KJVR
Korean Journal of Veterinary Research

Original Article

pISSN 2466-1384 · eISSN 2466-1392
Korean J Vet Res 2021;61(3):e20
https://doi.org/10.14405/kjvr.2021.61.e20

*Corresponding author:
Insik Nam
School of Animal Life Convergence Science, Hankyong National University, 327 Jungang-ro, Anseong 17579, Korea
Tel: +82-31-670-5126
Fax: +82-31-670-5129
E-mail: isnam@hknu.ac.kr

ORCID:
https://orcid.org/0000-0002-3785-315X

Conflict of interest:
The authors declare no conflict of interest.

Received: May 20, 2021
Revised: June 25, 2021
Accepted: June 30, 2021

Check for updates

© 2021 The Korean Society of Veterinary Science.

This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial license (http://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

A study on the improvement of the score system in the hazard analysis and critical control points prerequisite program for meat shops in Korea

Seung-Hee Baek[1], Insik Nam[1,2,*]

[1]Research Centre for Environment Friendly and Quality Livestock Production Technology, Hankyong National University, Anseong 17579, Korea
[2]School of Animal Life Convergence Science, Hankyong National University, Anseong 17579, Korea

This study is to develop a new scoring system for rating Hazard analysis and critical control points prerequisite evaluation items for meat shops to provide a more objective and accurate evaluation of food safety compliance. The importance of each item was measured by looking at the hazard severity level and the rate of non-compliance associated with it. It was found that the new scoring system is more stringent and gives a clearer picture of compliance with the most critical safety standards, and therefore is expected to have a positive effect on the hygiene and safety of livestock products.

Keywords: hazard analysis and critical control points; Butcher's shop; livestock; food safety; assessment

Introduction

Food poisoning incidents caused by various foods have been a common occurrence since the past [1-4]. In particular, livestock products are most likely to be contaminated with bacteria during production, slaughter, processing, distribution, and sales due to various factors such as the presence of moisture and nutrients conducive for bacterial growth [5,6]. In Korea, the hazard analysis and critical control points (HACCP) system is implemented for all livestock industries such as feed factories, animal farms, slaughterhouses, processing plants, meat packaging plants, milk collection centers, distribution centers, and meat and milk retail stores for ensuring the hygiene and safety of livestock products [7-9]. After the implementation of the HACCP system for the domestic livestock industry, the hygiene and safety of livestock products has greatly improved [10,11]. However, there is still room for improvement, and consumers have demanded that the system be further strengthened and optimized to enhance food safety.

Until now, studies on HACCP in the livestock sector were mainly limited to the effectiveness of HACCP implementation [12,13]. There are very few studies on HACCP evaluation items and inspection methods in the livestock products sector [14,15]. In order to increase the effectiveness of the HACCP system, it is considered necessary to examine the evaluation items and conduct a detailed study on the methods of inspection. The meat shop represents a stage in which slaughtered and processed livestock products are finally sold to consumers, and has a very im-

portant part in hygiene and safety management. The HACCP evaluation items for meat shops consist of the prerequisite program and HACCP management [16]. Among them, the evaluation items in the HACCP management field were composed based on Codex [17], and the prerequisite program was established based on the Livestock Products Sanitation Management Act [18]. The evaluation items of the HACCP prerequisite program for meat shops include total 51 items (facilities management, 23; sanitation management, 7; storage and transportation management, 12; inspection management, 8; recall management, 1) [16]. All these 51 items are scored using a 3-point scale, with the highest score being 2 points, medium score being 1 point, and lowest score being 0 point. This current evaluation and scoring system is not sufficiently effective in terms of ensuring food safety as all evaluation items are assumed to have the same level of importance despite their varying impact on food safety. For example, compliance with standards for "restroom, changing room management" and "raw meat and finished product inspection" will both earn 2 points, even though the latter has a much greater effect on consumer health safety. As a result, the final total score does not clearly reflect whether a store has fulfilled the most critical food safety requirements. This shortcoming of the current evaluation system may compromise the hygiene and safety management of livestock products. For this reason, the HACCP evaluation items in the general food sector in Korea and Good Agricultural Practices (GAP) evaluation items in the United States use scoring methods in which different scores are given according to the level of importance of each evaluation item [16,19].

The purpose of this study was to assess the importance of each prerequisite evaluation item and give a differential score for each item in order to increase the accuracy and effectiveness of the HACCP evaluation system for meat shops in assessing compliance with food safety standards.

Materials and Methods

Method for improving the scoring of evaluation items

The importance (i.e., the safety relevance) of each evaluation item was analyzed based on the analysis of: (1) the severity of hazards caused by each item, and (2) the non-compliance ratio associated with each item over the past 3 years. The analyzed results were applied to the evaluation items of the prerequisite program, and the practical effectiveness was verified through comparative analysis with the current evaluation score system.

Analysis of non-compliance ratio

The rate of non-compliance with the prerequisite evaluation items in a total 1,400 meat shops over the past 3 years was analyzed (Fig. 1). The results were used for portfolio map analysis.

Analysis of severity level of hazards

The HACCP prerequisite evaluation items for meat shops were classified into 3 categories (high, middle, and low) based on their hazard severity levels. The hazard severity level was determined based on the effects of the evaluation item on human health safety and the quickness with which the damage can be corrected. Evaluation items with a high (3 points) level of hazard directly affect meat quality and health safety and corrective action for the safety incident takes a long time. Middle-scored (2 point) items are indirectly related to meat quality and health safety and corrective action takes a long time. Low (1 point) indicates items whose effects on meat quality and health safety are indirect and the effects can be corrected immediately.

Portfolio map analysis

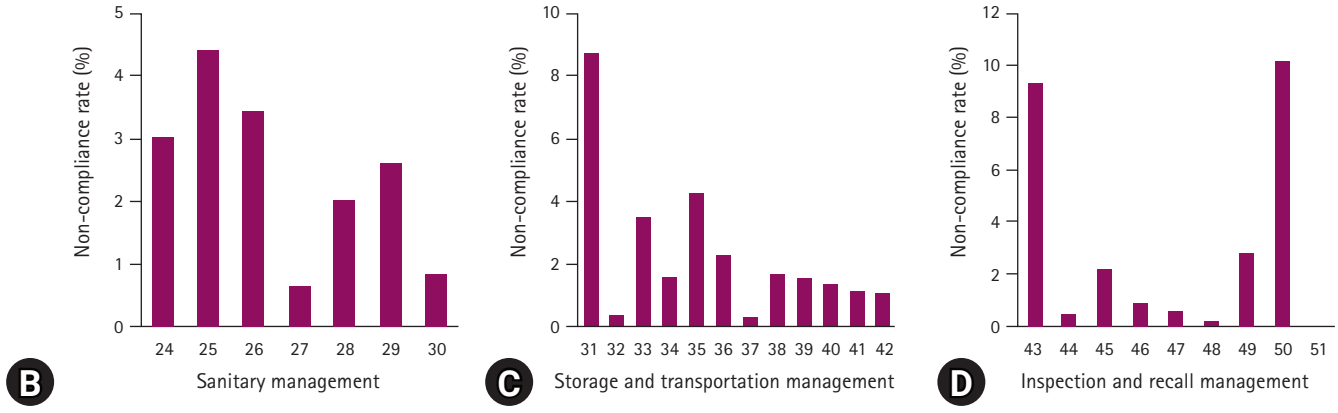
The importance level of each evaluation item was determined by analyzing the portfolio map. The portfolio map has the advantage of facilitating analysis by visually representing each value. In this study, the differentiated score for each evaluation item was presented through the portfolio analysis using the results of analysis of the hazard severity level and the rate of non-compliance with the prerequisite evaluation items. The average value of the rate of non-compliance and the hazard severity level was set as a cut-off value, and the area corresponding to the higher value was judged as highly important, scoring 3 points. Next, 2 points were given to the areas where either the rate of non-compliance or the hazard severity level was lower than the average value. One point was given to the areas where both the rate of non-compliance and the hazard severity level were lower than the average value.

Field implementation and comparative analysis

The new scoring system developed through this study was compared with the scoring system currently being used. This comparison was done to verify whether the new scoring system is more accurate and effective in assessing safety compliance. The new scoring system was analyzed for differences with the currently used evaluation score system through evaluation of HACCP prerequisites for meat shops.

https://doi.org/10.14405/kjvr.2021.61.e20

1. Separation of other facilities
2. Classification of workplace, temperature management
3. Floor management
4. Drainage cleanliness management
5. Door and interior wall cleanliness
6. Ceiling cleanliness management
7. Ventilation facility management
8. Lighting management
9. Management of worms and mice
10. Restroom, changing room management
11. Compliance with transport facilities
12. Door and window management
13. Tap water or ground water supply
14. Water tank lock
15. Ground water quality inspection
16. Equipped with facilities and tools management
17. Whether to use it for other purposes
18. Management of facilities and equipment
19. Regular inspection of manufacturing facilities
20. Record management of corrective actions
21. Refrigeration and freezing facilities, display boxes
22. Storage capacity of livestock products
23. Preparation of operation standards



24. Hygienic conditions of facilities and equipment
25. Indication of equipment and container
26. Employees' hygiene management
27. Employees' disease management
28. Cleaning and disinfection of working places and restroom
29. Regular education and training
30. Recording of hygiene management standard

31. Raw meat warehousing record
32. Rapid drop-off and loading
33. Use of standardized packaging materials
34. Storage temperature of raw meat
35. Raw and subsidiary materials and product management
36. Storage and recording of defective products
37. Measures to improve defective products
38. Product storage, display temperature management
39. First-in, first-out of raw meat and products
40. Display shelf signs
41. Recoding of storage management standard
42. Hygiene management of vehicles, tools, etc.

43. Raw meat and finished product inspection
44. Regular inspection and recording of lab
45. Consumables management book record
46. Inspection management item setting
47. Inspection report
48. Hygienic collection of test samples
49. Action of critical deviation
50. Measuring instrument calibration, record keeping
51. Recall program management

Fig. 1. Analysis of non-compliance rates for each hazard analysis and critical control points prerequisite evaluation item for meat shops over the last 3 years. (A) Work place of facility management. (B) Sanitary management. (C) Storage and transportation management. (D) Inspection and recall management.

Results

Analysis of the non-compliance ration in meat shop

Fig. 1 shows the analysis result of the non-compliance rate for the HACCP prerequisite program for a total of 1,400 meat shops. In the workplace facility management, a total 6 items (no. 2, classification of workplace, temperature management; no. 8, lighting management; no. 9, management of worms and mice; no. 12, door and window management; no. 19, regular inspection of manufacturing facilities; no. 21, refrigeration and freezing facilities, display boxes) with a non-compliance rate of 2.0% or more were identified. On the other hand, there were 3 evaluation items that had never met with non-compliance. For most other evaluation items, the non-compliance rate was around 1.0%. Most of the evaluation items related to sanitary management showed a high non-compliance rate. Of the total 7 evaluation items, 5 items showed a non-compliance rate of over 2.0%, and 2 items showed a rate of less than 1.0%. In the domain of storage and transportation management, the highest non-compliance rate (over 8.0%) was found in raw meat warehousing records. In addition, the non-compliance rate above 2.0% was seen in no. 33 (use of standardized packaging materials), no. 35 (raw and subsidiary materials and product management), and no. 36 (storage and recording of defective products). In the field of inspection and recall management, no. 43 (raw meat and finished product inspection), no. 45 (consumables management book record), no. 49 (action of critical deviation), and no. 50 (measuring instrument calibration, record keeping) showed high non-compliance.

Analysis of hazard severity level of each HACCP prerequisite evaluation item

Table 1 shows the analysis results by dividing the hazard severity levels into 3 categories (high, middle, low) for each evaluation item of the HACCP prerequisites for meat shops. The hazard severity level for each evaluation item was established through consultation with Korea Agency of HACCP Accreditation and Services (KAHAS). There were a total 15 items (no. 2, 19, 21, 22, 25, 26, 27, 28, 29, 31, 33, 35, 43, 49, 50) in the evaluation items for which the hazard severity level was high. A total 17 evaluation items (no. 3, 4, 6, 8, 9, 11, 12, 16, 18, 24, 30, 32, 34, 36, 38, 39, 40) had middle hazard severity levels. The remaining 19 evaluation items (no. 1, 5, 7, 10, 13, 14, 15, 17, 20, 23, 37, 41, 42, 44, 45, 46, 47, 48, 51) showed low hazard severity levels.

Analysis of the importance level of each evaluation item

In this study, the importance level was classified using the portfolio map method through the analysis of the rate of non-compliance (statistical method) and hazard severity level (subjective method) of each evaluation item (Fig. 2). As per the portfolio map analysis, the evaluation items that belong to the B area with both high non-compliance rate and high hazard severity level were no. 2, 8, 9, 12, 19, 21, 24, 25, 26, 28, 29, 31, 33, 35, 36, 43, 49, and 50. The number of evaluation items in the D area, with high hazard severity level and low non-compliance rate was 1 (no. 45). The evaluation items corresponding to the A area, with high non-compliance rate and low hazard severity level were no. 3, 4, 6, 11, 16, 18, 22, 27, 30, 32, 34, 38, and 39. And both low non-compliance ration and low hazard severity level (C area) was no. 1, 5, 7, 10, 13, 14, 15, 17, 41, 42, 44, and 46.

Comparative analysis with the current scoring system

Based on the results of the portfolio map analysis, 2 points were given for the evaluation items in the areas A and D, 3 points for items in the B area, and 1 point for items in the C area. Table 2 compares the scoring system for each evaluation item used currently in meat shops and the scoring system developed through this study. In the current scoring system for meat shops 3 points are given regardless of the importance level of each evaluation item. However, in the system developed through this study, evaluation items are given 3 points, 2 points, or 1 point according to their importance level. The score system composition according to the level of importance consisted of 15 evaluation items (29.4%) corresponding to 3 points, 17 evaluation items (33.3%) for 2 points, and 19 evaluation items (37.3%) with 1 point.

Evaluation of the meat shops using the newly developed score system

In order to compare the current scoring system with the new scoring system developed in this study, the evaluation was conducted by selecting meat shop X with excellent facilities and poor prerequisite operation, and a meat shop Y with poor facilities and excellent prerequisite operation (Table 3). The evaluation found that a total of 11 non-compliances occurred, including evaluation item no. 19 (regular inspection of manufacturing facilities), no. 21 (refrigeration and freezing facilities, display box), no. 24 (hygienic conditions of facilities and equipment), no. 25 (indication of equipment and container), no. 26 (employees' hygiene management), no. 29 (regular education and training), no. 31 (raw meat warehousing record), no. 36 (storage and recording of defective products), no. 43 (raw meat and finished product inspection), no. 49 (action of critical deviation), and

https://doi.org/10.14405/kjvr.2021.61.e20

Table 1. Analysis of hazard severity levels of each hazard analysis and critical control points evaluation item in meat shops

Index	The severity levels of hazards		
	High	Middle	Low
Evaluation items	2. Classification of workplace, temperature management	3. Floor management	1. Separation of other facilities
	19. Regular inspection of manufacturing facilities	4. Drainage cleanliness management	5. Door and interior wall cleanliness
	21. Refrigeration and freezing facilities, display boxes	6. Ceiling cleanliness management	7. Ventilation facility management
	22. Storage capacity of livestock products	8. Lighting management	10. Restroom, changing room management
	25. Indication of equipment and container	9. Management of worms and mice	13. Tap water or ground water supply
	26. Employees' hygiene management	11. Compliance with transport facilities	14. Water tank lock
	27. Employees' disease management	12. Door and window management	15. Ground water quality inspection
	28. Cleaning and disinfection of working places and restroom	16. Equipped with facilities and tools management	17. Whether to use it for other purposes
	29. Regular education and training	18. Management of facilities and equipment	20. Record management of corrective actions
	31. Raw meat warehousing record	24. Hygienic conditions of facilities and equipment	23. Preparation of operation standards
	33. Use of standardized packaging materials	30. Recoding of hygiene management standard	37. Measures to improve defective products
	35. Raw and subsidiary materials and product management	32. Rapid drop-off and loading	41. Recording of storage management standard
	43. Raw meat and finished product inspection	34. Storage temperature of raw meat	42. Hygiene management of vehicles, tools, etc.
	49. Action of critical deviation	36. Storage and recording of defective products	44. Regular inspection and recording of lab
	50. Measuring instrument calibration, record keeping	38. Product storage, display temperature management	45. Consumables management book record
		39. First-in, first-out of raw meat and products	46. Inspection management item setting
		40. Display shelf signs	47. Inspection report
			48. Hygienic collection of test samples
			51. Recall program management

High, point 3; middle, point 2; low, point 1.

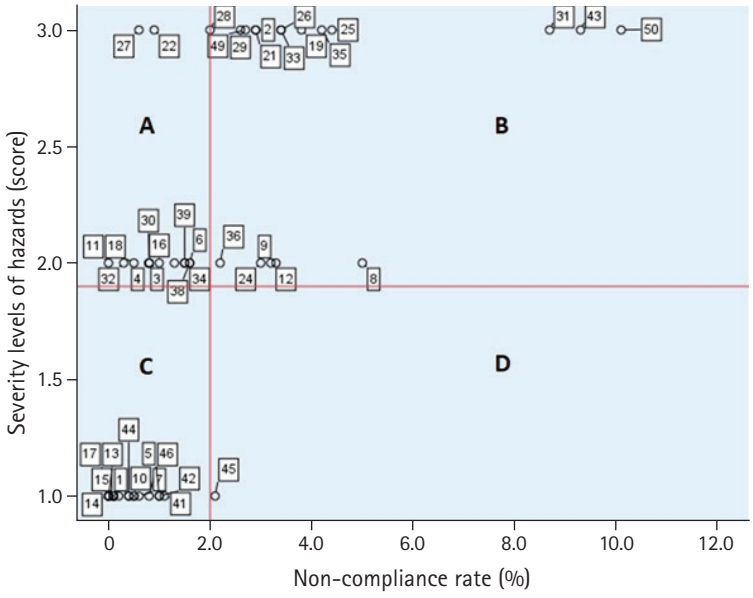


Fig. 2. Classification and scoring of importance levels using the method of portfolio analysis.

Table 2. Comparison of the current scoring system and the new scoring system developed in this study

No.	Evaluation items	Current	This study
1	Separation of other facilities	3	1
2	Classification of workplace, temperature management	3	3
3	Floor management	3	2
4	Drainage cleanliness management	3	2
5	Door and interior wall cleanliness	3	1
6	Ceiling cleanliness management	3	2
7	Ventilation facility management	3	1
8	Lighting management	3	3
9	Management of worms and mice	3	3
10	Restroom, changing room management	3	1
11	Compliance with transport facilities	3	2
12	Door and window management	3	3
13	Tap water or ground water supply	3	1
14	Water tank lock	3	1
15	Ground water quality inspection	3	1
16	Equipped with facilities and tools management	3	2
17	Whether to use it for other purposes	3	1
18	Management of facilities and equipment	3	2
19	Regular inspection of manufacturing facilities	3	3
20	Record management of corrective actions	3	1
21	Refrigeration and freezing facilities, display boxes	3	3
22	Storage capacity of livestock products	3	2
23	Preparation of operation standards	3	1
24	Hygienic conditions of facilities and equipment	3	3
25	Indication of equipment and container	3	3
26	Employees' hygiene management	3	3
27	Employees' disease management	3	2
28	Cleaning and disinfection of working places and restroom	3	3
29	Regular education and training	3	3
30	Recoding of hygiene management standard	3	2
31	Raw meat warehousing record	3	3
32	Rapid drop-off and loading	3	2
33	Use of standardized packaging materials	3	3
34	Storage temperature of raw meat	3	2
35	Raw and subsidiary materials and product management	3	3
36	Storage and recording of defective products	3	3
37	Measures to improve defective products	3	1
38	Product storage, display temperature management	3	2
39	First-in, first-out of raw meat and products	3	2
40	Display shelf signs	3	2
41	Recording of storage management standard	3	1
42	Hygiene management of vehicles, tools, etc.	3	1
43	Raw meat and finished product inspection	3	3
44	Regular inspection and recording of lab	3	1
45	Consumables management book record	3	2
46	Inspection management item setting	3	1
47	Inspection report	3	1
48	Hygienic collection of test samples	3	1
49	Action of critical deviation	3	3
50	Measuring instrument calibration, record keeping	3	3
51	Recall program management	3	1

https://doi.org/10.14405/kjvr.2021.61.e20

Table 3. Differences in the evaluation of the meat shop Y based on the current scoring system and the new scoring system developed in this study

No.	Evaluation items	A		B	
		a	b	a	b
1	Separation of other facilities	3	3	1	1
2	Classification of workplace, temperature management	3	3	3	3
3	Floor management	3	3	2	2
4	Drainage cleanliness management	3	3	2	2
5	Door and interior wall cleanliness	3	3	1	1
6	Ceiling cleanliness management	3	3	2	2
7	Ventilation facility management	3	3	1	1
8	Lighting management	3	3	3	3
9	Management of worms and mice	3	3	3	3
10	Restroom, changing room management	3	3	1	1
11	Compliance with transport facilities	3	3	2	2
12	Door and window management	3	3	3	3
13	Tap water or ground water supply	3	3	1	1
14	Water tank lock	3	3	1	1
15	Ground water quality inspection	3	3	1	1
16	Equipped with facilities and tools management	3	3	2	2
17	Whether to use it for other purposes	3	3	1	1
18	Management of facilities and equipment	3	3	2	2
19	Regular inspection of manufacturing facilities	3	1	3	1
20	Record management of corrective actions	3	3	1	1
21	Refrigeration and freezing facilities, display boxes	3	1	3	1
22	Storage capacity of livestock products	3	3	2	2
23	Preparation of operation standards	3	3	1	1
24	Hygienic conditions of facilities and equipment	3	1	3	1
25	Indication of equipment and container	3	1	3	1
26	Employees' hygiene management	3	1	3	1
27	Employees' disease management	3	3	2	2
28	Cleaning and disinfection of working places and restroom	3	3	3	3
29	Regular education and training	3	1	3	1
30	Recoding of hygiene management standard	3	3	2	2
31	Raw meat warehousing record	3	1	3	1
32	Rapid drop-off and loading	3	3	2	2
33	Use of standardized packaging materials	3	3	3	3
34	Storage temperature of raw meat	3	3	2	2
35	Raw and subsidiary materials and product management	3	3	3	3
36	Storage and recording of defective products	3	1	3	1
37	Measures to improve defective products	3	3	1	1
38	Product storage, display temperature management	3	3	2	2
39	First-in, first-out of raw meat and products	3	3	2	2
40	Display shelf signs	3	3	2	2
41	Recording of storage management standard	3	3	1	1
42	Hygiene management of vehicles, tools, etc.	3	3	1	1
43	Raw meat and finished product inspection	3	1	3	1
44	Regular inspection and recording of lab	3	3	1	1
45	Consumables management book record	3	3	2	2
46	Inspection management item setting	3	3	1	1
47	Inspection report	3	3	1	1
48	Hygienic collection of test samples	3	3	1	1
49	Action of critical deviation	3	1	3	1
50	Measuring instrument calibration, record keeping	3	1	3	1
51	Recall program management	3	3	1	1

A, current scoring system; B, newly developed scoring system; a, maximum score; b, the number of scores obtained as a result of evaluation.

no. 50 (measuring instrument calibration, record keeping). These evaluation items are classified as evaluation items that can directly hazard consumer's safety if management is neglected. Thus, when the same meat shop was evaluated using the current and new scoring systems, the current system gave the store a quality rating of "suitable" with 85.6% (131 points), but the new scoring system gave the rating of "non-compliance" with 78.4% (80 points). This shows that the new scoring system is more accurate and stringent, which can improve food safety management.

Discussion

The most advanced food hygiene and safety management program is the HACCP system. For this reason, many developed countries implement the HACCP system in all food sectors [20-23]. The effects of implementation of the HACCP system are appearing in various fields, such as improving the hygiene and safety of food, systemic management, and increasing consumer satisfaction [10,24,25]. The HACCP system of meat shops is divided into the prerequisite program and HACCP management field. Among them, the HACCP management field was established based on Codex [17], and the prerequisite program was developed based on the Livestock Products Sanitation Management Act [18]. Accordingly, the HACCP evaluation items for meat shops were developed in accordance with the legal standards (prerequisite evaluation items) and Codex (HACCP evaluation items). The meat shop is the final stage of the meat production chain where consumers come to purchase meat. Therefore, a lot of attention is needed on the hygiene and safety of meat. However, the effectiveness of HACCP implementation is compromised because all evaluation items of the HACCP prerequisite program for meat shops are evaluated on a 3-point scale despite the differences in their safety relevance [16]. In fact, the HACCP evaluation items for most livestock products do not consider the level of importance of each item in terms of their effect on human safety. In order to resolve this problem, the US GAP [19] or the Korean food HACCP system [16] is operated by assigning different levels of importance according to the evaluation items. The scoring system that considers the level of importance of each evaluation item is considered to be effective in enhancing the safety of food as it has a positive effect on the evaluation results. The purpose of this study was re-establishing the score according to the level of importance of the HACCP prerequisite evaluation items for meat shops. As a result of implementing the results of this study in a meat shop quality inspection, it was verified that effective hygiene and safety management is possible. In addition, if there are no detailed criteria for evaluation items, the evaluation results are determined according to the subjective opinion and bias of the inspector, so additional studies on establishing detailed criteria for each evaluation item are required to increase objectivity.

ORCID

Seung-Hee Baek, https://orcid.org/0000-0003-0737-7268
Insik Nam, https://orcid.org/0000-0002-3785-315X

References

1. Kangethe EK, Sirma AJ, Murithi G, Mburugu-Mosoti CK, Ouko EO, Korhonen HJ, Nduhiu GJ, Mungatu JK, Joutsjoki V, Lindfors E, Ramo S. Occurrence of mycotoxins in food, feed, and milk in two counties from different agro-ecological zones and with historical outbreak of aflatoxins and fumonisins poisonings in Kenya. Food Qual Saf 2017;1:161–170.
2. Wakabayashi Y, Umeda K, Yonogi S, Nakamura H, Yamamoto K, Kumeda Y, Kawatsu K. Staphylococcal food poisoning caused by Staphylococcus argenteus harboring staphylococcal enterotoxin genes. Int J Food Microbiol 2018;265:23–29.
3. Filipello V, Bonometti E, Campagnani M, Bertoletti I, Romano A, Zuccon F, Campanella C, Losio MN, Finazzi G. Investigation and follow-up of a staphylococcal food poisoning outbreak linked to the consumption of traditional hand-crafted alm cheese. Pathogens 2020;9:1064.
4. Li X, Sapp AC, Singh N, Matthias L, Bailey C, DeMENT J, Havelaar AH. Detecting foodborne disease outbreaks in Florida through consumer complaints. J Food Prot 2020;83:1877–1888.
5. Tegegne HA, Phyo HWW. Food safety knowledge, attitude and practices of meat handler in abattoir and retail meat shops of Jigjiga Town, Ethiopia. J Prev Med Hyg 2017;58:E320–E327.
6. Nielsen B, Colle MJ, Ünlü G. Meat safety and quality: a biological approach. Int J Food Sci Technol 2021;56:39–51.
7. Nam IS. The implementation and effects of HACCP system on broiler farms in Korea. J Anim Plant Sci 2017;27:2063–2068.
8. Kim S, Choi K, Myung D, Chung H, Kim S, Choe N. A study on the needs to improve Korea abattoir's critical control point of HACCP system. Korean J Vet Res 2020;60:105–108.
9. Baek SH, Nam I. Evaluation of the effects of seasonal raw materials and processing stages in feed mills implementing the

https://doi.org/10.14405/kjvr.2021.61.e20

HACCP system on mycotoxin content in feed. Korean J Vet Res 2021;61:e7.
10. Kim JH, Hur SJ, Yim DG. Monitoring of microbial contaminants of beef, pork, and chicken in HACCP implemented meat processing plants of Korea. Korean J Food Sci Anim Resour 2018;38:282–290.
11. Cho SH, Baek SH, Ahn JH, Nam IS. A study on microbial management level of manufacturing environment, raw meat and products in HACCP implemented meat market. Korean J Org Agric 2019;27:193–204.
12. Lee SM, Yoo HS, Honsg CH. Analysis of biological hazards and control points in layer houses. Korean J Vet Res 2004;44: 593–605.
13. Kang IB, Song KY, Kim DH, Kim HS, Yim JH, Kim YJ, Lee JY, Chon JW, Kim H, Om A, Koo R, Kim SH, Seo KH. Analysis and Improvement of HACCP program for small and medium-sized dairy plants of Korea. J Food Hyg Saf 2017;32:14–19.
14. Hong CH, Lee JH. Weak points of HACCP prerequisite program operation at slaughterhouses in Korea. J Prev Vet Med 2012;36:55–59.
15. Hong CH. Simplification of HACCP prerequisite requirements in meat packaging plants. J Prev Vet Med 2016;40:39–45.
16. Ministry of Food and Drug Safety. Food and livestock products Safety Management Certification Standard (HACCP). Notification number 2020-15. Ministry of Food and Drug Safety, Cheongju, 2020.
17. Joint FAO/WHO Codex Alimentarius Commission. Codex Alimentarius: Food Hygiene Basic Texts. 2nd ed. Food and Agriculture Organization of the United Nations, Rome, 2001.
18. Ministry of Agriculture, Food and Rural Affairs (MAFRA). Livestock Products Sanitary Control Act. MAFRA, Sejong, 2020.
19. United States Department of Agriculture (USDA). USDA Good Agricultural Practices Good Handling Practices Audit Verification Checklist. USDA, Washington, DC, 2014.
20. Ropkins K, Beck AJ. Evaluation of worldwide approaches to the use of HACCP to control food safety. Trends Food Sci Technol 2000;11:10–21.
21. Ismail RM, Latiff FAA, Mustafar M. Malaysia food safety concern-bringing HACCP to the community. J Soc Sci Res 2018; Spec No 6:202–207.
22. Yang Y, Wei L, Pei J. Application of meta-analysis technique to assess effectiveness of HACCP-based FSM systems in Chinese SLDBs. Food Control 2019;96:291–298.
23. Dzwolak W. Assessment of HACCP plans in standardized food safety management systems–the case of small-sized Polish food businesses. Food Control 2019;106:106716.
24. Imami D, Zhllima E, Skreli E. Analyzing consumer awareness and perceptions about food safety in the context of a European transition country applying segmentation approach. J Econ Agribus 2020;13:14–28.
25. Mandal S, Singh AK, Singh B, Singh K, Singh S, Pandey VK. Study on safety and quality aspects in restaurants based on HACCP in Allahabad city. Eur J Biotechnol Biosci 2021;9:6–9.