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Comparison of Dry and Wet De-Feathering Methods on the Quality Characteristics and Shelf Life of Broiler Carcasses

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ABSTRACT
In poultry slaughterhouses, carcasses can be contaminated with microorganisms at various points during the slaughtering processes, affecting some quality characteristics and shelf life of chicken meat. The present study was conducted to investigate the effects of different de-feathering methods on the meat quality characteristics and shelf life of broiler chickens. Forty male broilers 42 days of age (Ross 308) were used in the experiment. After slaughtering, they divided into 2 groups and first group was de-feathered by simple dry plucking method (DPM) and the other was a classic wet method (CWM). 5 fillets and 5 drumsticks from each treatment group were analyzed 0, 3, 5, and 7th days of storage time. The water holding capacity (WHC), color, pH and Warner-Bratzler shear force value (W-BSFV) were analyzed for meat quality characteristics of the raw meat samples. Total aerobic mesophilic bacteria, total psychrophilic bacteria, numbers of microorganisms assessed critically for food safety such as coliform bacteria, *E. coli*, *Enterococcus* spp. *Campylobacter* spp. also, the presence of *Salmonella* spp. in carcasses was determined. The results indicated that the skin colors of the fillets and drumsticks were yellower and the meat color of the drumsticks was darker in the DPM group than CWM. On the other hand, no significant effects of the plucking method were detected on the WHC and W-BSFV of the samples. The pH value of the fillets was higher in CWM group ($P<0.01$), but there were no differences between the pH values of drumsticks of two groups. The microorganism levels, however, were influenced significantly ($P<0.01$) by the plucking methods and the storage time. The shelf life of the carcasses was shortened, due to the high microbial load in DPM group. It is concluded that simple DPM may be used by low capacity farms which produce the broilers for consumers who prefer yellow-skinned chicken meat at the expense of reduction in the shelf life due to increased microbial load.

Keywords: Dry feather plucking, Meat quality, Microbial properties, Texture, Water holding capacity

1. Introduction

Poultry meat is the most important source of low-cost animal protein, rich in nutrients, minerals and vitamins. This protein source may contain a high level of pathogenic and spoilage bacteria, and may have risk for human health. Therefore, the level of microorganisms in chicken meat is important in terms of food safety.

In general, chicken feathers, skin, feet and digestive tracts are contaminated with microorganisms due to the farm conditions and production methods. Therefore, it is important to be careful during harvesting, transporting and also slaughtering processes after bleeding. In classic wet method which is widely used, there is a risk of contamination of the broiler carcasses at various points during the slaughtering process, mainly as scalding (immersion in water), de-feathering and evisceration. At the stage of evisceration, especially when the internal organs are mechanically separated, the intestines are mostly damaged by the equipment, thus causing fecal contamination of the carcasses. In addition, scalding and plucking processes may remove the epidermis layer of the skin. This may cause bacteria contamination, quick growth of bacteria and increased colonization on the carcass surface during the intestines removal and water cooling stages, which affects the shelf life of the meat (Erginkaya & Yurdakul 2010; Var et al. 2011). At the same time, there is also cross-contamination risk of other carcasses via contaminated equipments in slaughterhouses (Rivera-Perez et al. 2014; Hernandez et al. 2018; Perez-Arnedo & Gonzalez-Fandos 2019).

These bacterial contaminants have been known to affect some quality characteristics and the shelf life of chicken meat. Furthermore, it threatens human health. Studies showed that chicken meat can be contaminated with different pathogenic microorganisms especially *Salmonella* spp. and *Campylobacter jejuni*, which causes food infections in humans (Erol 2007).

Dry plucking is another method used for de-feathering of poultry. In this commercially applied method, a hot water boiler is not used to soften the feathers of the chickens. Instead of being immersed in the hot water, the chickens are passed through steam tunnels to loosen their follicles. Softened feathers are cleaned with the help of automatic plucking machines (Anonymous 2021). Another dry plucking method we used in our research is the simple dry plucking method. In this method, a dry plucking machine is used, consisting of a system on which gears are used to catch and pluck the feathers. The stems, whose cutting process has been completed, are taken one by one without wetting the feathers, and their feathers are plucked in the dry plucking machine. After the carcass is thoroughly washed, it is rested at +4 ºC until it cools down. Since feather plucking can be done hot or cold in the animals applied DPM, microbiological problems do not occur in the carcass due to burning and moisture, so the shelf life of the carcass is long.

In some studies, it has been reported that there is an increase in the level of microorganisms in carcasses after the application of the classical wet plucking (Anıl et al. 1989; Pacholewicz et al. 2015; Althaus et al. 2017; Ae Kim et al. 2017; Corry et al. 2017; Mota-Gutierrez et al. 2022). On the contrary, the DPM is a more hygienic method since immersion in hot water is not carried out after cutting and therefore the risk of contamination by pathogenic microorganisms is limited (Riggs et al. 2011).

The present study is important and original in the lack of scientific research on the comparison of the effect of dry and wet plucking methods on the quality and shelf life of the broiler carcasses. In addition, it is also important to reveal which one is a more hygienic method and for producing healthy meat. The DPM can be preferred as an alternative method for them. Therefore, the present study was conducted to determine the effects of different feather plucking methods on the meat quality characteristics and shelf life of the broiler carcasses.

2. Material and Methods

2.1. Breeding and De-feathering of animals

Forty male broilers (Ross 308) at 42 days of age obtained from a private company were used in the experiment. All the animals were raised up in the same flock using the same feeding regimes, in which four types of feeds were used such as, broiler starter feed (0-11 day, 3 000 Kcal/kg ME; 23% CP), grower feed 1 (11-21 day, 3 100 Kcal/kg ME; 22% CP), grower feed 2 (22-37 day, 3 250 Kcal/kg ME; 20% CP) and finisher feed (38-42 day, 3 250 Kcal/kg ME; 20% CP) during the fattening period. The selection process ensured the same breeding and feeding period, feed and feeding conditions, age, sex and approximately similar weight. All vaccinations of the animals have been made and care has been taken to ensure that they are healthy. The birds were divided into two groups and each group was included twenty birds. After the birds were cut from the neck, they were left for 1-2 minutes for bleeding. In the classical wet method, the birds were scalded by placing the carcasses in a 50-60 °C hot water tank for 60-90 seconds to ensure that the feathers are easily plucked. The wetted bodies were subjected to the first cooling process in cold water after they were plucked in the plucking machine. Later, they were eviscerated, washed, rested in cold water and drained respectively (Türkoğlu & Sarıca 2014).

In the simple dry plucking method, a dry plucking machine consisting of a system with gears to catch and pluck the feathers was used. The birds were de-feathered one by one in the dry plucking machine without scalding step. Afterward, they were eviscerated, washed and stored at + 4 °C up to analysis was done.

All the carcass of two groups were placed in sterile bags individually and transferred to Cukurova University Animal Nutrition Laboratory, and stored at +4 °C up to analysis was done. Each group was stored in a different refrigerator so that there is no contamination from one group to another. A total of 10 carcasses at week 0, five from each group, were used to perform the meat quality study after cutting. The rest of 30 carcasses, 15 from each group, were stored at +4 °C for 7 days (as the current legislation could let chicken meat to consume maximum 7 days from the slaughter) (GSO 2013) to carry out the shelf life studies.

Five breast and five drumsticks samples from each treatment group were analyzed for pH, WHC and W-BSFV during storage at day 0, 3, 5, and 7 of the shelf life. Only colors of breast and drumstick were analyzed for their muscle and skin separately.

The experimental procedure was approved by the Ethics Committee of Cukurova University (Approval No: 2022-5)

2.2. pH value

To determine pH values of the raw meat obtained from the drumstick and breast meat taken from each carcass was separately minced. One hundred mL of pure water was added to 10 g of meat samples taken from the minced meat, and homogenizers were used to homogenize the samples for 1 min, after which the pH values were read by means of a pH meter (HANNA HI99163).

2.3. Color

The basic color parameters *(L*, a*, b*)* of the breast and drumstick skins as well as meat samples (minced) from the left side muscle were measured by using a spectrocolorimeter (HunterLab, ColorFlex EZ) (Hunt et al. 1991).

2.4. Warner-Bratzler shear force value

Muscle samples were removed from the left side of the *pectoralis major*. Raw meat samples were cut into 1 cm × 2 cm × 3 cm (height × width × length) pieces with the length following the fiber direction. The texture analyzer which has an HDP/WBV Warner Bratzler blade set with V slot table was used for determining of the shear force value (TA/XT Analyzer Plus of Stable Micro Systems, Vienna Court, UK). Samples were sheared at a test speed of 5 mm/s, and perpendicular to the longitudinal orientation of the muscle fibers. The probe's pre-test speed was 10 mm/s, test speed 5 mm/s and cutting distance 5 cm. The mean of recorded peak shear force (kg) of samples was used for statistical analysis (Barbanti & Pasquini 2005; Carvalho et al. 2013; Schwarz et al. 2021).

2.5. Water holding capacity

WHC was estimated by centrifuging 1 g of the sample placed on tissue paper in a tube for 4 minutes at 1500 rpm. The water remaining after centrifugation was measured by drying the samples overnight at 70 °C (Castellini et al. 1998).

WHC has been calculated as follows (Eq 1).

$$WHC\ (\%) = (M1 - M2) / m \times 100 \quad (1)$$

M1: Filter paper + sample weight
M2: Filter paper + dry weight
m: Initial sample weight

2.6. Microbiological analysis

In the experiment, the microbiological quality of carcasses was determined by using the method of Ransom et al. (2002). Samples were collected from the muscle and skin parts of the 5 randomly selected carcasses in each group at days 0, 3, 5, and 7th of the shelf life and analyzed to determine the microorganism levels. Ten grams of muscle and skin pieces were taken from the drumstick and breast areas per carcass for microbiological analysis. Samples were added to 90 mL of 0.1% sterile peptone water and homogenized using a stomacher for 2 minutes. Then serial dilutions were made up to 10^{-8} in the tubes containing 9 mL of sterile peptone water.

Total mesophilic and psychrophilic bacteria counts were calculated using the petri dish spread method. The prepared dilutions spread to the Petri dishes they were incubated for 2 days at 30 °C and 10 days at 10 °C for mesophilic and psychrophilic bacteria growth (respectively). Violet Red Bile Agar VRBA, Oxoid, CM 0107) was used to state the total coliform bacteria count using the double pouring plate method. Petri dishes were incubated for 24 h at 37 °C. Total *Enterococcus* spp. counts were determined by pouring method with Kanamycin Aesculin Azide Agar Base (OXOID) (Oxoid CM 485) and were incubated for 18 hours at 37 °C, BD 151 *Campylobacter* Agar was used to determine *Campylobacter* spp counts 37 °C, in a jar and microaerobic atmosphere 42-48 hours. *E. coli* isolation was made in Tryptone Bile X–Glucuronide Medium (TBX) (Oxoid CM 945), for 24 hours at 30 °C. The presence of *Salmonella* spp. was determined by the ISO (2007) 6579 procedure (ISO 6579:2002/amd 1). The first step of the study; 25 g (mL) carcass samples were incubated in 225 mL peptone water (Peptone Water; Buffered (TPS) * 1.07228.0500) pre-enrichment (18±2 hours at 37 ºC), from which 0.1 mL is taken and 10 mL *Salmonella* Enrichment Broth acc. To Rappaport- Vassiliadis ((RVS Broth) * 1.07700.0500) is inoculated into the liquid medium and selective pre-enrichment is performed (24±3 hours at 41.5 ºC). Seeding was done on XLD agar and the empty colonies were confirmed on TSI agar. Seeding was done on Xylose Lysine Deoxycholate (BD, XLD agar) Agar and the empty colonies were confirmed on BD Triple Sugar Iron Agar (TSI Agar).

2.7. Statistical analysis

Data were processed using a general linear model of the ANOVA that included: plucking methods (group), the shelf life of the carcass (day), and its interaction as fixed effects. The data were analyzed statistically using the GLM (General Linear Model) procedure of SAS (2004). Statistical significance was declared at $P \leq 0.05$. All data are reported as least squares means with pooled standard errors (SEM).

3. Results and Discussions

3.1. Meat quality results

The color values of the meat and skin samples of the drumstick and breast parts were determined and analysis results were summarized in Table 1 and Table 2. According to the research results, the plucking method had significant effects on the drumstick meat and skin color *L**, *a** and *b** values (P<0.01). Also, an interaction was observed between the plucking method and the shelf life with respect to drumstick meat redness (P<0.01) and yellowness (P<0.05).

Table 1-The effect of plucking methods on the drumstick skin and meat color in shelf life studies

Drumstick Skin Color	*Shelf Life (day)*	*Group (Plucking Method)*		*SEM*	*P*		
		Dry Plucking Method	*Wet Classic Method*		*Group*	*Day*	*Group x Day*
L*	**0**	64.3	67.4	0.81	< 0.01	0.014	0.317
	3	64.6	67.8				
	5	63.6	64.1				
	7	63.1	65.8				
a*	**0**	2.1	2.3	0.56	< 0.01	< 0.01	0.082
	3	2.5	-0.2				
	5	1.9	0.6				
	7	0.4	-1.3				
b*	**0**	23.8	11.6	1.33	< 0.01	0.013	0.430
	3	22.3	6.4				
	5	21.9	12.3				
	7	20.5	6.6				
Drumstick Meat Color							
L*	**0**	59.0	67.4	0.87	< 0.01	0.053	0.245
	3	58.8	67.8				
	5	58.5	64.1				
	7	57.7	65.8				
a*	**0**	4.6	2.3	0.53	< 0.01	0.098	< 0.01
	3	4.6	-0.2				
	5	5.9	0.6				
	7	7.7	-1.3				
b*	**0**	21.3	11.6	1.13	< 0.01	0.074	0.028
	3	20.5	9.4				
	5	21.8	12.3				
	7	22.2	6.6				

***L**:** Lightness, ***a**:** Redness, ***b**:** Yellowness

While the effect of the plucking method on the breast skin color was found to be significant in terms of *a** and *b** values (P<0.01), the effect of the shelf life stage was determined to be significant only in terms of *a** value (P<0.01). On the other hand, the effect of the plucking method on the breast meat color was significant in terms of the *L** value (P<0.01), in the meantime, the effect of the shelf life stage was significant with respect to *a** (P<0.01) and *b** (P<0.05) values. Our finding shows that the drumstick and breast skin colors of the CWM group were brighter than those of the DPM group. In light of these results, it can be said that water treatments (scalding and cooling) cause the skin to shine. It has been reported that high water temperatures at scalding affect the appearance and color of the skin (Heath & Tomas 1973). If the scalding temperature is 60-66 °C and the exposure time is 45-90 s, the epidermis or cuticle of the carcass is removed. So, the yellow skin color turns into pale white (Heath & Tomas 1973; Perez-Vendrell 2001). In this study, the epidermis layer was intact and the skin was yellow, because scalding treatment was not applied during slaughtering in the DPM group. Also, the DPM group's skin colors were found to be redder and yellower. These increases in *a** and *b** values may be a result of bloody tissue formation, depending on the pressure applied to the skin during plucking.

Table 2-The effect of plucking methods on the breast skin and meat color in shelf life studies

Breast Skin Color	*Shelf Life (day)*	*Group (Plucking Method)*		*SEM*	*P*		
		Dry Plucking Method	*Wet Classic Method*		*Group*	*Day*	*Group x Day*
L*	**0**	63.4	66.4	0.71	0.141	0.073	0.054
	3	63.9	63.8				
	5	63.4	62.7				
	7	63.1	63.9				
a*	**0**	3.0	3.0	0.60	< 0.01	< 0.01	0.071
	3	3.0	-0.2				
	5	2.6	1.2				
	7	0.6	-0.6				
b*	**0**	24.7	13.3	0.92	< 0.01	0.159	0.863
	3	23.4	11.0				
	5	23.6	13.5				
	7	22.0	10.6				
Breast Meat Color							
L*	**0**	62.1	58.0	0.92	< 0.01	0.056	0.112
	3	62.9	60.9				
	5	59.6	60.1				
	7	60.4	58.7				
a*	**0**	4.9	2.8	0.43	0.768	< 0.01	< 0.01
	3	4.0	6.1				
	5	6.6	6.6				
	7	6.1	6.4				
b*	**0**	23.5	20.6	0.36	0.324	0.018	< 0.01
	3	21.5	23.4				
	5	22.9	23.5				
	7	23.1	22.5				

***L**:* Lightness, ***a**:* Redness, ***b**:* Yellowness

Drumstick meat color was brighter and light colored in the CWM group, while it was redder and yellower in the DPM group. It is reported that lighter color of meat was associated with low WHC just as dark color is related to high WHC (Qiao et al. 2001; Mudalal et al. 2014; Tijare et al. 2016; Cai et al. 2018). This may be related to the light color of the drumstick meat in our study. Unlike the drumstick, the breast meat color was brighter and lighter in the DPM group. It is reported that there is a significant negative correlation between the light color and pH values of breast meat (Barbut 1993; Allen et al. 1997; Qiao et al. 2001). Just like our results, low pH causes the spread of proteins in the muscle and the light is reflected differently from the surface and causes light color (Mir et al. 2017).

The effects of different feather plucking methods and shelf life stage on pH, W-BSFV and WHC are presented in Table 3. According to the results obtained from the present experiment showed that the plucking methods and shelf life stage have no significant ($P>0.05$) effects on W-BSFV and WHC. On the other hand, the W-BSFV was higher in the breast meat of DPM group on the first day and no differences were observed between the means of all groups for the shelf life duration. In both DPM and CWM pH value of the drumstick has no significant differences, although higher pH value tendency was observed in the breast part of the DPM group ($P<0.01$). The shelf life studies showed that, a significant decrease tendency was observed pH value of the drumstick (DPM: 6.15; CWM: 6.18) and the breast meat of the DPM application group.

Table 3-The effects of different feather plucking methods on pH, W-B shear value (kg) and water holding capacity (%) in shelf life studies

Parameters	*Shelf Life (day)*	*Group (Plucking Method)*		*SEM*	*P*		
		Dry Plucking Method	*Wet Classic Method*		*Group*	*Day*	*Group x Day*
Drumstick pH	**0**	6.1	5.9	0.10	0.613	0.103	0.145
	3	6.0	6.2				
	5	6.3	6.2				
	7	6.2	6.4				
Breast pH	**0**	5.8	5.9	0.05	< 0.01	0.256	0.166
	3	5.7	5.9				
	5	5.8	5.9				
	7	5.8	5.8				
Breast W-B Shear Value	**0**	35.0	34.0	1.79	0.533	0.221	0.997
	3	34.1	33.1				
	5	33.4	32.6				
	7	31.1	30.7				
Drumstick WHC	**0**	76.0	76.4	0.68	0.504	0.844	0.308
	3	76.3	76.2				
	5	76.3	75.5				
	7	74.8	76.6				
Breast WHC	**0**	75.1	75.2	0.57	0.962	0.287	0.247
	3	75.3	76.4				
	5	75.1	75.0				
	7	76.5	75.3				

W-B: Warner-Bratzler**, WHC:** Water Holding Capacity

It has been reported that there is a negative correlation between the pH and *L** value of breast meat. Although the pH value of light colored meat shows a marked tendency towards a decrease, there is a reverse tendency in dark colored meat (Allen et al. 1997; Barbut 1997; Fletcher 2002; Petracci 2004; Kralik et al. 2014). Additionally, there are some reports stating that if the pH value of the muscle after slaughtering is high, it causes the meat to be dark, hard and dry as well as shortens its shelf life. On the other hand, low pH values at 24 hours after slaughtering causes the WHC and color intensity of the meat to be lower but leads to a longer shelf life of the meat (Yang 1993; Allen et al. 1997). Similarly, in our study the pH value of drumstick meat was higher in the DPM group on the slaughtering day, and so the meats became harder (DPM: 74.0; CWM: 72.9) and darker (DPM 59.0 - CWM 67.4), and the deterioration occurred earlier than the other group. On the other hand, the low pH value of drumstick meat in the CWM group caused high WHC and *L** values.

However, our findings suggesting low pH value and WHC of breast meat caused high *L** values in DPM group do not support the previous findings (Yang 1993; Allen et al. 1997).

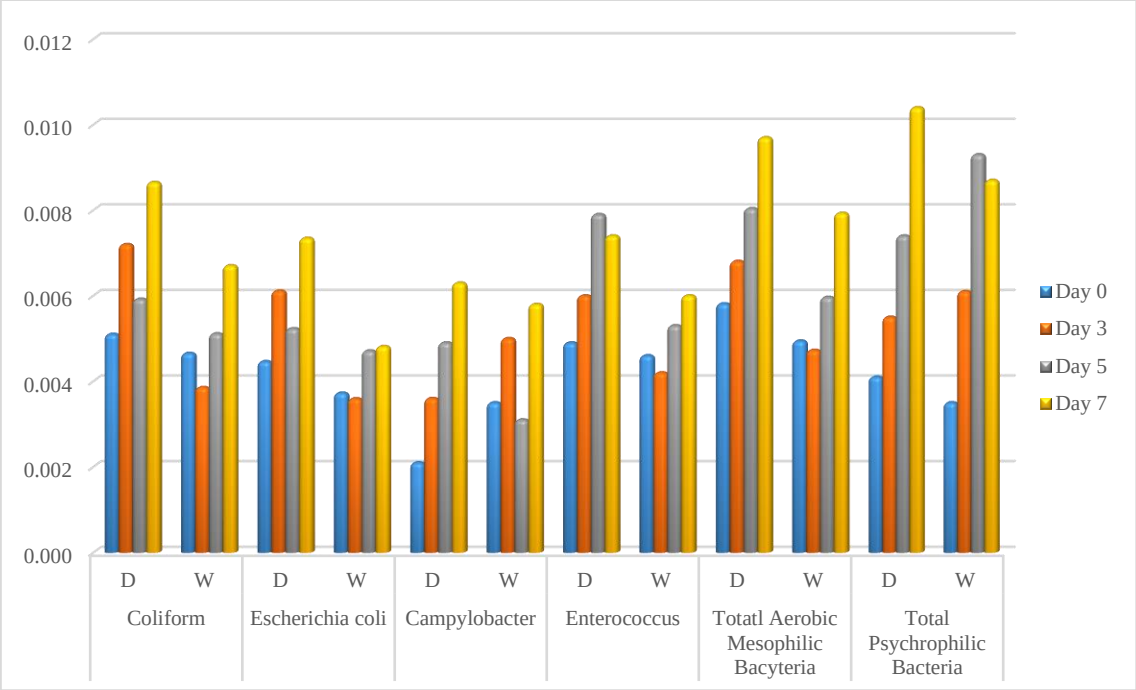
In our study, in the DPM group, the W-BSFV of the breast meat increased after slaughter, and the meat was hardened when compared with the CWM group. Anton et al. (2019) report that, after death, muscle cells are producing lactic acid and release proteolytic enzymes. This causes the disruption of connective tissue and results in the softening of the meat. This degradation occurs only when the meat is warm. In our research, the CWM group was scalded in hot water. So the cooling rate of the carcass has been slower than the DPM group. This resulted in the muscles being softer than the DPM group.

According to the results of shelf life studies, the plucking methods did not have a significant effect on the WHC. The average WHC of the drumstick was higher in the CWM group (DPM: 75.85; CWM: 76.20), but in the breast meat, the WHC was higher in the DPM group (DPM: 75.50; CWM: 75.48). The pH value of meat becomes low due to changes in myofibrillar structure in the muscle, which also causes low WHC (Petracci, 2004). The reason for the lower WHC of the drumstick in the DPM group (DPM: 75.85; CWM: 76.20) is because the mean pH value was lower (DPM: 6.15; CWM: 6.18). Also, the pH value of the breast meat was lower in the DPM group (DPM: 5.78; CWM: 5.88), while the WHC is lower in CWM group (DPM: 75.50; CWM: 75.48). It is reported that a low pH value of poultry meat is related to low water-holding capacity (WHC), so cook-loss, drip loss, shelf life is increased and tenderness is decreased (Barbut, 1993). The broiler breast meat is so light colored when the muscle holds much water (Petracci 2004). According to the research findings, it was determined that the WHC of breast meat in the CWM group after slaughtering was higher (DPM: 75.10; CWM: 75.20) and the color was darker (*L** value) (DPM: 62.10; CWM: 58.00), contrary to report.

3.2. Microbiological results

In the present study, samples were collected from the meat and skin parts of the carcasses at day 0, 3, 5 and 7th of the shelf life

and analyzed to determine the microorganism levels. Our results indicate that, the effects of plucking methods and shelf life stage on total mesophilic aerobic bacteria, total psychrophilic bacteria, coliform bacteria, *E. coli*, *Campylobacter* and *Enterococcus* spp. levels of the carcass after slaughtering were very significant (P<0.01). At the same time, the level of microorganisms was higher in the DPM group, compared with the CWM group, both after slaughtering and at the end of the shelf life studies (Figure 1). *Salmonella* was, also, found in the DPM and the CWM groups at day 0, 3, 5 and 7th of the shelf life of studies.



D: Dry Plucking Method, **W:** Classic Wet Method

Figure 1- The effect of different feather plucking methods on carcass microbial load (Log10 CFU / g)

The microbial contamination level of chicken meat is determined its shelf life (Morshedy & Sallam 2009). Some studies reported that the prevalence of *Campylobacter* decreases after scalding but increases after plucking and evisceration (Guerin et al. 2010). In the scalding stage of slaughterhouses, the high temperatures of the water expand the hair follicles and relax the skin. In the next processes, bacteria transfer to the enlarged follicles, and cooling of the carcasses may cause the bacteria to be trapped. This increases the bacterial load of chicken meat (Demirok et al. 2013). On the contrary, it has been reported that the process of poultry slaughterhouses, such as the scalding process in hot water reduces the level of *Salmonella* and microbial load in the carcass. It is recommended for the control of microbial growth that the scalding water temperature is above 47 °C. High scalding water temperatures greatly decrease the levels of the microorganisms in the carcass compared with low water temperatures (Dickens et al. 1999; Rivera-Perez et al. 2014; Rouger et al. 2017; Maharjan et al. 2019). Total aerobic mesophilic bacteria, total psychrophilic bacteria, coliform bacteria, *E. coli*, *Enterococcus* spp. and *Campylobacter* levels have decreased significantly. It is also worth noting that; the microbial load of the DPM group was significantly high. It is because; microorganisms on the feathers may be infected to the carcass surface during the dry feather plucking since the carcass had been turned with a hand during plucking. Similarly, the gut microorganisms may be infected inside the carcass during the evisceration. So, the shelf life of the carcasses in the DPM group was shorter than CWM group. Anıl et al. (1989) noted that the DPM is a more hygienic method than the CWM, and this application may lead to microbial contamination. Our findings were opposite the observations of Anıl et al. (1989). The reason for the incompatibility of the results may be that the DPM application in our study was different from commercial slaughterhouses.

The wet plucking method applied in the conventional broiler industry is not preferred today by some people with the suspicion of being halal-haram. This is because the scalding process is considered unhealthy for hygiene and carries a microbial risk. The main problem is that scalding water is thought to be contaminated with blood and feces, which causes an increase in microbial load and contamination of carcasses.

Many studies have shown that the increase of microorganism levels during the storage time can affect the pH value of meat (Nychas et al. 2008). Similarly, some studies have shown that there is a positive correlation between the pH value and the shelf life of the meat. When the pH value of the breast meat is high, the shelf life is prolonged (Yang 1993). Moreover, there is also a significant relationship between the number of microorganisms and meat color. While the pH value of the dark breast meat is high, that of the light color is low. High pH meat is dark, hard and dry, whereas low pH meat is pale, softer and has PSE (Pale

Soft Exudative) (Yang 1993; Allen et al. 1997; Fletcher 2002; Karaoglu et al. 2006; Garcia et al. 2010). Elliott & Heiniger (1965) reported that the minimum temperature that limits *Salmonella* proliferation is 46.2 °C. According to this for the prevention of increasing *Salmonella* load, wetting water temperature, higher than 47 °C, should be sufficient (Buhr 2014). In our study, hot water scalding did not prevent the growth of *Salmonella*. The appearance of *Salmonella* in both dry and CWM groups after slaughter and during shelf life studies suggests that *Salmonella* is present in the flock.

4. Conclusions

The results indicated that the feather plucking methods have significant effects on the skin and meat *L**, *a**, *b** values. When DPM is applied, the color of the drumstick and breast skin is more yellow. Likewise, the CWM increased the brightness of the drumstick and breast skin colors, and water applications caused the shine of the skin. It was observed that the DPM had no significant effect on the water-holding capacity of the drumstick and the breast meat. On the other hand, decreased pH value caused the meat to harden a little.

Our results suggest that scalding in hot water reduced the microbial load. The high level of microorganisms associated with the DPM caused the shelf life of the carcass to become shorter when stored under the conditions of +4 °C refrigerator. It is concluded that simple DPM may be used by low capacity farms which produce the broilers for consumers who prefer yellow-skinned chicken meat at the expense of a reduction in the shelf life due to increased microbial load.

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