J. Fd Hyg. Safety 13(3), 238 - 242(1998)

Microbiological Evaluations on Chicken Carcasses During a Commercial Chicken Processing and Storage

Chang-Ryoul Kim†

Department of Food and Nutrition Science, Seo Kang College, Kwangju 500-742, Korea

상업적 도계공정 및 저장 동안 닭고기의 미생물 평가

김창렬†

서강정보대학 식품영양과

ABSTRACT — **Chicken carcass microflora were evaluated for aerobic microorganisms after defeathering, evisceration, washing, chilling, and sanitizing during a commercial chicken processing and storage at wholesale and retailsale levels. Sampling was at between December 1997, and March, 1998. Tap water washing and sanitizing with 25 ppm chlorine for 10 sec significantly (P<0.05) reduced aerobic plate counts (APC) and gram-negative bacterial counts (GNC) on chicken carcasses from a commercial chicken-processing plant. After 4 days at 2±2°C, APC and GNC on chicken carcasses in retailsale store rapidly increased compared to those in wholesale store (P<0.05). Chicken wings from retailsale store significantly (P<0.05) decreased generation time (GT) compared to other chicken carcasses.**

Key words □ Chicken carcasses, Aerobic plate counts, Gram-negative bacterial counts, Commercial chicken processing, Wholesale, Retailsale

Microbial decontamination on meat carcasses has been considered to before final carcasses washing and chilling during commercial meat processing procedures.[2-4,9,10,12,16,19,20] Washing and sanitizing procedures have generally proven for reducing high levels of microbial contamination during normal processing of chicken and meat carcasses.[2-4,10,16] Dorsa *et al.*[4] and Rathegeber and Waldroup[16] noted that a water rinsing as well as a various sanitizing agents has been used for preventing growth of undesirable microorganisms on chicken and meat carcasses.

The general safety and quality of meat and fish are associated with the growth of aerobic spoilage bacteria and foodborne pathogens during the meat-processing procedures, storage, and handling,[3,4,6-9,18,19] which can reduce microbiological shelf-life. Dorsa *et al.*[4] noted that decontamination with hot water washes (15.6 to 82.2°C) was applied as intervention treatments. They found that when a commercial steam-vaccum was used in conjunction with hot water of 72°C after treating with warm water at 30°C and sprayed at 125 psi reducing on beef of 3.1, 4.2, and 4.3 log cycles for aerobic plate counts, coliforms, and *Escherichia coli* populations, respectively, were achieved. According to Barkate *et al.*,[1] hot water washes of 95°C significantly reduced aerobic plate counts on beef carcasses. Ledesma *et al.*[11] noted that most or all of the contamination of chicken carcasses resides on the surface of the carcasses, since healthy chickens do not have bacteremia with salmonella or other organisms.

However, there are not in-plant studies to determine the efficacy of washing and sanitizing for removing aerobic plate counts and gram-negative bacterial counts on the surface of poultry skin.

The first study was the basis for the microbial decontamination relating series of commercial chicken processing after defeathering, evisceration, washing, chilling, and sanitizing. The second study was evaluated of microbial levels on chicken carcasses under storage and handling at a wholesale and retail stores.

† Author to whom correspondence should be addressed.

MATERIALS AND METHODS

Chicken samples

In Experiment 1, aerobic plate counts (APC) and gram-negative bacterial counts (GNC) on the commercial chicken carcasses (average weight 500g per chicken) obtained from the local processing plants after defeathering, evisceration, chilling, and sanitizing (25 ppm chlorine dipping for 10 sec) were evaluated in two replicate trials.

Chicken carcassess were randomly selected from the carcasses being processed, transported to laboratory on ice, and examined within 3hr. The chicken carcasses put individually into the Whirl-Pak sample bags (Fisher Chemical Co., USA), which were placed on ice until microbiological examination were performed.

In Experiment 2, Chicken carcasses (average weight 500 g per chicken) obtained from wholesale store and retailstore store were divided into groups of 4 parts (wing, leg, breast, whole chicken) in Whirl-Pak sample bags, respectively. The Chicken carcasses from those stores were transported to clean containers containing ice at each sampling day for microbiological analyses.

Testing was performed during the months of December, 1997 and March, 1998, and it was tested 10 carcasses at each sampling day.

Microbiological analysis

Individual chicken carcasses were aseptically transfered to Whirl-Pak bags, weighed, and diluted 1:1 with 0.1% (w/v) sterile peptone water. Samples were shaken for 60 times using standard rinse method.[8] The liquid from each sample was diluted and plated in volumes of 0.1 ml on standard plate count agar (Difco Laboratories, Detroit, MI) for aerobic plate count (APC) and MacConkey agar for gram-negative bacteria counts (GNC), respectively. The plates were incubated for 48 hr at 37°C before colonies were counted. The number of bacteria was expressed as mean Log_{10} CFU/g for the duplicate treatments.

Calculation of growth curves

The growth rates of aerobes were determined using the following to calculate generation times.[14] Two points on the logarithmic growth phase of each curve were used in the calculation.

Generation time (GT)=$(0.301\ (T_2-T_1))/(\log P_2-P_1)$

Where: T_1=time of P_1, T_2=time of P_2,

P_1=CFU/g at T_1, and P_2=CFU/g at T_2

Statistical analyses

APC, GNC, and GT data were analyzed using ANOVA, and means were seperated by the least significant difference test at $P<0.05$.[17]

RESULTS AND DISCUSSION

APC and GNC on whole chicken carcasses from commercial chicken processing plant were significantly ($P<0.05$) reduced after washing and sanitizing (Table 1). After sanitizing with 25 ppm chlorine dipping for 10 sec, the carcasses were effective in lowering ($P<0.05$) APC and GNC by 0.93 and 0.61 log units compared to that of after defeathering, respectively. After evisceration, the carcasses allowed growth of APC and GNC to 5.48 and 4.17 log units, which increased rapidly the levels of aerobic microorganisms.

Results showed that gram-negative bacteria was the major cause of microbial spoilage of chicken carcasses. Gosting *et al.*[5] noted that the significant rise of the prevalence of undesirable organisms at postevisceration and prechilling at postchilling implicated the immersion chiller as the most significant cross-contamination point in broiler-processing plants.

There was significant ($P<0.05$) difference on APC and GNC of between the chicken carcasses from wholesale store and retailsaile store (Table 2).

During storage for 4 days at 0 ± 2°C and 2 ± 2°C, the wings had a significantly higher levels of APC and GNC compared to other parts. After 7 days of storage at 3 ± 1°C, the wings and whole chicken from retailsale store allowed microbial growth to 7.25 and 6.71, respectively, which was the most spoiled by the gowth of un-

Table 1. APC and GNC on whole chicken carcasses during a commercial chicken processing at five different processing steps between December, 1997 and March, 1998

Treatment	Log CFU/g	
	APC*	GNC*
After defeathering	5.05 ± 0.071^b	3.90 ± 0.064^a
After evisceration	5.48 ± 0.001^c	4.17 ± 0.021^c
After washing	5.04 ± 0.005^b	3.99 ± 0.330^a
After chilling	4.94 ± 0.064^b	3.95 ± 0.332^a
After sanitizng[1]	4.12 ± 0.170^a	3.29 ± 0.000^b

*Means of 2 replication (Mean±: standard deviation).

[1]25 ppm chlorine dipping for 10 sec.

[a-c]Counts within the same column with different superscripts are significantly different ($P<0.05$).

Table 2. APC and GNC on chicken carcasses from a wholesale store and a retail store in between December, 1997 and March, 1998

Chicken parts		Log CFU/g					
		APC*			GNC*		
		0 d	4 d	7 d	0 d	4 d	7 d
Wing	A[1]	4.39±0.035[a]			3.53±0.071[a]		
	B[2]	4.39±0.035[a]	6.12±0.162[b]	7.00±0.163[c]	3.53±0.071[a]	5.00±0.012[b]	6.20±0.017[a]
	C[3]	4.39±0.035[a]	6.51±0.000[b]	7.25±0.099[c]	3.53±0.071[a]	6.15±0.049[c]	6.48±0.170[b]
Leg	A	4.52±0.106[a]			3.69±0.043[a]		
	B	4.52±0.106[a]	5.36±0.012[a]	6.48±0.016[b]	3.69±0.043[a]	4.69±0.049[a]	6.32±0.011[a]
	C	4.52±0.106[a]	6.14±0.085[b]	6.31±0.013[b]	3.69±0.043[a]	5.19±0.120[b]	6.21±0.289[a]
Breast	A	4.42±0.014[a]			3.23±0.071[a]		
	B	4.42±0.014[a]	5.40±0.012[a]	6.41±0.012[b]	3.23±0.071[a]	4.33±0.014[a]	6.01±0.013[a]
	C	4.42±0.014[a]	6.24±0.282[b]	6.50±0.191[b]	3.23±0.071[a]	5.72±0.163[bc]	6.20±0.230[a]
Whole chicken	A	4.65±0.014[a]			3.62±0.028[a]		
	B	4.65±0.014[a]	5.50±0.057[a]	6.61±0.438[b]	3.62±0.028[a]	4.61±0.035[a]	6.13±0.078[a]
	C	4.65±0.014[a]	6.38±0.163[b]	6.71±0.014[b]	3.62±0.028[a]	6.41±0.012[cd]	6.21±0.183[a]

*Means of 2 replication (Mean±: standard deviation).
[1]Chickens from a commercial chicken-processing plant.
[2]Chickens from wholesale store during storage of 4 days (0±2°C) and 7 days (1±1°C).
[3]Chickens from retailsale store during storage of 4 days (2±2°C) and 7 days (3±1°C).
[a-d]Counts within the same column with different superscripts are significantly different (P<0.05).

desirable microorganisms. Results showed that the chicken could not extended microbiological shelf-life after 7 days of storage. It is assumed that commercial chicken carcasses could not promise the microbiological safety under extended storage at winter when the physical and microbiological contaminations of the tissue does not completely remove. Hence, washing and sanitizing practice in commercial chicken processing should be more efficient in physical and microbiological decontamination until chicken carcasses reached at a wholesale and retail stores. Researchers[3,12,15,16] noted that organic acids and phosphates as a antimicrobial surface sanitizer could be used for suppressing the growth of aerobic spoilage bacteria on chicken carcasses. Kim *et al.*[8] reported that chicken wings treated with 1.5% acetic acid for 10 min significantly inhibited APC and GNC compared to the initial controls for 12 days of storage at 4°C, which prolonged microbiological shelf-life by 4-additional days compared to treatments of 1.5% acetic acid for 5 min. Rathgeber and Waldroup[16] noted that 1.5% Brifisol KTM (a commercial blend of sodium acid pyrophosphate and orthophosphoric acid) significantly reduced APC on postchill broilers and increased microbiological shelf-life by 1 to 2 days when stored at 4.4°C.

There was a significant difference (P<0.05) to GT between wings and other chicken carcasses from a retailsale store (Fig. 1). GT of aerobic microorganisms in wing, leg, breast, and whole chicken were 17.7, 28.3, 24.3, and 24.5 hr, respectively. Results indicate that the growth of undesirable microorganisms on chicken wing skins is responsible for the largest proportion of poultry food spoilage during transportation and storage at a retail levels. Efforts to increase antimicrobial activity of chicken carcasses by washing and sanitizing treatments

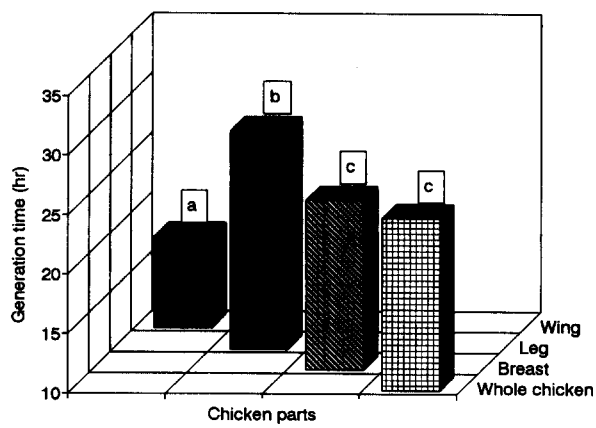

Fig. 1. Generation time (GT) of aerobic spoilage bacteia in chicken carcasses from a retailsale store between December, 1997 and March, 1998.
[a-c]Bars with different superscripts are significantly different (P<0.05).

from commercial chicken-processing plant proved unsuccessful. Kim et al.8) noted that chicken wings treated with 0.5~1.5% acetic acid for 5 min significantly ($P< 0.05$) reduced aerobic plate counts and gram-negative bacterial counts compared to the controls for 8 days of storage at 4°C. They noted that treatments of 1.0% and 1.5% acetic acid for 5 min prolonged the microbiological shelf-life for 8 days compared to those of 0.5% acetic acid and the controls. This results suggested that chicken wings from retailsale store was a higher number of aerobic microorganisms compared to other chicken carcasses. Therefore, the efficacy of washing and sanitizing procedures should be further studied for suppressing the growth of aerobic spoilage bacteria at a retail level.

CONCLUSIONS

The current industry practice of washing and sanitizing of chicken carcasses reduced initial populations of aerobic spoilage bacteria. Nevertheless, it is not the only factor involved in suppressing aerobic spoilage bacteria because chlorine treatments, as applied in this study, had minor effects during storage and handling at a retail levels.

It is considered that chicken carcasses in the wholesale and retail chain should be applied to a further suitable washing and sanitizing methods for enhancing microbiological shelf-life.

ACKNOWLEDGEMENTS

This study was supported by a grant of the '97 ARPC project, Ministry of Agriculture and Forestry under project SKA-1.

국문요약

상업적 도계공정에서 탈모, 내장적출, 세척, 냉각 및 위생수 침지후 그리고 도매 및 소매의 저장동안 닭고기의 호기성 미생물에 대하여 평가 하였다. 시료분석은 1997년 12월 부터 1998년 3월에 얻은 닭고기를 이용하여 실시하였다. 상업적 도계공정에서 닭고기의 물세척 및 10초 동안 25 ppm 염소 침지는 각각 호기성세균(APC) 및 그람음성세균(GNC)의 증식을 유의적($P<0.05$) 으로 억제하였다. 저장 4일후 소매점에서 얻은 닭고기는 도매점의 닭고기와 비교하여 호기성 세균 및 그람음성 세균의 유의적($P<0.05$) 증가을 보였다. 소매점에서 얻은 닭고기 날개는 다른부위들 보다 세대시간(GT)의 감소($P<0.05$)를 보였다.

REFERENCES

1. Barkate, M.L., Acuff, G.R., Lucia, L.M., and Hale, D.S.: Hot water decontamination of beef carcasses for reduction of initial bacterial numbers. *Meat Sci.* **35**, 397 (1993).
2. Davet, K.R. and Smith, M.G.: A lavoratory evaluation of a novel hot water cabinet for the decontamination of sides of beef. *Int. J. Food Sci. Tech.* **24**, 305 (1989).
3. Dickens, J. A. and Whitemore, A. D.: The effects of extended chilling times with acetic acid on the temperature and microbiological quality of processed poultry carcasses. *Poult. Sci.*, **74**, 1044 (1995).
4. Dorsa, W. J., Cutter, C. N., Siragusa, G. R., and Koohmaraie, M.: Microbial decontamination of beef and sheep carcasses by steam, hot water spray washes, and a steam-vaccum sanitizer. *J. Food Prot.* **59**, 127 (1995).
5. Gosting, D.C., Doyle, M.E. Steinhart, C.E. and Cochrane, B.A.: Food Safety 1990: an annotated bibliography of the literature. Butterworth-Heinemann, Boston, MA (1990).
6. Hardin, M.D., Acuff, G.R., Lucia, L.M., Oman, J.S. and Savell, J.W.: Comparison of methods for decontamination from beef carcasses surfaces. *J. Food Prot.*, **58**, 368 (1995).
7. Kim, C.R., Hearnsberger, J.O. and Eun, J.B.: Gram-negative bacteria in refrigerated catfish fillets treated with lactic culture and lactic acid. *J. Food Prot.*, **58**, 639 (1995).
8. Kim, C.R., Lee, J.I., Kim, K.H., Moon, S.J. and Lee, Y. K.: Microbiological evaluations of refrigerated chicken wings treated with acetic acid. *Kor. J. Fd Hyg. Safety*, **12**, 277 (1997).
9. Kim, C.R., Kim, K.H., Moon, S.J., Kim, Y.J. and Lee, Y. K.: Microbiological and physical quality of refrigerated chicken legs treated with acetic acid. *Kor. Food Sci. and Biotech.*, **7**, 13 (1998).
10. Kotula, K. L. and Pandya, Y.: Bacterial contamination of

broiler chickens before scalding. *J. Food Prot.,* **58**, 1326 (1995).
11. Ledesma, A.M.R.D., Riemann, H.P. and Farver, T.B.: Short-time treatment with alkali and/or hot water to remove common pathogenic and spoilage bacteria from chicken wings skin. *J. Food Prot.,* **59**, 746 (1996).
12. Lillard, H.S., Blankenship, L.C., Dickens, J.A., Craven, S.E. and Shackelford, A.D.: Effect of acetic acid on the microbiological quality of scalded picked and unpicked broiler carcasses. *J. Food Prot.* **50**, 112 (1987).
13. Marshall, D.L. and Kim, C.R.: Microbiological and sensory analyses of refrigerated catfish fillets treated with acetic and lactic acids. *J. Food Qual.,* **19**, 317 (1996).
14. Marshall, D.L. and Schmidt, R.H.: Growth of *Listeria monocytogenes* at 10°C in milk preincubated with selected pseudomonads. *J. Food Prot.,* **51**, 277 (1988).
15. Okrend, A.J., Johnston, R.W. and Moran, A.B.: Effect of acetic acid on the death rates at 52°C of *Salmonella newport, Salmonella typhimurium,* and *Campylobacter jejuni* in poultry scald water. *J. Food Prot.,* **49**, 500 (1986).
16. Rathgeber, B.M. and Waldroup, A.L.: Antibacterial activity of a sodium acid pyrophosphate product in chiller water against selected bacteria on broiler carcasses. *J. Food Prot.* **58**, 530 (1995).
17. SAS: SAS User's Guide.: Stastics. SAS Institute Inc., Cary, N. C. (1996).
18. Swanson, KMJ, Busta, FF, Peterson, EH and Johnson, MG: Colony count methods. In Compendium of Methods for the Microbiological Examination of Foods, 3rd ed., C. Vanderzant and D. F. Splittstoesser (Ed.), P. 75-95. Am Publ. Health Assoc., Washington, D.C. (1992).
19. USDA-FSIS.: Immediate actions: cattle clean meat program. FSIS correlation packet, interview guidelines for inspectors. United States Department of Agriculture, Washington, D.C. (1993)
20. Visser, I.J.R., Koolmees, P.A., and Bijker, P.G.H.: Microbiological conditions and keeping quality of veal tongues as affected by lactic acid decontamination and vaccum packaging. *J. Food Prot.* **51**, 208 (1988).