

Sanitation control of some equipments used in poultry slaughterhouse line

Kanatlı kesim hattında kullanılan bazı alet ve ekipmanlarda sanitasyon işleminin kontrolü

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ABSTRACT

Objective: Microbial contamination of chicken meat varies depending on various processes applied during production, slaughtering and processing. This study was carried out to investigate the effectiveness of sanitation (cleaning+disinfection) implemented in a commercial poultry slaughterhouse in Elazığ.

Methods: For this purpose, swab samples from defeathering machine fingers, outlet band of water cooling tank, outlet band of air cooling and end product band of diet department were taken to analyze the number of total mesophilic aerobic bacteria (TMAB), coliforms, *Enterobacteriaceae* and the prevalence of *Salmonella* spp. before sanitation and at the 20 and 30 minutes after sanitation process.

Results: Total mesophilic aerobic bacteria numbers of the samples taken from fingers of mechanical defeathering machine before sanitation and at the 30 minutes after sanitation process were 5.69 ± 0.83 , and 4.64 ± 0.83 log₁₀cfu/cm², and the differences between before and after sanitation were significant ($p < 0.05$). In addition, it was determined that the differences of the total mesophilic aerobic bacteria counts between before and after sanitation in the water cooling

ÖZET

Amaç: Tavuk etinin mikrobiyal kontaminasyonu üretim, işleme ve kesimhane aşamalarına bağlı olarak değişiklik göstermektedir. Bu çalışma, Elazığ'da bulunan ticari bir kanatlı kesimhanesinde uygulanan sanitasyon (temizlik+dezenfeksiyon) işleminin etkinliğini incelemek amacıyla yapıldı.

Yöntem: Bu amaçla mekanik tüy yolma makinesi parmakları, su soğutma tankı çıkış bandı, hava soğutma çıkış bandı ve diyet bölümü son ürün dizme bandında sanitasyon öncesi, sanitasyon sonrası 20. ve 30. dakikalarda swap örnekleri alınarak toplam mezofilik aerob bakteri, koliform grubu bakteri ve *Enterobacteriaceae* sayıları ile *Salmonella* spp. prevalansı yönünden araştırıldı.

Bulgular: Sanitasyon öncesi ile sanitasyon sonrası 30. dakikalarda toplam mezofilik aerob bakteri sayılarının tüy yolma parmağında sırasıyla; $5,69 \pm 0,83$, ve $4,64 \pm 0,83$ log₁₀ kob/cm² olduğu ve sanitasyon öncesi ile sonrası arasındaki farkın önemli olduğu tespit edilmiştir ($p < 0,05$). Ayrıca, toplam mezofilik aerobik bakteri sayılarının su soğutma çıkış bandında, hava soğutma çıkış bandında ve diyet bölümü son ürün bandında sanitasyon öncesi ile sonrası arasındaki

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outlet band, air cooling outlet band and the diet product final product band were significant ($p<0.05$). *Enterobacteriaceae* numbers of the samples taken from fingers of mechanical defeathering machine before sanitation and at the 20 and 30 minutes after sanitation process were 4.00 ± 2.09 , 2.43 ± 0.58 and 3.27 ± 0.69 log₁₀ cfu/cm², in the samples taken from outlet band of water cooling tank were 2.74 ± 0.82 , 1.47 ± 1.35 and 0.32 ± 0.86 log₁₀ cfu/cm², respectively. Coliform bacteria number of the samples taken from end product band of diet department before sanitation and at the 20 min after sanitation process were 2.44 ± 0.81 and 1.65 ± 1.43 log₁₀ cfu/cm², respectively, no coliform bacteria was detected at the 30 min after sanitation process. The prevalence of *Salmonella* spp. in the samples taken from defeathering machine fingers before sanitation and at the 20 and 30 minutes after sanitation process were 66.67%, 33.33% and 16.67%, respectively. *Salmonella* spp. was detected in 8.33% of the samples taken from outlet band of water cooling tank and air cooling. *Salmonella* spp. was not detected in the samples taken from the end product band of diet department at any time.

Conclusion: As a result, it can be speculated that the cleaning and sanitation process implemented in the related establishment is satisfactory, however, extending shelf life of the products and eliminating the poultry meat-borne pathogenic microorganisms that threaten public health, performing better sanitation process may be recommended.

Key Words: *Enterobacteriaceae*, *Salmonella* spp., sanitation, slaughterhouse, poultry

farkın önemli olduğu tespit edilmiştir ($p<0,05$). *Enterobacteriaceae* sayısı sanitasyon öncesi ve sonrası 20. ile 30. dakikalarda tüy yolma parmağında sırasıyla; $4,00\pm 2,09$, $2,43\pm 0,58$ ve $3,27\pm 0,69$ log₁₀ kob/cm², su soğutma çıkış bandında sırasıyla; $2,74\pm 0,82$, $1,47\pm 1,35$ ve $0,32\pm 0,86$ log₁₀ kob/cm² olarak tespit edildi. Diyet bölümü son ürün bandında sanitasyon öncesi ve sonrası 20. dakikada sırasıyla; $2,44\pm 0,81$, $1,65\pm 1,43$ log₁₀ kob/cm² olarak saptanırken sanitasyon sonrası 30. dakikada koliform grubu bakteriye rastlanmadı. *Salmonella* spp. prevalansı ise sanitasyon öncesi tüy yolma parmağında örneklerin %66,67'sinde, sanitasyon sonrası 20. dakikada %33,33'ünde ve 30. dakikada örneklerin %16,67'sinde, sanitasyon öncesi su soğutma çıkış ve hava soğutma çıkış bantlarında örneklerin %8,33'ünde *Salmonella* spp. tespit edildi. Diyet bölümü son ürün bandında ise hiçbir aşamada *Salmonella* spp. varlığına rastlanmadı.

Sonuç: Sonuç olarak, daha iyi bir hijyenin sağlanması, üretilen ürünlerin daha uzun raf ömrüne sahip olması ve kanatlı eti kaynaklı halk sağlığını tehdit edici mikroorganizmaları elemine etmek için sanitasyonun daha etkili bir şekilde yapılması önerilebilir.

Anahtar Kelimeler: *Enterobacteriaceae*, *Salmonella* spp. kanatlı, kesimhane, sanitasyon

INTRODUCTION

Microbial contamination of chicken meat vary depending on various processes applied during production, slaughtering and processing (1, 2). In spite of slaughtering hygiene, contamination of poultry meat with microorganisms can not be completely prevented. Many factors influence the microflora

of poultry meat. These factors include water, air, breeding conditions, transport, slaughterhouse process, packaging, and distribution conditions (3). Due to the factors effecting on poultry microflora, poultry and poultry meat can contain numerous and various microorganisms. Among these microorganisms,

pathogenic bacteria such as *Salmonella* spp., *Listeria monocytogenes*, *Bacillus cereus*, *Escherichia coli*, *Clostridium* spp. may be present (4, 5). Many studies have shown that *Salmonella* spp., *Campylobacter*, *Staphylococcus aureus* and pathogenic *Escherichia coli* strains are the main responsible microorganisms of chicken meat-borne infections (6-9).

The only one possibility of extending the shelf life of fresh chicken meat and inactivating pathogenic microorganisms is the implementation of an appropriate hygiene and sanitation program during operation. For this purpose, a number of studies have been carried out on the sanitation applications at different stages of the slaughter process. It has been reported that the hygiene and sanitation processes which are applied according to the product flow chart in the slaughtering process can reduce or increase the level of microorganisms on the final products (10-12). The prevalence of *Salmonella* and *Campylobacter* are found to be increased in the carcasses, especially after carcass cooling process, and it was reported that this increase is caused by cross contamination (13). The disinfectants which are applied to prevent cross-contamination in many slaughterhouse differ, due to their application dose and effectiveness. It is emphasized that sanitization applications are applied at more than one point (defeathering, crop removal, inner-outer bird washing, pre-cooling) or only in the last stage of the slaughtering process in the forms of immersion (pre-cooling water) or spraying (air cooling) (9, 14).

There are many chemical substances which antimicrobial effects have been investigated, and their effectiveness have been compared in many studies (6- 8, 11, 15). The most commonly used chemicals are organic acids (13), trisodium phosphate (15), chlorinated disinfectants (11), acidified sodium chloride (6), acetic acid (9), and cetylpyridiniumchloride (16). The antimicrobial effect of the used chemical substances depends on disinfectant, concentration, pH, temperature,

application time and application method. Applied chemical substances generally have a capacity of reducing *Salmonella* spp. up to 2-3 log₁₀ (9). Although there are many studies in the literature conducted on the microbial quality of poultry carcasses and carcass parts (17-22), there have been limited number of studies regarding the efficacy of disinfectant application on surfaces which have directly contact with the carcasses or carcass parts.

The present study was conducted to investigate the antimicrobial effect of the sanitation process, performed in a commercial slaughterhouse, on rubber fingers of mechanical defeathering machine, outlet band of water chilling tank, outlet band of air cooling band and the final product band.

MATERIAL and METHOD

Cleaning and Disinfection Process Applied in Slaughterhouse

The cleaning-disinfection operations in the slaughterhouse where the samples were taken, start with the physical cleaning using pressurized hot water at 50-60 °C. Subsequently, detergent (alkaline foam cleaning product at minimum 2% (v/v) concentration) is added to the system by automatic dispensing system and then foam application is performed. Afterwards, the brushing process is performed manually (minimum 20 minutes), and the cleaning step is completed by washing with hot water at 50-60 °C. Disinfection is applied after the cleaning phase. For disinfection application, at least 0.2% (v/v) solution of a commercial disinfectant containing minimum 30% (v/v) hydrogen peroxide solution, is prepared and applied to the defeathering machine by manually.

The disinfectant used for the outlet band of water chilling, outlet band of air cooling, and final product bands is prepared at minimum 2% (v/v) concentration by using a commercial disinfectant including C12-

C14-alkyldimethyl (quaternary salt and amphoteric substance), disodium tetraborate decahydrate, betains, quaternary ammonium alkaloids, quaternary salt and amphotericine, N-(3-aminopropyl), dodecylpropane-1,3-diamine (amine functionalized biocidal amine effective against Gram negative and Gram positive bacteria), and applied. Approximately 45 minutes after the disinfection process, rinsing is carried out using pressurized hot water at 50-60 °C. The qualitative residue control of disinfectants which are applied during slaughterhouse sanitation is carried out using test strips.

Samples Collection

Swab samples were collected from 4 different points including defeathering machine fingers (DF), water chilling outlet band (WC), air cooling outlet band (AC) and final product band (diet section) (DS) (before sanitation and at the 20 and 30 minutes after sanitation process). In a total 36 samples (4 sampling point x 3 samples for each sampling points x 3 sampling times) were collected in each sampling day, The study was repeated 4 times and a total of 144 swab samples were examined.

Samples were taken from 10x10 cm² area of the water chilling tank outlet band, air cooling outlet band and diet section by swab method. Swab samples of the mechanical defeathering machine were taken from the rubber fingers (~137 cm²). Total number of mesophilic aerobic bacteria (TMAB), *Enterobacteriaceae*, coliform group bacteria counts, and *Salmonella* spp. prevalence were determined.

Microbiological Analysis

Plate Count Agar medium (PCA) (Merck, Darmstadt/Germany) was used for total mesophilic aerobic bacteria counts, and petri plates incubated at 35 °C for 24-48 hours. Colonies were counted at the end of the incubation period (23). Violet Red Bile Dextrose Agar (VRBD) (Merck, Darmstadt/Germany) medium was used to detect count of *Enterobacteriaceae*. After the first layer of medium solidification, the second

layer of VRBD was added to the petri plates and plates were incubated at 37 °C for 24 hours. At the end of the incubation period, colonies with a red color of 1-2 mm in diameter and a ring shape around them were evaluated as a suspect colony of *Enterobacteriaceae*. At least 5 of the suspected colonies were taken and tested for oxidase and then total numbers were determined (24). Violet Red Bile Agar (Merck, Darmstadt/Germany) medium was used for coliform bacteria counts and petri plates were incubated for 24 hours at 37 °C. After the incubation period, all red colored colonies in petri dishes were counted as coliform bacteria (25).

Salmonella spp. samples were analyzed with the Mini Vidas at the slaughterhouse laboratory. For *Salmonella* spp. analysis the samples were taken with sterile sponges (10x10 cm², sponges weight approximately 25 g). Sponges were incubated at 41.5 °C for 18-24 hours in 225 ml buffered peptone water containing 1 ml *Salmonella* supplement (Biomerieux, France) for the pre-enrichment step. After the pre-enrichment step, 0.5 ml of samples were added to the wells of the Vidas up *Salmonella* test kits and heated on the Vidas heat&go for 5 minutes. Subsequently, the results were evaluated after 48 minutes. Manufacturer's guidelines were followed during *Salmonella* spp. analysis (BioMerieux, France).

Statistical Analysis

In this study, the microbiological data were converted to log₁₀ cfu/cm² and statistical analyzes were performed. For this purpose, conformity to the assumption of normality from the prerequisites of the parametric tests was performed using the Shapiro-Wilk test and the homogeneity of the variances were checked with the Levene "test and then parametric tests were used. Analysis of variance (ANOVA) test was performed determine the differences between the groups and post-hoc Tukey test was used for comparisons of the groups. The Kruskal Wallis test was used for the analysis of variance of the groups with no normality assumption, and pairwise comparisons of the groups were evaluated with the Mann Whitney U test.

All statistical analyzes were performed using the SAS (Statistical Analysis System) package program (26). The statistical significance level was accepted as $p < 0.05$.

RESULTS

Total Mesophilic Aerobic Bacteria (TMAB) Results

The TMAB counts on the defeathering machine fingers were 5.69, 4.55, and 4.64 \log_{10} cfu/cm² before sanitation, 20 min and 30 min after sanitation, respectively (Table 1). The differences between TMAB counts before, 20 and 30 min after sanitation were significant ($p < 0.05$). The differences in TMAB number before and after sanitation on the water chilling outlet band were not significant ($p > 0.05$). TMAB counts on air cooling outlet band were significant between before and 20 and 30 min after sanitation ($p < 0.05$). In the diet section, the difference between before sanitation and 20 minutes after sanitation was insignificant ($p > 0.05$), while the difference between before sanitation and 30 minutes after sanitation was significant ($p < 0.05$).

Before sanitation, the differences between the TMAB counts of defeathering machine fingers and other sampling points were significant ($p < 0.05$). A

significant difference was found between the water chilling and air cooling outlet bands, while there were not found any differences between the water chilling and air cooling outlet bands at 20 minutes after the sanitation ($p < 0.05$). 30 min after sanitation, the TMAB numbers were 4.64 \log_{10} cfu/cm² in defeathering machine fingers, while the water chilling output, the air cooling output and the diet section final product bands were 0.47, 0.19, and 0.09 \log_{10} cfu/cm², respectively. The differences between the defeathering stage and other sampling points were significant ($p < 0.05$).

Enterobacteriaceae Results

The difference between pre-sanitation and 20 min post-sanitary counts of *Enterobacteriaceae* was statistically significant ($p < 0.05$), while the difference between before sanitation and 30 min after sanitation was insignificant ($p > 0.05$). The difference between before sanitation, 20 and 30 min after sanitation in the water chilling outlet band was significant ($p < 0.05$). *Enterobacteriaceae* counts in the air cooling outlet band, before sanitation and 20 min after sanitation were 2.60, 1.46 \log_{10} cfu/cm² respectively, while

Table 1. The mean numbers of total mesophilic aerobic bacteria of the swab samples (\log_{10} cfu/cm²±SD), (n: 12)

Sampling Points	Sampling Time (min)		
	Before Sanitation	20 min After Sanitation	30 min After Sanitation
DF	5.69±0.83 ^{ax}	4.55±1.22 ^{ay}	4.64±0.83 ^{ay}
WC	0.32±0.86 ^{cy}	1.91±1.65 ^{bx}	0.47±0.93 ^{by}
AC	3.45±0.5 ^{bx}	1.52±1.64 ^{by}	0.19±0.38 ^{bz}
DS	3.03±0.4 ^{bx}	3.11±2.13 ^{abx}	0.09±0.31 ^{by}

abc: The numbers in the same column with the different letters are significantly different ($p < 0.05$).

xyz: The numbers in the same row with the different letters are significantly different ($p < 0.05$).

DF: Defeathering machine fingers; WC: Water chilling outlet band; AC: Air chilling outlet band; DS: Diet section.

Enterobacteriaceae was not detected 30 min after sanitation. The differences between before and after sanitation (20 and 30 min) were significant ($p < 0.05$). The differences between 20 min and 30 min after sanitation in diet section was significant ($p < 0.05$).

Although, *Enterobacteriaceae* counts differences between the defeathering machine fingers and water chilling output band were insignificant ($p > 0.05$), it was found that the differences among the defeathering machine fingers and other sampling points were significant ($p < 0.05$). It was determined that the difference between sampling points 20 min after sanitation was not significant ($p > 0.05$) and 30 min difference between defeathering machine fingers and other sampling points was significant ($p < 0.05$) (Table 2).

Coliform Bacteria Results

Coliform bacteria counts in the defeathering machine fingers were found as 4.16, 2.72, and 3.37 log₁₀ cfu/cm² before sanitation, 20 min after sanitation, and 30 min after sanitation, respectively. Coliform bacteria count differences between before sanitation and 20 min after sanitation on defeathering machine fingers were significant ($p < 0.05$). The differences among before sanitation, 20 min, and 30 min after sanitation on the water chilling outlet

band were significant ($p < 0.05$), while the differences on the air cooling outlet band were insignificant ($p > 0.05$). The difference between the before sanitation and 20 min after sanitation in the dietary section final product line was insignificant ($p > 0.05$). However, the difference between before sanitation and 30 min after sanitation was significant ($p < 0.05$). The differences among the defeathering step and other sampling points were significant before and 30 min after sanitation ($p < 0.05$) (Table 3).

Salmonella spp. Results

While 30 min after sanitation *Salmonella* spp. was not found in the diet section outlet band and air chilling outlet band, *Salmonella* spp. prevalences before sanitation in defeathering machine fingers, water chilling outlet band and air cooling outlet band were found as 66.67%, 8.33% and 8.33%, respectively. 20 min after sanitation, *Salmonella* spp. prevalence in defeathering machine fingers was found as 33.33%, while on water chilling, air cooling and diet section were not detected. The prevalences of *Salmonella* spp. in defeathering machine finger and water chilling outlet band 30 min after sanitation were found as 16.67% and 8.33%, respectively. *Salmonella* spp. was not detected on the air cooling outlet band and the diet section (Table 4).

Table 2. The mean numbers of *Enterobacteriaceae* of the swab samples (log₁₀ cfu/cm²±SD), (n: 12)

Sampling Points	Sampling Time (min)		
	Before Sanitation	20 min After Sanitation	30 min After Sanitation
DF	4.00±2.09 ^{ax}	2.43±0.58 ^{ay}	3.27±0.69 ^{axy}
WC	2.74±0.82 ^{abx}	1.47±1.35 ^{ay}	0.32±0.86 ^{bz}
AC	2.60±0.49 ^{bx}	1.46±1.46 ^{ay}	0.00±0.00 ^{bz}
DS	2.57±0.86 ^{bx}	1.55±1.36 ^{ay}	0.00±0.00 ^{bz}

ab: The numbers in the same column with the different letters are significantly different ($p < 0.05$).

xyz: The numbers in the same row with the different letters are significantly different ($p < 0.05$).

DF: Defeathering machine fingers; WC: Water chilling outlet band; AC: Air chilling outlet band; DS: Diet section.

DISCUSSION

This study was conducted to investigate the effectiveness of the sanitation (cleaning + disinfection) treatment applied in poultry slaughterhouses with the samples taken from steps with different levels of pollution, which can be the source for cross contamination in slaughterhouses. Although there are many studies on poultry meat, carcass parts and decontamination materials (6-8, 11, 15, 17-22), a very limited number of literature regarding effectiveness of sanitization are available. Results of these studies summarized below.

Rasschaert et al. (27) investigated the slaughtering process for *Salmonella* contamination in 3 different broiler slaughterhouses located in Belgium and applying the same production procedure. There had been analysed samples for *Salmonella* spp. which were taken one hour before the starting slaughter and a few hours after the cleaning-disinfection process from defeathering machine, which was selected as an important equipment for contamination, and it stated that the defeathering machine was risky for *Salmonella* spp. contamination. They detected *Salmonella* spp. in the first slaughterhouse, 24 samples were tested and 17

Table 3. The mean numbers of coliform bacteria of the swab samples (\log_{10} cfu/cm 2 ±SD), (n: 12)

Sampling Points	Sampling Time (min)		
	Before Sanitation	20 min After Sanitation	30 min After Sanitation
DF	4.16±1.53 ^{ax}	2.72±0.55 ^{ay}	3.37±0.75 ^{axy}
WC	2.76±0.59 ^{bx}	1.40±1.44 ^{aby}	0.46±1.00 ^{by}
AC	0.47±0.93 ^{cy}	0.99±1.35 ^{bx}	0.00±0.00 ^{by}
DS	2.44±0.81 ^{bx}	1.65±1.43 ^{abx}	0.00±0.00 ^{by}

abc: The numbers in the same column with the different letters are significantly different ($p < 0.05$).

xy: The numbers in the same row with the different letters are significantly different ($p < 0.05$).

DF: Defeathering machine fingers; WC: Water chilling outlet band; AC: Air chilling outlet band; DS: Diet section.

Table 4. *Salmonella* spp. prevalences of the swab samples (%) (Positive samples/Total samples), (n: 12)

Sampling Points	Sampling Time (min)		
	Before Sanitation	20 min After Sanitation	30 min After Sanitation
DF	66.67% (8/12)	33.33% (4/12)	16.67% (2/12)
WC	8.33% (1/12)	0.00% (0/12)	8.33% (1/12)
AC	8.33% (1/12)	0.00% (0/12)	0.00% (0/12)
DS	0.00% (0/12)	0.00% (0/12)	0.00% (0/12)

DF: Defeathering machine fingers; WC: Water chilling outlet band; AC: Air chilling outlet band; DS: Diet section.

(70.83%) of them received from the clamps, conveyor belts and wheels of the defeathering machine, from the fingers and between the fingers were positive in means of *Salmonella* spp., in the 2nd slaughterhouse 12 samples were tested and 7 (58.3%) of them taken from out of the bands among the conveyor belt, wheels and fingers were positive. *Salmonella* spp. was not detected in the samples taken from the third slaughterhouse. They emphasized that transport vessels and the slaughterhouse environment could also be contamination source for the final products. In our study, *Salmonella* spp. was detected in 66.7% of the samples taken from the defeathering machine in pre-sanitation stage.

In a study conducted in the poultry slaughterhouse in South Africa 7.7 log₁₀ cfu/cm² TMAB count was reported on the defeathering machine fingers (28). In this study, TAMB was found 5.69 log₁₀ cfu/cm² before the sanitation. The reason of the lower number of detected TMAB, because of the differences in the sampling methods between the studies, and the poultry slaughtered at different times also may have different microbial loads.

Geornaras et al. (28), was found the number of TMAB more than 6 log₁₀ cfu /25 cm² and the number of *Enterobacteriaceae* more than 4 log₁₀ cfu/25 cm² in swabs taken from a band in the packaging section. In our study, the TMAB numbers of the 2 different bands (air cooling and final product bands) in the packaging area of the slaughterhouse were 3.45 and 3.03 log₁₀ cfu/cm² respectively; while the number of *Enterobacteriaceae* were 2.60 and 2.57 log₁₀ cfu/cm², respectively.

Arnold (29) determined the number of TMAB in the rubber fingers of three different slaughterhouse as 2.98 log₁₀ cfu/cm² for the first slaughterhouse, 3.70 log₁₀ cfu/cm² for the second slaughterhouse, and 5.57 log₁₀ cfu/cm² for the third slaughterhouse. In our study, number of total mesophilic aerobic bacteria were detected as 5.69 log₁₀ cfu/cm² at the defeathering machine finger. The number of total

mesophilic bacteria that was found in the other two slaughterhouse by Arnold (29) were considerably lower than our findings, although there is a similarity between the TMAB count of the third slaughterhouse and the number of TMAB counts we found in our current study.

Abu-Ruwaida et al. (30) investigated the microbial contamination of equipment and containers in two different poultry slaughterhouse in Kuwait and found that in the first and second slaughterhouse of 10-20 cm² of chicken pick-up band, one of the surfaces chosen from packaging area had 5.4 and 5.3 log₁₀ TMAB, respectively. In the present study, 3.45 log₁₀ TMAB were detected in each cm² in the swab result of pre-sanitation from the air-cooling outlet band. The reasons of the differences between these studies and our findings, may be the sampling method, the water temperature used in scalding, the chemical decontaminants added to the scalding water, the duration of scalding, the outer surface pollution ratings of the poultry, the amount of water entering the water chilling tanks, the type and amount of disinfectants used in the water chilling, the cleaning, disinfection, and hygiene program applied in the slaughtering process.

In this study, the number of microorganisms detected in samples that were taken at 20 and 30 min after sanitation in the same places were higher than the pre-sanitation values, this can be due to cracks, deformations or roughness of the fingers or finger surfaces where swabs were taken. Effective sanitation does not take place in these areas due to the fact that both sanitary and disinfectant substances can not sufficiently affect in these sites. There is no criteria for hygienic condition of tools and equipments in the Turkish Codex Alimentarius, Regulation on Microbiological Criteria Annex-2 In production hygiene criteria (31), there is only microbial criteria for broiler and turkey carcasses. However, in our study, it was determined that the *Salmonella* spp. prevalence reduced as passing from

the dirty area to the clean area, and it was evaluated as a positive result that *Salmonella* spp. was not detected in the final product band.

In conclusion, microorganisms from the environment after the cleaning process can multiply rapidly in the food production enterprises and cause contamination in the next production. In addition to, some of the microorganisms during cleaning process can be removed by the water and spreaded to other surfaces. For this reason, a disinfection process must be performed after the cleaning process. The disinfection process, must completely destroy or reduce level of microorganisms that do not cause harmful effects. Equipment, tools, conveyor belts etc. used in operation should not be deformed, torn, cracked, rough or worn. Due to this, to change the

defective, and problematic tools and equipments at the end of every working day or taking the necessary precautions by taking control of the slaughter line are very important for hygiene. Effective hygiene procedures are also essential for effective hygiene measures (including an effective hygiene program, appropriate water use, appropriate disinfectant selection and replacement at regular intervals, appropriate dosage, appropriate duration of effect, personnel training, etc.). In addition, it is extremely important for product hygiene that the necessary hygiene measures (an effective hygiene program, the appropriate use of water, appropriate disinfectant selection and replacement at regular intervals, appropriate dose, appropriate duration of effect, personnel training etc.) should be applied effectively.

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