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Short Communication

THE IMPLEMENTATION AND EFFECTS OF HACCP SYSTEM ON BROILER FARMS IN KOREA

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ABSTRACT

This study evaluates Hazard Analysis and Critical Control Point (HACCP) systems implemented on 25 broiler farms in Korea, thus enabling us to investigate the effects of such systems on broiler farm productivity. In addition, the reasons for, and the advantages of implementing HACCP systems on broiler farms are determined. These results showed that HACCP systems have a significant positive influence on the viability ratio and a negative monthly disinfectant fee on such farms. But the effect on monthly medicine fee was tended to be increased after HACCP implementation in broiler farm. The survey shows that the main reasons for implementing HACCP systems are hygiene and safe broiler production. The biggest advantage of an HACCP system is systemic farm management. Thus, HACCP systems can have positive effects on broiler farms by increasing productivity and improving systemic farm management. Furthermore, broiler farm HACCP systems might reduce food poisoning caused by chickens.

Key words: HACCP; Implementation; Broiler farm; Productivity; Advantage.

INTRODUCTION

In the 1960s, the Hazard Analysis Critical Control Point (HACCP) concept was developed to ensure food safety for the first manned space missions. The HACCP concept differs from traditional food safety programs, such as the Good Hygiene Practices (GHP), Good Manufacturing Practices (GMP), and Good Agricultural Practices (GAP). It is a systematic approach to identifying, evaluating, and controlling hazards related to food safety (Codex, 2001). The goal of implementing the HACCP concept is to manage potential hazards through risk analyses, focusing on prevention rather than end-product testing. In the 1990s, the concept became the primary approach for ensuring the safety of the food supply (Buchanan, 1990). Since then, considerable effort has gone into using the HACCP approach by national and international institutions for managing food safety hazards in the food industry worldwide. Implementing the HACCP concept includes food processing and the overall food chain, thus providing safe food to the consumer. Livestock products are easily contaminated by pathogenic bacteria because there is enough protein and water activity for the bacteria to grow. Since 1998, the Ministry of Agriculture, Food, and Rural Affairs (MAFRA) in Korea has implemented the HACCP approach in all livestock industries, including animal feed factories, livestock farms (pig, cow, poultry, etc.), slaughterhouses, and meat packing factories, as well as in the processing factories (eggs, milk, meat), storage, transportation, and sales outlets for livestock products. This became the basis for the Livestock Products Sanitary Control Act (MAFRA, 2015). The from-farm-to-table HACCP policy in Korea means the concept is currently implemented in more than 11,100 of the 75,000 livestock-related companies, including livestock farms (Korean Livestock Products HACCP Accreditation Service, KLPHAS, 2016). With regard to livestock farming, the HACCP implementation began on swine farms in 2006, cattle farms (dairy and beef) in 2007, and poultry farms (broilers and laying hens) in 2008. As of 2015, there were approximately 19,000 animal farms in Korea, over 7,200 of which are currently implementing HACCP systems (KLPHAS, 2016). Currently, HACCP systems are implemented on all broiler farms. The from-farm-to-table HACCP policy increases the sanitary level of livestock products in Korea. However, few countries have developed and implemented the HACCP system on farms, and there is no published research on how the HACCP system influences broiler farms. This study introduces the configuration of the HACCP evaluation standard, and investigates the influence of an HACCP implementation on the productivity of broiler farms in Korea. In addition, the reasons for, and the advantages of HACCP implementations on broiler farms are examined.

MATERIALS AND METHODS

Broiler farms and data collection: The influence of HACCP systems on the productivity and animal medicine fees on broiler farms are examined. The following data were collected from each of 25 randomly selected broiler farms: feed conversion ratio, production index, viability ratio, monthly medicine fee (MMF), and monthly

disinfectant fee (MDF). Here, data from before and after the HACCP implementation are compared based on the daily records provided at the each farm for over ten months. The average number of broiler farms is between 65,000 and 85,000. Here, we survey the farms' reasons for implementing HACCP systems, as well as the advantages of such systems. The survey questionnaire was prepared and modified based on scores on the order of importance, taken from the results of related studies (Bai *et al*., 2007; Spencer *et al*., 1999). The survey instrument consists of two parts. In part one, we investigate the reasons for implementing an HACCP system. Farm owners were asked to rank the following items in order of importance: (1) financial support from the government; (2) higher chicken prices; (3) hygienic chicken production; (4) requirements from buyers; (5) systemic farm management; and (6) enhanced competitiveness. In part two, we examine the advantages of HACCP systems, and asked farm owners to rank the following items: (1) productivity improvement; (2) reduction in production costs; (3) improved level of sanitation management; (4) disease control and prevention; (5) systemic farm management; and (6) hygienic chicken production.

Statistical analysis: The statistical analysis was carried out using the Statistical Analysis System (SAS, 2002). The effects of the feed conversion ratio, production index, viability ratio, MMF, and MDF were tested using an ANOVA test. The differences between the means before and after the HACCP implementation were determined using Student's t-test. The level of statistical significance was set to $p < 0.05$.

RESULTS AND DISCUSSION

Configuration of HACCP system evaluation standard for broiler farms: Broiler farms normally prepare for an HACCP implementation with the help of a consultant for three to six month, before applying to the KLPHAS. Then, the KLPHAS visit the farm to assess it using the broiler farm HACCP evaluation standard (Table 1 and Table 2). This standard includes a prerequisite management section (Table 1) and an HACCP management section (Table 2) (Walker *et al.,* 2003). The prerequisite program for broiler farms was created based on the livestock laws (i.e., GHP and GAP) in Korea, and includes seven items evaluating farm bio-security management, nine items for farm facility management, nine items for farm sanitary management, ten ~~10~~ items for feed, drinking water, and medication management, six items for disease management, and four items for carry-in and shipment management (MAFRA, 2008).

The broiler farm HACCP management section is composed of five items for hazard analyses (assemble HACCP team, identify intended use, describe chicken products, construct a flow diagram, an on-site confirmation of the flow diagram and hazard analysis), six items for the critical control points (CCP) (record each hazard, determine the CCP, set up critical limits (CL), set up CCP monitoring, execute CCP monitoring, take corrective action), and four items on verification and record keeping (HACCP verification, HACCP recording, HACCP education and training, documentation and record keeping). The scores and evaluations for each HACCP standard (i.e., the prerequisite management program and HACCP management program) are shown in Table 1 and Table 2, respectively. In Korea, the prerequisite management program for broiler farms was developed by the Korea Broiler Farm Association (KBFA), government officers, university professors, and staff of the KLPHAS. HACCP system implementations in food-processing businesses should include the prerequisite management program and the HACCP management program (WHO, 1993). Then, the HACCP management program is implemented. The concepts of the prerequisite management program and how it will benefit HACCP management program have been reported by Wallace and Williams (2001). If the HACCP management program is used without the prerequisite management program, this will likely result in a waste of resources and money, and might cause resistance for future HACCP system implementations (Baş *et al.,* 2006). The CCPs of the HACCP systems implemented on broiler farms in Korea control the *Salmonella enteritidis* contamination and antibiotic residues of broilers. The CCPs can be managed by the HACCP management program and the prerequisite management program together.

The effects of HACCP systems on broiler farms: The feed conversion ratio, production index, and viability ratio are examined on broiler farms following their implementation of an HACCP system (Table 3). The average feed conversion ratio before the HACCP implementation was 1.76%, and after the implementation was 1.78%. No significant difference was found for the production index before and after the HACCP system implementation (222.20% vs. 227.20%). The viability ratio after the HACCP system implementation was significantly higher (97.36%) than it was before the implementation (96.97%) ($p < 0.05$). Table 4 shows the change in the MMF and MDF as a result of implementing an HACCP system on a broiler farm. The average MMF before the HACCP system was in place was USD955.31/farm, and afterwards, was USD763.89/farm. These figures suggest that broiler farms without HACCP systems tend to spend more money on animal medicine than those with HACCP systems do. The MDF after the HACCP implementation (USD320.12/farm) was significantly higher than it was before the implementation (USD192.08/farm) ($p < 0.05$). To date, in order to

improve broiler farm productivity, studies have been conducted in a variety fields, including diet (Batal and Parsons, 2002; Adedokum *et al.,* 2008), breeding (McConnell *et al.,* 1999; Komiyama *et al.,* 2004), and reproduction (McDanial *et al.,* 1981; Robinson *et al.,* 1996). The results of such studies have had a significant influence on the productivity of broiler chicken farms. However, research in these fields is limited, which has meant farmers have needed to find other ways of enhancing the productivity of their farms. The reason for the increase in the viability ratio is likely the HACCP prerequisite management program. In the case of swine studies, the average number of piglets weaned per sow per year (PSY) and the number of market pigs per sow per year (MSY) increased after implementing HACCP systems (Nam *et al.,* 2008). These results are similar to those of the current study. European countries have been using HACCP based programs to improve productivity through animal welfare, health, sanitation, and environmental improvements (von-Borell *et al.,* 2001). Thus, we believe that using the HACCP prerequisite program increases the viability ratio.

Reasons for, and advantages of HACCP system implementation: The respondents (25 broiler farmers) were presented with a list of two different subjects (each subject contains six items) related to implementing an HACCP system, and were then asked to rank them in order of importance (mean rank score: six being very important, and one unimportant; a high percentage of respondents specified a value of one). Table 4 shows the relative importance of the reasons and advantages of HACCP systems on broiler farms. The reasons for implementing an HACCP system can be divided into four groups, by importance. The most important reason given for implementing an HACCP system was hygienic and safe broiler production (25.32%, score of 4.4). Systemic farm management (20.25%, score of 3.6) and enhanced competitiveness (18.35%, score of 3.2) were classified in the second group. The third group comprised financial support from a local or central government (14.56%, score of 2.6) and higher broiler prices (13.29%, score of 2.3). The fourth group contained requirements from buyer (8.23%, score of 1.4). The relative importance of the HACCP system advantages were ranked as follows (see Table 5). Of the six advantages listed, systemic farm management and improved sanitation management were indicated by 24.28% (score of 4.7) and 21.35% (score of 4.1) of respondents, respectively. These were followed by hygienic and safe broiler production 19.27% (score of 3.7), disease control and prevention 16.15% (score of 3.1), and productivity improvement (10.97%, score of 2.1). We expected the main reasons for implementing HACCP systems on broiler farms would be hygienic and safe broiler production and systemic farm management. These were the original reasons for the Korean government's implementation of HACCP systems on broiler farms. Implementing an HACCP system is obligatory. Nevertheless, the reasons given for implementing HACCP systems are clearly related to the advantages (systemic farm management and improvement of sanitation management level) to be had after an HACCP implementation. These results may indicate that farmers want to use the HACCP system as tool to expand their businesses by enhancing their competitiveness. In addition, the Korean government has two financial support programs for HACCP and eco-friendly certified animal farms: a direct payment program, and a modernization program for farm facilities **(**MAFRA, 2013**)**. However, while operating an HACCP system in the farming sector also has disadvantages and difficulties (von-Borell *et al.,* 2001; Horchner and Pointon, 2011), such systems contribute to public health through hygienic and safe broiler production.

Table 1. Evaluation standard (Pre-request management section) and the method for judgment of each evaluation standard on broiler farm HACCP in Korea.

No	Evaluation standard	No	Evaluation standard
	Farm bio-security management	23	Education of sanitation and biosecurity
1	Operation of farm biosecurity standard	24	Control standard of each growing stage
2	Biosecurity warning signal at farm gate	25	*Salmonella enteritidis* test in farm environment and animal
3	Access control of car and guest		*Feed · Medicine · Drinking water management*
4	Disinfection record of car and guest	26	Operation of feed, medicine and water management standard
5	Preparation of preventive articles	27	Feeding HACCP certified feed
6	Access control of animal house	28	Management of feed
7	Fence of outside farm	29	Cleanliness of feed storage place
	Farm facility management	30	Cleanliness of feeder and feed supply facility
8	Operation of farm facility management standard	31	Standard of self produced feed at farm
9	Disease control facilities	32	Residue prevention plan of antibiotics in chicken
10	Maintenance of drain water way in farm	33	In and out control of animal medicine

11	Division of growing stage of broiler	34	Test of drinking water in regular time
12	Rearing density of broiler	35	Cleanliness of water supply facility
13	Feces and urine control facility in broiler house		*Disease management*
14	Drinking water and feed supply facility	36	Operation of disease management standard
15	Temperature, humidity and ventilation control facility	37	Disease control and prevention
16	Feces and urine disposal facility	38	Consultation by veterinarian in regular time
	Farm sanitary management	39	Helminth control
17	Operation of farm sanitary management standard	40	Periodic inspection of breeding and hatchery farm
18	Cleanliness of tools and shoes etc.	41	Control plan of *M. gallisepticum, M. synoviae* in breeding farm
19	Foot disinfector in front of gate at broiler house		*Carry-in and shipment management*
20	Management of dead chickens	42	Operation of carry in and shipping management standard
21	Feces and urine control in regular time	43	Broiler trading record book
22	Rodent and vermin control	44	Clinical observation of introduced flock
		45	Broiler shipment recording book

A standard of judgment for evaluation standard

Score 5 (Good) : Without any mistake, consistent implementation of the field and record keeping according to the HACCP manual
Score 3 (Generally) : Some mistake but consistent implementation of the field and record keeping according to the HACCP manua1
Score 1 (Inadequate) : Many mistake and low implementation of the field and record keeping.
Score 0 (Executory) : Law violations
Judgment : Pass (over 85% of 100%), Complement (between 70~84% of 100%), Fail (less than 70% of 100)

Table 2. Evaluation standard (HACCP management section) and the method for judgment of each evaluation standard on broiler farm HACCP in Korea.

No	Evaluation standard	No	Evaluation standard
	Hazard analysis	8	Set up of critical limit
1	Assemble HACCP team	9	Set up of CCP monitoring
2	Identify intended use	10	Execution of CCP monitoring
3	Descript broiler product	11	Establish corrective action
4	Construct flow diagram and on site conformation		*Verification and recode keeping*
5	Hazard analysis	12	HACCP verification
	Critical control point	13	HACCP recoding
6	Recoding in each hazard	14	HACCP education and training
7	Determine CCP	15	Documentation and record keeping

A standard of judgment of evaluation standard

Score 5 (Good) : Without any mistake, consistent implementation of the field and record keeping according to the HACCP manual
Score 3 (Generally) : Some mistake but consistent implementation of the field and record keeping according to the HACCP manual
Score 1 (Inadequate) : Many mistake and low implementation of the field and record keeping.
Score 0 (Executory) : Law violations
Judgment : Pass (over 85% of 100%), Complement (between 70~84% of 100%), Fail (less than 70% of 100%)

Table 3. Changes of productivity before and after HACCP system implementation of Broiler farm in Korea.

Item	HACCP implementation		P value
	Before	After	
	%		
Feed conversion ration	1.76± 0.17	1.78± 0.18	0.89
Production index	222.20± 28.57	227.20± 32.45	0.94
Viability ration	96.97± 0.44	97.36± 0.87	0.03

Mean ± Standard error of the mean
n= 25 (Broiler farm)

Table 4. Changes of MMF and MDF before and after HACCP implementation of broiler farm in Korea.

Item	HACCP implementation		P value
	Before	After	
	USD/Farm/Month		
MMF[1)]	955.31 ± 62.49	763.89 ± 46.49	1.64
MDF[2)]	192.08 ± 33.49	320,13 ± 21.38	0.04

Mean ± Standard error of the mean
n= 25 (Broiler farm)
[1)]MMF : Monthly medicine fee (MMF is including antibiotics, vaccines, vitamins, minerals etc.)
[2)]MDF : Monthly disinfectant fee

Table 5. Mean rank sources and percentage of respondents giving different reason and advantage of HACCP system implementation on broiler farm in Korea.

Classification	Broiler farm	
	Proportion of respondents giving rank of one (%)	Mean rank score[1)]
Propose of implementing HACCP		
Financial support from government	14.56	2.6
Higher broiler price	13.29	2.3
Hygienic and safe broiler production	25.32	4.4
Requirement from buyer	8.23	1.4
Systematic farm management	20.25	3.6
Enhancement of competitiveness	18.35	3.2
Advantage after HACCP implementation		
Productivity improvement	10.97	2.1
Reduction of the production cost	7.81	1.5
Improvement of sanitation management level	21.35	4.1
Disease control and prevention	16.15	3.1
Systematic farm management	24.48	4.7
Hygienic and safe broiler production	19.27	3.7

n= 25 (Broiler farm)
[1)] Where 6=very important and 1=unimportant

Conclusion: Implementing the HACCP evaluation standard (prerequisite management and HACCP management programs) on broiler farms influences the viability ratio, also known as the productivity index. Hygienic and safe broiler production was investigated as a primary reason for implementing an HACCP system. In addition, a major advantage of an HACCP system is the improvement in the level of systemic farm management. These results will have an effect on hygienic broiler production and, thus, will improve public health. Lastly, continuous HACCP education and training is required to ensure a stable HACCP system.

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