vision to everyone and production documents such as procedures, meetings minutes be accessible to all employees, accurate and accessible bookkeeping of all activities with software backup, maintain good relationship with suppliers/sugarcane planters and customers and train well its personnel on food hygiene, sanitation and HACCP The implementation of HACCP in company C is a great factor in lowering all contextual risks compared to having only GMP as with the case of Company B.

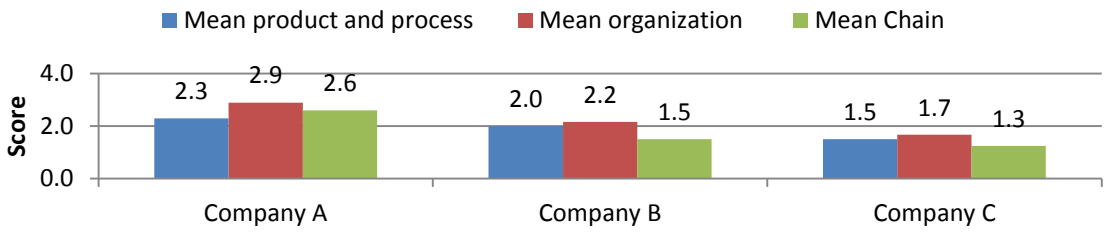

Figure 1. Results of diagnosis of contextual factors in an FSMS of three muscovado…

2.4. Core Control Activities

In four core control activities, as expected, company A operated at basic level with mean scores of 1.0 in each category, except for operation core safety control system with score of 1.1 while companies B and C operated from basic to average level with mean scores of 2.2, 1.5, 1.6, 1.4 and 2.3, 2.3, 2.3 and 2.0, respectively (Fig. 2). This result implies that traditional procedure and lack of analytical monitoring of raw material and product indicates that the company should at least fully implement GMP if the company wants to level up. The plant's core control activities are considered at the basic level but nevertheless the identification of core control activities-related problems is the start of improving the system. Companies B and C, with GMP and HACCP, the equipment used such as the cane crusher, cooking vats are hygienic and have efficient design so as not to cause contamination in the product as well as in raw material. With HACCP, a company is obliged to use the appropriate cleaning agents, install washing facilities, good packaging technology, and good intervention

and monitoring systems and not based on ad hoc only, thus will improve the company's core control level. With at least GMP, company B obtained an average level in core control activities. In contrast, the company A with all its ad hoc procedure and limited number of personnel, hazard identification and risk evaluation are done on internal discussions and there is no methodology used. In addition, laboratory in the plant is not yet functional and samples sent to sugar milling for analysis, and most of the time results of analysis are delayed. Other problems include; production procedures are available on location and paper-based, not up-to-date, untrained laborers/operators, lack of automatic temperature devices, still the old cooking thermometers are used, if there is a record of temperature it is kept in a logbook and measuring devices are quite old and analytical equipment such as analytical balances are quite obsolete and really needs replacement.

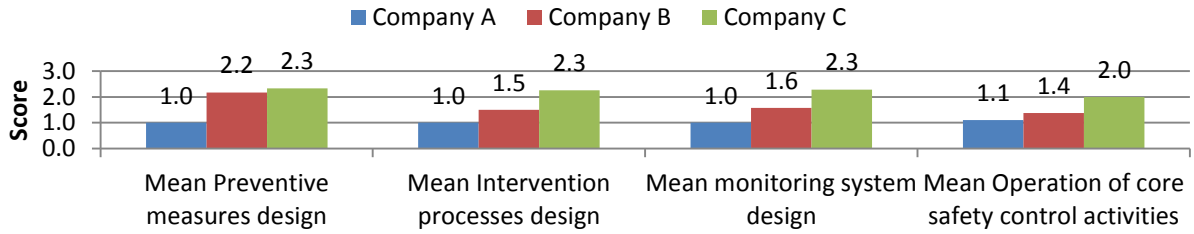

Figure 2. Results of diagnosis of control activities in an FSMS of three muscovado companies

2.5. Core Assurance Activities

As shown in Figure 3, company C with HACCP system obtained the highest core assurance mean score of 2.3, followed by B and A with mean scores of 2.1 and 1, respectively. This implies that with HACCP, assurance activities of a company such as record-keeping and documentation, validation of intervention system, verification of procedures and compliance by checking the procedures and records are improved and eventually resulted to a good system output. Company B with only GMP in its system operates on average level in its core control assurance activities and is preferably better than company A operating mostly in all its assurance activities on ad hoc or by personnel's available knowledge and experiences. Company A should endeavor to at least fully implement GMP in its system to assure production of safe and quality product.

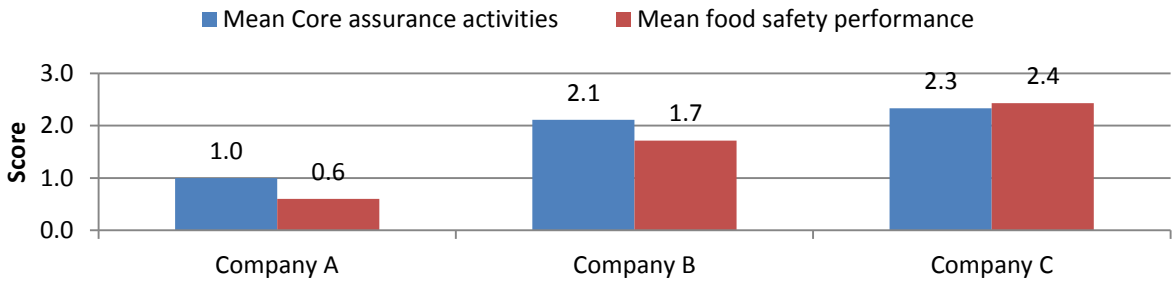

Figure 3. Results of diagnosis of assurance activities and system output in an FSMS of three muscovado companies

2.6 System Output

In Figure 3, the context factors and FSMS activities significantly affects the FS output of the companies, as with company A on ad hoc system, resulted to poor safety output with mean score of 0.6 while with company B and C having GMP and HACCP, companies were diagnosed having moderate to good performance with mean scores of 1.7 and 2.4, respectively. FSMS activity levels and context riskiness in relation to the food safety output provided an insight on FSMS activities which have an impact on the food safety output or FSMS performance (Table 5). In company A, which is still working towards full GMP implementation, in its third year of operation have no identified strong points even in context, core control and assurance activities, leading to poor safety output. There is much to do to improve the food safety management system of company A and it is necessary to have at least GMP in place to improve the organizational management, food safety as well as quality of the product. With GMP, the company is obliged to conform to codes of practice, industry standards, regulations and laws concerning production, processing, handling, labelling and sale of foods decreed by industry, thus protecting the public from illness, product adulteration and fraud.

Table 5: FSMS Diagnosis Mean Scores and Interpretation of Small-scale Muscovado Companies

Company	Type	Context	Control Activities	Assurance	System output
A	None	2.6 (High Risk)	1.0 (Basic level)	1.0 (Basic level)	0.6 (Poor performance)
B	GMP	1.9 (Moderate Risk)	1.7 (Basic to average level)	2.1 (Average level)	1.7 (Poor to moderate performance)
C	HACCP	1.5 (Moderate to Low Risk)	2.2 (Average level)	2.3 Average to advanced level)	2.4 (Moderate to good performance)

2.7. Muscovado Quality Assessment

To assess product quality, CPSU-MPP muscovado quality attributes are being compared to product standards set by ICUMSA (Table 6). Also found in the table are the prescribed ICUMSA methods of analysis for each parameter. Muscovado producers should see to it that their product conforms to ICUMSA standards and should have high pol, lower MC, SF, RS,

ash, insoluble solids content, total plate count, yeasts and molds . Sugarcane being harvested manually and processed in large quantity cannot be cleaned well before crushing and juice extraction. The harvested sugarcane when not crushed within 24hr will undergo sugar inversion due to presence of *Bacillus subtilis* and *Leuconostoc mesenteroides* and sugar will not solidify anymore resulting to low sugar polarization of 91.63% much lower than the standard of 94-99%. Although pol is not a direct measure of sucrose content, pol readings obtained in the sugar industry gives an estimate of sucrose content. This critical stage of immediate cane crushing after harvesting also has direct effect towards increase in total plate count, molds and yeast of the product which exceeds the standard of 10,000 and 62 cfu/g, respectively. All parameters like muscovado moisture, color, sulphated ash, SF and insolubles-which pose chemical hazard to product consumers, went beyond the standards and this result is partly attributed to the food safety management of the plant. The basic level of core control activities and monitoring system design of CPSU-MPP positively affects the muscovado quality and if at least GMP is fully implemented and work out towards HACCP, greater chance that product may conform to standards.

Table 6: Mean values of physico-chemical and microbiological properties of CPSU-MPP muscovado

Parameter	CPSU-MPP Muscovado Specifications	ICUMSA Requirements/ limits	Method of Test
Polarization, %	91.63	94-99	ICUMSA Method GS 1/2/3/9-1
Invert sugar, %	2.11	1.2	ICUMSA Method GS 1-5 ICUMSA Method GS 1/3/7-3
Moisture content, %	3.58	1.0	ICUMSA Method GS 2/1/3/9-15
Color, I.U.	2371 - 9850	>1300-6000	ICUMSA Method GS 1/3-7 ICUMSA Method GS 9/1/2/3-8
Sulphated ash, % m/m, max	1.33	0.8	ICUMSA Method GS 1-10
Safety Factor=mc/100-pol	0.43	0.3 min	
Insolubles, %	1.12	0.5	ICUMSA Method GS 2/3/9-25
Total plate count, cfu/g	10,857	10^4	ISO 4833
Yeasts & molds, cfu/g, max	62	50	ISO 21527-2

3. Conclusions and Recommendation

Identification of food safety issues, gaps and problems of a poor performing small-scale muscovado company leads to a conclusion that if financially incapable of implementing HACCP, the company should at least follow GMP towards safety and quality processing of muscovado even if product is only intended for local market. FSMS diagnosis showed great difference between a HACCP certified and ad hoc system small-scale companies in terms of the context factors, core assurance and control activities that also resulted to different levels of safety output. The poor performing muscocado company operating on the basic level with high risk context factors likewise resulted to product quality that were below the ICUMSA standards. Hence, it can be concluded that HACCP implementation in a small-scale muscovado company positively influenced the company's food safety output and

performance. With GMP in place, a company can lower its risk in all context factors, level up its core control and assurance activities and improve its safety output performance, but not as much as having HACCP in the company. Based on problem analysis of the poor performing company, there is a need of full implementation of GMP in the company to produce safe, quality and commercially competitive muscovado. It is then recommended that GMP be implemented on muscovado companies with an ad hoc system to improve the organizational management, food safety as well as quality of the product.

References

Chen, J. 1985. Cane Sugar Handbook, John Wiley & Sons, Inc.

Chen, J. And Chou, C. 1993. Cane Sugar Handbook: A manual for cane sugar manufacturers and their chemists. John Wiley & Sons, Inc.

Chou, Chung Chi. 2000. Handbook of Sugar Refining. A Manual for the design and operation of sugar refining facilities. John Wiley and Sons. pp 39-40

Dumlao, T. 2008. Why Muscovado is a Must These Days. Philippine Daily Inquirer. Posted_5/25/2008

FDA. 1988a. Sulfiting agents in standardized foods: Labeling requirements. Food and Drug Admin., Fed Reg. 53: 51062-51084.

http://www.cncahealth.com/explore/learn/nutrition-food/- the-dangers-of-sugar-is-it-really-that-bad

Industrial Technology Development Institute (ITDI-DOST). 2007. Guide Book on Improved Operating Practices in the Manufacture of Muscovado Sugar. Integrated Program on Cleaner Production Technologies-PCIERD-DOST.

Inocentes, A., King, A., and R. Torres. 1978. The Living and Working Conditions of Sugar Plantation Workers: The Sugar Workers two Studies. Institute of Labor and Manpower Studies, Manila.

International Commission for Uniform Methods of Sugar Analysis (ICUMSA) Gs1/3/7. 2002.

Jacxsens, L., Kussaga, J., Luning, P. A., Van de Spiegel, M., Devlighere, F., & Uyttendaele, M. (2009). A microbial assessment scheme to support microbial performance measurements of food safety management systems. International Journal of Food Microbiology, 134,113-125.

Jacxsens, L., Luning, P. A., Marcelis, W. J., van Boekel, T., Rovira, J., Oses, S., et al. (2011). Tools for the performance assessment and improvement of food safety management systems. Trends in Food Science and Technology, 22(1), S80-S89.

Jacxsens, L., Uyttendaele, M., Devlighere, F., Rovira, J., Oses-Gomez, S., & Luning, P. A. (2010). Food safety performance indicators to benchmark food safety output of food safety management system. International Journal of Food Microbiology, 141, 180e187.

Latiza, A. 2004. A Primer on Muscovado Production and Technology. Sugar Regulatory Administration, Quezon City.

Luning, P. A., & Marcelis, W. J. (2007). A food quality management functions model from a techno-managerial perspective. Trends in Food Science and Technology, 18, 159-166

Luning, P. A., Bango, L., Kussaga, J., Rovira, J., & Marcelis,W. J. (2008). Comprehensive analysis and differentiated assessment of food safety control systems: a diagnostic instrument. Trends in Food Science and Technology, 19, 522-534.

Luning, P. A., Marcelis, W. J., Rovira, J., Van der Spiegel, M., Uyttendaele, M., & Jacxsens, L. (2009). Systematic assessment of core assurance activities in company specific food safety management. Trends in Food Science & Technology, 20, 300-312.

Lustig, R. 2010. JAMA. Apr 21;303(15):1490-7. Accessed on Dec 8, 2014 at:

Papazian, R. 1996. Sulfites: Safe for most, dangerous for some. FDA Consumer Magazine. 30(10).

Phil. Development Assistance Program (PDAP). 2005. Prospects of the Muscovado Sugar Industry in the Philippines. Manila, Philippines.

Phil. Development Assistance Program (PDAP). 2005. Prospects of the Muscovado Sugar Industry in the Philippines. Manila, Philippines.

Philippine Association of Sugar Technologists, Inc. (PHILSUTECH). 1997. Methods Book. Official Chemical Handbook for Philippine Sugar Industries.

Philippine Council for Agriculture, Forestry and Nat. Resources Research and Development (PCARRD) .2006. Industry cluster Analysis and Sectoral Plan Workshop for Muscovado