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Student Knowledge, Understanding, Behavior, and Satisfaction Related to Good Manufacturing Practice in Herbal Medicines and Health Products at College of Allied Health Sciences, Suan Sunandha Rajabhat University

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ABSTRACT

Good Manufacturing Practice (GMP) is an essential component in manufacturing, consisting of basic requirements that manufacturers are required to perform and for which they must control. Successful GMP standards assessment requires the appropriate management and implementation of the requirements. This study aimed to 1) examine Suan Sunandha Rajabhat University College of Allied Health Sciences students' knowledge and understanding of GMP standard, 2) comprehend Suan Sunandha Rajabhat University College of Allied Health Sciences students' behaviors relative to GMP standards, 3) measure Suan Sunandha Rajabhat University College of Allied Health Sciences students' levels of satisfaction with GMP standards, and 4) analyze the ability to explain variations in the students' knowledge/understanding and behaviors towards their satisfaction with GMP standards. This research employed a quantitative approach, using a descriptive analysis to explore the necessary knowledge and understanding and determine averages and percentages and to determine regression coefficients using a multiple regression analysis. The level of statistical significance is typically expressed as a *p*-value ≤ 0.05. The samples used in the research were 73 students associated with the herbal medicine and health product factory at the College of Allied Health Sciences, Suan Sunandha Rajabhat University. The tool in this research was a survey. The results showed that students' levels of knowledge and understanding about GMP standards fell in the middle range, as did their behaviors associated with GMP standards. Moreover, the levels of satisfaction with the GMP standards of the students were at the high level. Thus, knowledge/understanding and behavior cannot explain the students' satisfaction with GMP standards. Findings in this research provide new knowledge for management, which can serve as a helpful guideline for students in the university, new operators and entrepreneurs in the private sector, and those planning to undergo GMP assessment.

Keywords: Knowledge, understanding, behavior, satisfaction, students, GMP

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INTRODUCTION

Good manufacturing practice (GMP) refers to manufacturing practices that follow basic standards (Yong *et al*., 2020). To receive GMP certification, manufacturers must meet the GMP standards assessment criteria by implementing GMP standards according to the requirements and the Food and Drug Administration Agreement (Ratanamaneichat & Rakkarn, 2013; Slipchenko, 2019). Manufacturers or producers that meet the GMP standards must employ good product process management to receive consumers' trust (Panriansaen, 2011).

GMP is a crucial component in factory operations that specifies basic manufacturing requirements to control operations for producing quality products (The Office of Industrial Economics, 2018). GMP standards emphasize prevention and elimination of any risks that may affect consumers. GMP is a type of quality assurance system that consists of procedures approved by food experts. The more closely the GMP is followed, the safer and better quality of the items produced (Bavornniraman, 2011).

The College of Allied Health Sciences, Suan Sunandha Rajabhat University is one of the educational institutions that has operated an herbal medicine and health product manufacturing factory to provide enhanced learning and teaching opportunities for students and instructors. This factory is able to produce products for sale, from which it can earn profits. However, the factory has not yet received GMP certification, so the quality of the manufactured products cannot yet be guaranteed. Therefore, the herbal medicines and health product manufacturer at the College of Allied Health Sciences, Suan Sunandha Rajabhat University can only be used as a learning unit and not for mass production.

This research examines the knowledge/understanding, behavior, and satisfaction of Suan Sunandha Rajabhat University College of Allied Health Sciences students related to the GMP standards for the purpose of using the results as a guideline for a GMP assessment to upgrade the factory and eventually extend market opportunities for the factory.

LITERATURE REVIEW

GMP is an essential component of manufacturing that refers to the basic standards required in production and control with which manufacturers should comply to ensure the safety of their products (Capunzo *et al*., 2005; Chen & Cheng, 2007). The GMP standard focuses on the prevention and elimination of risks that lead to dangerous poisoning or cause consumers to lack trust in the products

(Gonzalez-Benito & Lannelongue, 2014). The GMP standards address location, building construction, excellent and safe production systems, and qualified production processes, starting with production planning, raw material control systems, production processes, storage, quality control, and logistics (Shboul *et al*., 2018). In this study, knowledge and understanding relates to the comprehension of information, knowledge, and facts learned from lessons and personal experiences and transformed for use in the workplace and in daily life (Ounprasertsuk *et al*., 2020; Suksatan & Tankumpuan, 2021). Behavior relates to expressions or reactions to a stimulus or situation. The various expressions may be observable or measurable movements, such as walking, speaking, writing, thinking, and heartbeat (Suksatan & Ounprasertsuk, 2020). The stimuli that affect behavior may be internal or external (Sahoo, 2020; Suksatan & Posai, 2020). Satisfaction refers to a person's good feeling or positive attitude. It is often triggered by the person receiving the response desired. On the contrary, if the person's needs are not met, that person will experience feelings of dissatisfaction (Gorane & Kant, 2017). Knowledge and understanding of the GMP standards and proper behavior in accordance with the GMP standard system will result in the satisfaction of the students who are associated with the herbal medicine and health product manufacture at the College of Allied Health Sciences, Suan Sunandha Rajabhat University.

RESEARCH OBJECTIVES

1. To study the Suan Sunandha Rajabhat University College of Allied Health Sciences students' knowledge and understanding of the GMP standards.
2. To comprehend Suan Sunandha Rajabhat University College of Allied Health Sciences students' behaviors relative to the GMP standards.
3. To measure the Suan Sunandha Rajabhat University College of Allied Health Sciences students' levels of satisfaction with the GMP standards.
4. To analyze the ability to explain variations in Suan Sunandha Rajabhat University College of Allied Health Sciences students' knowledge/understanding and behaviors related to satisfaction with GMP standards.

HYPOTHESIS

Suan Sunandha Rajabhat University College of Allied Health Sciences students' knowledge/understanding, and behaviors related to Good Manufacturing Practice standards can describe student satisfaction for Good Manufacturing Practice standards.

RESEARCH METHODOLOGY

The study employed a quantitative approach, using a descriptive analysis to examine students' levels of knowledge/understanding, behaviors, and satisfaction related to GMP standards and determine survey response averages and percentages and relationships between knowledge/understanding, behavior, and satisfaction in GMP standards using a multiple regression analysis. The researcher reviewed theories and facts and designed a conceptual framework, hypothesis, and survey following Sarisa-ard's (2002). The sample used in the research included 73 students associated with the herbal medicines and health product manufacture at the College of Allied Health Sciences, Suan Sunandha Rajabhat University. Data were collected from August to October 2019.

RESULTS

Students' overall levels of knowledge and understanding in GMP standards were fair. Based on responses to the survey questions, the results indicated that the targeted samples' knowledge and understanding of GMP standards pertaining to the building and utensil specifications in the manufacturing process were excellent. The responders demonstrated good knowledge and understanding of the definition of GMP, specifications for the commitment to mitigate GMP risks, good manufacturing practices, good personal hygiene, specifications for ancillary areas, quality control, raw materials specifications, and labeling on starting materials in inventory. Their knowledge and understanding were fair regarding the specifications for storage areas, production areas, starting materials, and the advantages of GMP. However, their level of knowledge and understanding on the specifications for packaging tended to be poor (see Table 1).

Table 1. Survey Results on Knowledge/Understanding of GMP Standards (*N*=73)

Knowledge and understanding of GMP standards	Correct responses		Incorrect responses/No information		Level of knowledge and understanding
	n	%	*n*	%	
1. Definition of GMP	54	74	19	26	Good
2. Specifications for commitment to mitigate GMP risks	57	78.1	16	21.9	Good
3. Good manufacturing specifications	51	69.9	22	30.1	Good
4. Personal hygiene specifications	52	71.2	21	28.8	Good
5. Building specifications	63	86.3	10	13.7	Excellent
6. Specifications for ancillary areas	53	72.6	20	27.4	Good
7. Storage areas specifications	32	43.8	41	56.2	Fair
8. Production area specifications	31	42.5	42	57.5	Fair
9. Quality control specifications	45	61.6	28	38.4	Good
10. Specifications for utensils in manufacturing process	59	80.0	14	19.2	Excellent
11. Raw materials specifications	49	61.1	42	32.9	Good
12. Starting materials specifications	33	45.2	40	54.5	Fair
13. Specifications for labeling starting materials in inventory	45	61.6	28	38.4	Good
14. Packaging specifications	25	34.2	48	65.8	Poor
15. Advantages of GMP	30	41.1	43	58.9	Fair

Table 2 presents the results on the study sample's personal hygiene behaviors, indicating that the behaviors that responders can best comply with were washing hands before commencing work and after using the restroom, followed by maintaining trimmed fingernails and not working with polished or artificial fingernails in the manufacturing areas; the students demonstrated lower ability to comply with the behaviors of wearing make-up or lipstick when entering the manufacturing areas.

Table 2. Survey Results on Personal Hygiene Behaviors Related to GMP Standards (*N*=73)

Personal hygiene behaviors	Compliant		Noncompliant	
	n	%	*n*	%
1. Wearing make-up or lipstick when entering the manufacturing area	8	11.0	65	89.9
2. Maintaining trimmed fingernails; no polished or artificial fingernails in the manufacturing area	59	80.0	14	19.2
3. Washing hands before commencing work and after using the restroom	70	95.9	3	4.1

The research proved the proper attire behaviors students were most likely to follow in accordance with GMP standards were wearing clean coveralls daily and maintaining footwear in a pristine condition before entering the manufacturing area. The levels of compliance with these practices were followed by wearing hair restraints at all times in the manufacturing area and changing them daily, wearing properly secured gloves that are checked for tear marks, and wearing clean aprons that are checked for tear marks, respectively. See Table 3.

Table 3. Survey Results on Proper Attire Behaviors Related to GMP Standards (*N*=73)

Proper attire behavior	Compliant		Noncompliant	
	n	%	*n*	%
1. Wearing hair restraint at all times in the manufacturing area and changing it daily	71	97.3	2	2.7
2. Wearing clean coveralls daily	72	98.6	1	1.4
3. Wearing properly secured gloves and checking for tear marks	71	97.3	2	2.7
4. Wearing a clean apron and checking for tear marks	71	97.3	2	2.7
5. Maintaining footwear in a pristine condition before entering the manufacturing area	72	98.6	1	1.4

The research proved that the GMP requirements for practical behaviors with which students were best able to comply were reporting any illness or lesions to their supervisor, followed by refraining from the acts of coughing or sneezing over products, talking or teasing during work, and eating sweets and candy, chewing gum, and drinking during work, respectively. See Table 4.

Table 4. Suan Sunandha Rajabhat University College of Allied Health Sciences Students' Survey Results on Practical Behaviors Related to GMP Standards (*N*=73)

Practical behaviors	Compliant		Noncompliant	
	n	%	*n*	%
1. Refrain from eating sweets and candy, chewing gum, and drinking during work	38	52.1	35	47.9
2. Report any illness or lesions to supervisor	62	84.9	11	15.1
3. Refrain from coughing or sneezing over products, talking or teasing during work	55	75.3	17	23.3

The survey revealed the study subjects' levels of satisfaction with all aspects of GMP standards. The students' average scores for GMP manufacturing processes and procedures and for hygiene and safety of utensils and equipment were highest, followed by the standards on product safety in the manufacturing process controlling system, the application of GMP standards to production plants to facilitate gaining more new and useful knowledge, and overall satisfaction with GMP standards. The level of satisfaction with building, facilities, manufacturing sanitation (i.e., electricity, water supply, lighting, disposal of waste, and other related functions), and maintenance systems for utensils and equipment produced the lowest average scores. See Table 5.

Table 5. Survey Results on Level of Satisfaction with GMP Standards (*N*=73)

Satisfaction with GMP Analysis	Level of satisfaction					$\bar{x}$	Level of satisfaction
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)		
1. GMP manufacturing process and procedures	5 (6.8)	45 (61.6)	23 (31.5)	0 (0)	0 (0)	3.70	Satisfied
2. Building specifications	2 (2.7)	40 (54.8)	31 (42.5)	0 (0)	0 (0)	3.60	Satisfied

Satisfaction with GMP Analysis	Level of satisfaction					$\bar{x}$	Level of satisfaction
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)		
3. Hygiene and safety of utensils and equipment	5 (6.8)	44 (60.3)	24 (32.9)	0 (0)	0 (0)	3.70	Satisfied
4. Standards and product safety in the manufacturing process controlling system	1 (1.4)	47 (64.4)	25 (34.2)	0 (0)	0 (0)	3.67	Satisfied
5. Facilities and manufacturing sanitation (i.e., electricity, water supply, lighting, disposal of waste, and other related functions)	4 (5.5)	36 (49.3)	33 (45.2)	0 (0)	0 (0)	3.60	Satisfied
6. Maintenance system for utensils and equipment	3 (4.1)	39 (53.4)	31 (42.5)	0 (0)	0 (0)	3.60	Satisfied
7. Personnel sanitation and hygiene	2 (2.7)	42 (57.6)	29 (39.7)	0 (0)	0 (0)	3.63	Satisfied
8. Working with others under the GMP standard	4 (5.5)	40 (54.8)	29 (39.7)	0 (0)	0 (0)	3.66	Satisfied
9. Applying GMP standard to production plant facilitates gaining more new and useful knowledge	4 (5.5)	41 (56.2)	28 (38.4)	0 (0)	0 (0)	3.67	Satisfied
10. Overall satisfaction on GMP standard	1 (1.4)	47 (64.4)	25 (34.2)	0 (0)	0 (0)	3.67	Satisfied

Table 6 reflects the survey outcomes on the investigation of whether knowledge/ understanding and behavior can explain the students' satisfaction with GMP standards. The results implied that the students do not have much knowledge or experience with GMP standards. However, this research followed a quantitative technique using a survey containing questions in the form of a checklist, which many not have given students the opportunity to indicate knowledge and understanding of certified GMP through in-place practice, which may have produced the unexplained results.

Table 6. Multiple Regression Coefficients and Statistics of Knowledge/Understanding and Behavior in GMP Standards Towards Suan Sunandha Rajabhat University College of Allied Health Sciences Students' Level of Understanding (*N*=73)

Variables	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*-value
	B	Std. Error	Beta		
Constant	37.649	3.900		9.654	.000
Knowledge and understanding	-.133	.179	-.089	-.740	.462
Behavior	.004	.253	.002	.014	.989

Notes: *p*-value < 0.05, R^2 = 0.008, Adjusted R^2 = 0.021, F= 0.276

DISCUSSION

As GMP standards constitute a crucial component of quality production and practical basic manufacturing standards that guide manufacturing operators to produce quality products for consumers safely, the person associated with herbal medicines and health products should understand and follow GMP procedures. According to the assessment for GMP certification in manufacturing, the operators associated with herbal medicines and health products at the College of Allied Health Sciences, Suan Sunandha Rajabhat University must comprehend various factors and procedures as identified in the following paragraphs.

According to the measurement of Suan Sunandha Rajabhat University College of Allied Health Sciences students' level of knowledge/understanding of GMP standards, most survey respondents had fair levels of knowledge. This affected the observed behaviors because, in the workplace, the operators must have knowledge about their duties and understand the GMP procedures. Operators' lack of adequate knowledge and understanding can lead to hazards. These results agree with Viboonsunti (2007), who studied the assessment of practices of herbal medicine manufacturing from 27 traditional medicinal plants in Chiang Mai Province. Viboonsunti's research proved that 22 of the 27 plants did not meet GMP certification standards due to a lack of knowledge in traditional medicinal production and a lack of action plans for developing a production facility for traditional medicines that employed methods suitable for herbal medicines (Viboonsunti, 2007).

The results of this research imply that respondents' or operators' increased knowledge and understanding would result in a better GMP standards assessment, which is related to Thanonkaew (2016), who studied the development of the Sangyod rice mill towards GMPs for rice mills in a case study of Ban-Khao-Klang Community Enterprise. Thanonkaew's proved that studying the GMP standard concept provides data useful for production plant development and improvement plans to ensure all issues are addressed before undergoing the GMP standard assessment. Moreover, after working on six tips for GMP, the average scores were increased. Those six components triggered the certification (Afum *et al*., 2020). Based on responses to the GMP standards questions, the operators had excellent levels of knowledge/understanding about building specifications. In addition, regarding the specifications for utensils in the manufacturing process, the operators were able to answer up to 90% of questions correctly, followed by demonstrating good levels of

understanding of the definition of GMP (Shrafat & Ismail, 2019), while regarding specifications for the commitment to mitigate GMP risks, quality manufacturing processes, good personal hygiene, ancillary areas, quality control, raw materials management, and the labeling of starting materials in inventory, the respondents answered less than 80% correctly. These numbers were inferior to the fair level of knowledge reflected pertaining to specifications for storage areas, production areas, starting materials, and the advantages of GMP, for which correct responses did not reach 50%. Respondents displayed very poor levels of knowledge and understanding on specifications for packaging, with less than 40% correct responses. However, to pass the GMP assessment, operators must demonstrate 100% levels of knowledge and understanding.

The results related to the knowledge and understanding of the GMP process and procedures, building specifications, hygiene and safety of utensils and equipment, standards and product safety in the manufacturing process controlling system, facilities and sanitation (i.e., electricity, water supply, lighting, disposal of waste, and other related functions), maintenance systems for utensils and equipment, personnel sanitation and hygiene, working with others under the GMP standards, and the application of GMP standards to production plants to facilitate gaining more new and useful knowledge are in line with Srisukanya (2005), who researched employees' cognition, behavior, and satisfaction relative to GMP standards at Dole Thailand Hua Hin Limited. Srisukanya's study revealed that good levels of knowledge, behavior, and satisfaction of the employees towards the GMP standards influenced employees' perseverance and work capacity (Srisukanya, 2005). If the employees were willing to fulfill their duties to achieve their goals, the work satisfaction was positive. On the contrary, if the employees were not willing to work, satisfaction levels were negative. The results are also related to Patanan (2008), who examined the potential of some Thai-style noodle (Ka-Nom-Jeen) producers to comply with established GMP standards in a case study of food producers in Northern Thailand. Patanan's study found that 18 production plants for Thai-style noodles (Ka-Nom-Jeen) did not pass the GMP standard assessment following the 193rd Announcement of the Ministry of Public Health 2000 because of problems with quality operators whose skills were not sufficient for their duties (Patanan, 2008).

The results of the current study indicated Suan Sunandha Rajabhat University College of Allied Health Sciences students' behaviors related to GMP standards were in the middle of the range. They tended to have limited knowledge and understanding and limited work skills. Some work behaviors were also inappropriate. These results agree with those of Polying (2013), who investigated the levels of GMP standards met in the production of drinking water in sealed containers in Kalasin Province. This study proved that the drinking water production areas did not adequately meet GMP standards, such as no reports on the source of water testing, utensils, and equipment in production areas. Moreover, the microbiological parameters did not follow GMP criteria, so the drinking water production did not meet the highest standards. Thus, paying attention to operators' behaviors is necessary to closely monitor compliance with GMP standards. However, the study on the relationship between knowledge/understanding and behavior in the GMP standards of the students could not explain the students' satisfaction with GMP standards due to the quantitative approach of using a survey on issues with which no students had experience in the real workplace.

RECOMMENDATIONS

Universities that operate herbal medicine and health products factories should provide a specific GMP program and a training course on the knowledge of GMP standards for their operators, which will facilitate the operators' knowledge and understanding of the correct practices for quality production.

FUTURE RESEARCH DIRECTIONS

1. The research suggests future research should measure the level of knowledge of personnel who work in Herbal Medicines and Health Products manufacturing firm.
2. The research also highlights the need to study quality assurance standards, such as ISO9000, to understand employees' levels of knowledge/understanding and behaviors.
3. The research points to the need to examine the attitudes of personnel towards quality assurance standards to be used as information for improving their organization's quality assurance system.

RESEARCH LIMITATIONS

This study employed a quantitative research technique and covered a limited time period; a qualitative approach should be employed over an extended timeframe to verify these quantitative research results. In addition, this study is applicable only in the context of the herbal medicines and health products factory at the Suan Sunandha Rajabhat University College of Allied Health Sciences. Further research should examine other factories to compare the results and to identify an approach to promoting knowledge/understanding, behavior, and satisfaction towards the GMP standards.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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