

The physical and microbiological quality of chicken meat in the different type of enterprise poultry slaughterhouse: a case study in Karanganyar District

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Abstract. The aim of this study was to determine the physical and microbiological quality of chicken meat produced by the different type of enterprise slaughterhouse in Karanganyar District. The number of 20 poultry slaughterhouses was determined by convenience sampling method. The samples of chicken meat were randomly collected from medium enterprise poultry slaughterhouses (n=12) and small enterprise poultry slaughterhouses (n=8). A survey was carried out among poultry slaughterhouses in Karanganyar District. All the samples were subjected to physical quality consisted of pH test, texture, and color, while microbiological quality consisted of total plate count, microbial detection of *Escherichia coli* and *Salmonella*. The data were analyzed using descriptive quantitative analysis. The study showed that chicken meat in 6 small enterprise slaughterhouses and 11 medium enterprise slaughterhouses had normal pH of 5.81 - 6.3. Color and texture of chicken meats had relatively normal in both small and medium enterprise slaughterhouses. The total plate count of chicken meat showed in both small and medium enterprise slaughterhouses was $<1 \times 10^6$ CFU/gr. The test of bacterial contamination showed that 3 of small and medium enterprise slaughterhouses were positively contaminated by *Escherichia coli* of $>1 \times 10^1$ CFU/gr, and *Salmonella* was detected in 1 medium enterprise slaughterhouse. The overall results of the study suggest that the potential risk of chicken meat contamination depends on the processing of chicken meat in poultry slaughterhouses.

Keywords: slaughterhouses, physical, microbiological, chicken meat

1. Introduction

Ensuring supply of safe food has been one of the major challenges and concerns for producers, consumers and public health officials in the world. This is because foods excessively contaminated with pathogenic and spoilage micro-organism are undesirable and can cause food borne illnesses [1–2]. Chicken meat, a food source of animal protein, is the most widely consumed by the community. Production of chicken meat in Karanganyar District in 2009 was 2,276,795 kg and increased by 30% in 2013 around 2,963,043 kg [3]. The chicken meat contributes about 20.22% to world meat production and Indonesia is the largest contributor to ASEAN with an average of 1.56 million tons.



The growth is expected more in near future [4]. This might be due to popularity, easy availability, price, no religious taboos, highly digestible, tasty and low-calorie food [5].

Raw or undercooked chicken meat is particularly prone to contamination. The microbiological and physical quality of chicken meat as purchased by consumers depends mostly on; the slaughter process, sanitation during processing and packaging, maintenance of adequate cold chain storage from the processing to the retail level and to the consumer and finally sanitation during handling at the retail end [6–7]. Microorganisms from the environment, equipment and operators hands can contaminate meat [8]. Chicken meat is responsible for many zoonotic foodborne infections in the World. Foodborne diseases have a serious impact on the public health and the economic losses due to food poisoning are in billions [9]. Poultry and poultry meat are often found contaminated with potentially pathogenic microorganisms such as *Salmonella*, *Campylobacter*, *S. aureus*, *E. coli* and *Listeria* [5]. Previous study conducted in slaughterhouses spread in middle java (District of Sukoharjo and City of Surakarta) and Province of Yogyakarta (City of Yogyakarta, District of Sleman and Bantul) showed all samples of chicken meat were contaminated by *E. coli*, *Staphylococcus sp.* and *Salmonella sp.* despite the chicken carcasses had good physical appearances [10].

According to meat contamination, poultry slaughterhouse has a role of chicken meat circulating in supply chain. It is one of the major critical points with potential effects on the hygiene of poultry meats. During slaughter operations, inter-contamination phenomena occur, which induces proliferation of bacterial pathogens on carcasses initially healthy. Special attention must be observed in chicken meat production because of possible contamination from alimentary tracts, water, packaging, utensils and handlers [11-13]. Therefore, good hygiene practices in food establishments are essential for consumer protection and the control of public health risks. The way of handling and the equipment used is very influential on the quality of meat produced, because chicken meat is one of the animal food material that is easily damaged.

This paper discusses the results of a study on assessment the hygienic conditions, conducted at a poultry slaughterhouse, which aimed to determine the physical and microbiological quality of chicken meat produced by the different type of enterprise slaughterhouse in Karanganyar District.

2. Materials and methods

2.1. Sampling size

Sampling of poultry slaughterhouses was conducted in medium enterprise poultry slaughterhouses (MEPS) (n=12) and small enterprise poultry slaughterhouses (SEPS) (n=8). The method of selecting poultry slaughterhouses in Karanganyar District used convenience sampling method. Convenience sampling method can be used with the provision if there is no information about the sampling population [14]. Sampling of broiler chicken meats was done randomly at poultry slaughterhouses in Karanganyar District.

2.2. Sample collection

One carcass of broiler chicken was randomly taken from enterprise poultry slaughterhouses after slaughtering process using a clean pair of latex gloves, a sterile bag, and cool box. Within 1 hours after sampling, samples were sent in an insulated box to Laboratory of Veterinary and Animal Health Center of Boyolali District where microbiology quality test were performed, and Laboratory of Livestock Processing Industry (Department of Animal Science, Faculty of Agriculture, Universitas Sebelas Maret*, Surakarta) for testing the physical quality of fresh chicken meat.

2.3. Microbiological test

Total Microbial Count was measured by Plate Count Agar (PCA) [15], the marking of the presence of *Escherichia coli* (*E. coli*) by [16], the marking of the presence of *Salmonella* [17].

2.4. Physical quality of chicken meat

Color test according to [18], texture test using a scale of one to five refers to [19], value of pH by [20].

3. Results and discussion

3.1. Condition of poultry slaughterhouses in Karanganyar

Results of research conducted in 12 MEPS and 8 SEPS spread in Karanganyar District stated there are 11 MEPS located in densely populated location (Table 1 and 2). All poultry slaughterhouses already has dirty and clean areas, although the use of the area is still less effective. [21] The dirty area is the area consisting of the place where the place of live poultry up to evisceration and the clean area consists of washing carcass up to the packaging stage. However, in most poultry slaughterhouses the dirty areas are used until the weighing stage of the carcass and the clean area is only used for carcass processing and packaging. Building of MEPS meets the SNI 01-6160-1999 standard on poultry slaughterhouse. The walls throughout the MEPS are already made of cement walls and are waterproof. Water used to clean the carcasses already used running water. The handling process of chicken was began with rest for a while before the chicken was cut.

Table 1. Conditions of medium enterprise slaughterhouses in Karaganyar District

Slaughterhouses tools of Indonesian National Standard	Conditions of medium enterprise slaughterhouses											
	1	2	3	4	5	6	7	8	9	10	11	12
1. The location is not in a crowded part of town	√	x	x	x	x	x	x	x	x	x	x	x
2. The buildings have dirty and clean areas	√	√	√	√	√	√	√	√	√	√	√	√
3. Buildings should be constructed of impact resistant walls, easy to clean and not flaking. The floor should be flat, waterproof material and easy to clea, and also good ventilation	√	√	√	√	√	√	√	√	√	√	√	√
4. Unloading of chicken is temporarily, rested and postmortem examination is done	√	x	√	x	√	√	x	x	√	√	√	√
5. The slaughter is done using an anti corrosive knife and is not easily damaged	√	√	√	√	√	√	√	√	√	√	√	√
6. Bleeding takes approximately 5 minutes	√	√	√	√	√	√	√	√	√	√	√	√
7. Scalding is done using anti-corrosive tools and periodically cleaned	√	√	√	√	√	√	√	√	√	√	√	√
8. Evisceration was performed using personal protective equipment (gloves, apron, headgear and mask) and anti-corrosive knives and antemortem examination	x	√	x	x	√	√	√	x	√	√	√	√
9. Carcass washing done in clean area using water flowing at least 25-35 liter/ tail	√	√	√	√	√	√	√	√	√	√	√	√
10. Carcass and parting process of chicken using a knife and anti-corrosive cutting board, and then do the packaging.	√	x	√	√	√	√	x	x	√	√	√	√

Caption: √ = in accordance with The Indonesian National Standard; x = not in accordance with The Indonesian National Standard

In other slaughterhouses, all SEPS buildings do not have dirty areas and clean areas. Poultry handling is done in the same room. The SEPS buildings are made of waterproof walls, flat floors and good ventilation. Bleeding process is done directly, because there was no resting room. The equipment used anti-corrosive tools and is cleaned regularly. This dirty equipment is a medium that can cause cross contamination from one carcass to another carcass [22]. In this study, some SEPS still use water that does not flow for the meat-cleaning process. Workers also have not used completely personal protective equipment. [15] Microbial contamination occurs due to a lot of equipment that is less clean, contamination from the hands of workers and contamination of water that has been contaminated. The process of slaughtering until the packaging is done as quickly as possible so as to minimize the

occurrence of direct contact with the outside. [5] High levels of bacterial cross-contamination may occur especially during defeathering and water chilling, with intestinal contamination apparently being the only source.

Table 2. Conditions of small enterprise poultry slaughterhouses in Karaganyar District

Slaughterhouses tools of Indonesian National Standard	Conditions of small enterprise poultry slaughterhouses							
	1	2	3	4	5	6	7	8
1. The location is not in a crowded part of town	x	x	x	x	√	√	√	√
2. The buildings have dirty areas and clean areas	x	x	x	x	x	x	x	x
3. Buildings should be constructed of impact resistant walls, easy to clean and not flaking. The floor should be flat, waterproof material and easy to clean, and also good ventilation	√	√	√	√	√	√	√	√
4. Unloading of chicken is temporarily, rested and postmortem examination is done	√	√	√	√	√	x	√	√
5. The slaughter is done using an anti corrosive knife and is not easily damaged	√	√	√	√	√	√	√	√
6. Bleeding takes approximately 5 minutes	√	√	√	√	√	√	√	√
7. Scalding is done using anti-corrosive tools and periodically cleaned	√	√	√	√	√	√	√	√
8. Evisceration was performed using personal protective equipment (gloves, apron, headgear and mask) and anti-corrosive knives and antemortem examination	x	x	x	√	√	√	x	x
9. Carcass washing done in clean area using water flowing at least 25-35 liter/ tail	x	√	√	√	√	√	√	√
10. Carcass and parting process of chicken using a knife and anti-corrosive cutting board, and then do the packaging.	√	√	x	√	√	x	x	√

Caption: √ = in accordance with The Indonesian National Standard; X = not in accordance with The Indonesian National Standard

3.2. Physical quality of chicken meat

The physical properties is very influential on the appearance of meat quality. Chicken meat has pH value of 6.26 - 6.30 that meet the normal pH of chicken meat, but the pH value still above the optimum pH of chicken meat.

Pre-postmortem treatment may affect the pH quality of chicken meat as it may affect the acidity or development of rigor time [23]. Based on the research, the treatment given by workers in some MEPS and SEPS on chicken before slaughtering was not rested so that the pH produced is different from previous research. Optimal pH of broiler chicken meat without treatment ranged from 6.11 to 6.25 [24]. Under normal conditions, fresh chicken meat has a pH range of about 5.3-6.5 post slaughtering [25]. The research refers to pH standard according to 6 - 7 [26].

The chicken meat color both MEPS and SEPS showed the normal color. Color scores 2 and 3 are good color scores for chicken meat because the pH value is about 5.70 - 6.50 [27]. Chicken meat that has not been exposed to contamination will be colored bright yellowish white has a pH of 5.7 to 6.50 [28]. The color of chicken meat influenced by several factors such as pH value, the lower the pH value so the color of the meat will be more pale [29].

The texture of chicken meat showed a variety of texture scores ranging from 3 to 5. This result was caused by a variety of pH value. The normal texture of chicken meat is related to pH and color values. Texture chicken meat has fine fibers and not mushy that shows a pH ranging from 5 - 6 and has a yellowish white color. However, the textures that tend to hard have a pH > 6 and a darker color [26].

The high value of final pH will increase the ability to bind water, because the meat fluid is bound by the protein. This causes the meat to have a harder texture that causes the texture of the meat becomes harder [30].

Table 3. The physical quality of broiler chicken meats in medium and small poultry slaughterhouses of Karanganyar District

Type of poultry slaughterhouses	No.	Physical quality		
		pH	Color**	Texture***
MEPS	1	6.12	3	5
	2	6.30	3	3
	3	6.24	3	5
	4	6.26	3	3
	5	6.11	3	5
	6	6.12	3	5
	7	6.27	3	3
	8	6.27	3	3
	9	5.99	2	4
	10	6.20	3	5
	11	5.96	2	4
	12	5.81	2	4
Mean±Stadev		6.14±0.15	2.75±0.43	4.08±0.86
SEPS	1	6.10	2	4
	2	5.90	2	4
	3	5.90	2	4
	4	6.26	3	3
	5	6.18	3	5
	6	5.98	2	4
	7	6.10	2	4
	8	6.15	3	5
Mean±Stadev		6.07±0.12	2.38±0.48	4.13±0.60

Caption: **: 2 = pale yellowish white, 3 = yellowish white.; ***: 3 = meat fibers rather smooth, not elastic and hard if pressed, 4 = fine meat fibers, elastic but feels moist when pressed, 5 = fine meat fibers, elastic and feels dry if pressed

3.3. Microbiological quality of chicken meat

Microbial contamination of meat begins since bleeding of slaughter steps, especially if the tools used for blood removal are not sterile. Therefore, it is necessary to test the quality of microbiology for contamination that occurs can be controlled [25].

The results showed that total bacteria of chicken meat samples was normal. The total bacteria in both MEPS and SEPS respectively were 11.8×10^4 CFU/g and 8.8×10^4 CFU/g. [26] Regarding to carcass and chicken quality, the maximum number of microbials in chicken meat was 1×10^6 CFU/g. Based on research, carcass washes at 12 MEPS already using running water and some equipment that was directly related to meat already using anti-corrosive materials.

The results showed that there were 14 samples of meat that were declared negative contaminated bacteria of *E. coli* and 6 samples of meat expressed positively polluted. The source of *E. coli* could be caused by equipment used for the process of slaughtering, evisceration and the division of meat. The bacteria lives normally in the intestinal tract of warm-blooded animals and can contaminate food in various ways, including hand pollution, during the evolutionary process, indirect pollution through water pollution, and product packaging [31]. *E. coli* probably comes from contamination with the environment especially water when processing [32]. This is consistent with the statement of [33], Contamination of *E. coli* in meat and its derivatives usually comes from water used at the time of

washing of carcass. The maximum limit of microbe contamination of *E. coli* in food is 1×10^1 CFU/g [20].

The results of *Salmonella* test showed that there was 1 MEPS positive bacteria contaminated. Previous research by [34] states that *Salmonella* bacteria are very easy to grow in a dirty environment of poultry slaughterhouse. The standard of food requires no *Salmonella* in 25 gram of food samples. The process of evisceration is not done quickly, whereas the process of evisceration is important in the process of handling chicken meat. The highest *Salmonella* contamination in poultry slaughterhouses occurred in the process of evisceration done manually so as to potentially cause contamination of carcasses. The process of manual evisceration can be done by considering the time of evisceration, the process must be done quickly and use the water flowing so that *Salmonella* contamination can be suppressed [35].

Tabel 4. Microbiological quality of broiler chicken meats in medium and small poultry slaughterhouses of Karanganyar District

Type of poultry Slaughterhouses	No.	Total plate count (TPC)	<i>E. coli</i> test	<i>Salmonella</i> test
MEPS	1	√	+	+
	2	√	+	-
	3	√	-	-
	4	√	-	-
	5	√	-	-
	6	√	-	-
	7	√	+	-
	8	√	+	-
	9	√	-	-
	10	√	-	-
	11	√	-	-
	12	√	-	-
SEPS	1	√	+	-
	2	√	-	-
	3	√	-	-
	4	√	+	-
	5	√	+	-
	6	√	-	-
	7	√	-	-
	8	√	-	-

Caption: √ = TPC in accordance with The Indonesian National Standard; x = TPC is not in accordance with The Indonesian National Standard; + = positive *Escherichia coli*, *Salmonella*; - = negative *Escherichia coli*, *Salmonella*

4. Conclusions

It can be concluded both MEPS and SEPS have the good physical quality of chicken meat (pH, color, and texture), and the total bacterial count of all fresh chicken meat did not exceed the maximum limit of microbial contamination established under SNI 3924-2009. However, there were meat contamination of *E. coli* in both MEPS and SEPS, and *Salmonella* in MEPS of Karanganyar District.

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