Assiut Vet. Med. J. Vol. 59 No. 137 April 2013

EFFECT OF UV RADIATION AND TRISODIUM PHOSPHATE ON BACTERIAL DECONTAMINATION OF CHICKEN FILLETS

H.F.A. EL-DOSOKY; SHERIN S. MOSTAFA and S. SHAFIK

Animal Health Research Institute, Mansoura Laboratory, Mansoura,Egypt.

ABSTRACT

Received at: 21/2/2013

Accepted: 12/3/2013

One hundred random samples of chicken fillets were collected from an automatic poultry slaughtering plant in Dakahlia Governorate just after preparation. The samples were divided into five groups, each group consists of 20 chicken fillets examined for Aerobic Plate Count (APC), *Enterobacteriaceae* and Most Probable Number (MPN) of *coliforms.* The first group dipped in 10% Triodium phosphate (TSP) for 30 seconds where the counts were reduced by 0.75,0.78 and 0.59 log cfu/gm, the second group were decontaminated with UV radiation for a minute where reduced by 0.45,0.34and 0.35log cfu/gm, the third group were decontaminated with UV radiation for three minutes where it reduced by 0.79, 0.64 and 0.67 log cfu/gm, The fourth group were dipped in 10% TSP for 30s then exposed to UV radiation for a minute where it reduced by 1.30,1.31 and 1.14 log cfu/gm and The fifth group were dipped in 10% TSP for 30s then exposed to UV radiation for three minutes where it reduced by 1.44,1.54 and 1.51 log cfu/gm respectively. The obtained results revealed that there were a significant reduction when compared with those before decontamination statistically for all groups ($P<0.05$). In conclusion, application of 10% TSP&UV reduced the aforementioned bacteria significantly ($P<0.05$), Therefore this study was focused on the effect of 10% TSP and/or UV radiation on bacterial populations, *Enterobacteriaceae* and *Coliforms* counts in chicken fillets.

Key words: *UV radiation, Chicken filets, Enterobacteriaceae* and *Coliforms*

INTRODUCTION

Chicken products can be contaminated during preparation with pathogens as *E. coli*, *Salmonella spp*. and *C. jejuni* which are present in chicken intestine Anang *et al.* (2007) and Hong *et al.* (2008). There was a growing interest in using UV radiation for food preservation particularly as UV disinfection does not require chemicals or heat and relatively inexpensive McDonald *et al.* (2000) and Lamikanra *et al.* (2005) added that UV technology used as an alternative to chemical sterilization in food products and so Wallner *et al.* (1994) and FDA (2007) stated that UV 220-300nm has germicidal effect on the surface of fresh meat and poultry and approved for use on food products to control surface contamination. Berrang *et al.* (2001) not detect *Coliforms* and *E. coli* while total aerobic count in breast meat were 1.3 $\log_{10}$ cfu/gm. F.S.I.S. (1992) and Capita *et al.* (2002) mentioned that 8-10% TSP (PH>11.5) were effective in poultry carcass decontamination, while UV kills bacteria by cell wall degradation Bachman (1975). Somers *et al.* (1994) and Federight *et al.* (1995) stated that (10-12% TSP) reduce total aerobes, *E.coli* and *Enterobacteriaceae* by more than2log cycles in poultry carcass. Stermer *et al.* (1987) reported 2 log reduction in bacteria on fresh beef by UV radiation. Susan *et al.* (1995) concluded that UV radiation reduce 80.5%of the inoculated poultry skin with *S. typhimurium.* Wang *et al.* (1998) and Zeong *et al.* (1998) declared that spraying chicken carcass with 10% TSP reduce the total aerobes by 0.74 $\log_{10}$ cfu /carcass and *S. typhimurium* decreased by 2log cycles. Gabriela *et al.* (2001) proved that 12% TSP and UV for 25min. reduce APC by 1.03 and 1.60 log cfu/egg, while UV exposure for 1hr gives no growth. Whyte *et al.* (2001), applied 10%TSP for 15 seconds. which reduce *E.coli* and *Enterobacteriaceae* by 1.95 and 1.86 $\log_{10}$ cfu/gm. Kim *et al.* (2002) *stated that* UV at 254 nm reduce inoculated skinless chicken with *S. typhimurium* and *E.coli* O_{157}*:* H_7 by 0.07 and 0.24 log cfu/cm^2 after one minute and 0.22 and 0.26 log cfu/cm^2 for two minutes. Guerrero and Babosa (2004) stated that UV reduce the microbial load by blockage DNA transcription and replication. Isohanni and Lyhs (2009) achieved 0.7 log cfu/ml reduction for *C. jejuni* by UV light on broiler fillets. Chun *et al.* (2010) obtained reductions of 1.26 and 1.19 $\log_{10}$cfu/gm for *C. jejuni* and *S. typhimurium* by UV treatment of chicken breast, while UV light (254nm) at 0.5-0.4 J. /cm reduce cocktail of *Salmonella spp., L.monocytogenes* and *Staph. aureus* on breast fillets by 0.4 log cfu/gm Sommers *et al.* (2010) and Haughton *et al.* (2011) mentioned that raw chicken fillets treated with UV at 0.192J/cm^2 reduce *E.coli,* total viable counts and *enterobacteriaceae* by 0.98, 1.76 and 1.29 log cfu/gm and fillets color was not

significantly affected. Keklik *et al.* (2011) achieved reduction from 0.87-1.43 log cfu/ml rinse solution after 30-180s treatment by pulsed UV light where the temperature ranged from 11.1-44.1^{0}c.

MATERIALS and METHODS

A- Sampling:

A total number of 100 chicken breast fillets were collected from an automatic poultry processing plant in Dakahlia, Governorate after complete preparation, the chicken breast fillets were packed in polyethylene film pack and stored at 4^{0}C and used for the experiment upon receipt to the laboratory. The examined samples were divided into five groups (20 chicken breast fillets for each group).The first group were dipped in 10% TSP for 30$_S$, the second group were exposed to UV irradiation at dose of 0.192 J/cm^{2}and 254nm wave length for one minute, the third group were exposed to UV irradiation at dose of 0.192 J/cm^2 and 254nm wave length for three minutes, the fourth group were dipped in 10% TSP for 30$_S$ and left ten minutes till fluid drainage then exposed to UV irradiation at dose of 0.192 J/cm^2 and 254nm wave length for one minute, the last group were dipped in 10% TSP for 30$_S$ and left ten minutes till fluid drainage then exposed to UV irradiation at dose of 0.192 J/cm^2 and 254 nm wave length for three min. UV irradiation was performed using unfiltered germicidal emitting lamps, The chicken fillets were placed on a stainless-steel tray and irradiated on both the upper and lower surfaces at a distance of 18cm, six germicidal emitting lamps were placed on both sides and the UV lamps were warmed up for 30 min. before irradiation process. UV intensity was determined using UV radiometer calibrated at 254nm and the UV irradiation dose was changed by altering exposure time. UV irradiation was performed in the darkroom to minimize photoreactivation of the pathogenic bacteria after irradiation.

B- Bacteiological analysis:

Following TSP&UV irradiation 25gm of each examined samples (before and after treatment) were removed using a sterile scalpel and mixed with 225ml of peptone water (0.1% sterile peptone) in a sterile stomacher bag. The samples were then homogenized using a stomacher for three minutes, filtered through a sterile cheese cloth, and diluted with peptone water for microbial count, after two to six serial dilutions (0.1ml) were spread on specific media to determine the following**:**

1- The aerobic plate count (APC).
2- *Enterobacteriaceae* count.
According to the methods recommended by APHA (2001).

3- Most Probable Number (MPN) of *Coliforms*.
According to the method recommended by FDA (2005).
The Microbial counts were expressed as log cfu/gm.

RESULTS

Table 1: Log mean viable counts of microbial contamination for the treated chicken fillets with 10% TSP (n=20).

Microbial count log mean ±S.E	Counts before TSP treatment	Counts after TSP treatment	Log red.
Aerobic plate count	4.83±0.80	4.08±0.70*	0.75
Enterobacteriaceae count	4.38±0.72	3.60±0.30*	0.78
Coliform count	3.32±0.48	2.73±0.48*	0.59

n= number of examined samples ,TSP = trisodium phosphate, red. = reduction, * = the results were significantly important($p<0.05$).

Table 2: Log mean viable counts of microbial contamination for the treated chicken fillets with UV for one minute (n=20).

Microbial count log mean ±S.E	Counts before UV treatment	Counts after UV treatment	Log red.
Aerobic plate count	4.66±0.34	4.21±0.65*	0.45
Enterobacteriaceae count	4.26±0.70	3.92±0.60*	0.34
Coliform count	3.11±0.90	2.76±0.85*	0.35

Table 3: Log mean viable counts of microbial contamination for the treated chicken fillets with UV for three minutes (n=20).

*Microbial count log mea*n ±*S.E*	Counts before treatment	Counts after UV treatment	Log red.
Aerobic plate count	4.71±0.53	3.92±0.70*	0.79
Enterobacteriaceae count	4.34±0.90	3.70±0.30*	0.64
Coliform count	3.53±0.84	2.86±0.78*	0.67

Table 4: Log mean viable counts of microbial contamination for treated chicken fillets with 10%TSP&UV for one minute (n=20).

*Microbial count log mea*n ±*S.E.*	Counts before treatment	Counts after TSP& UV treatment	Log red.
Aerobic plate count	4.80±0.95	3.50±0.40*	1.30
Enterobacteriaceae count	4.58±0.75	3.27±0.65*	1.31
Coliform count	3.34±0.78	2.20±0.30*	1.14

Table 5: Log mean viable counts of microbial contamination for treated chicken fillets with10%TSP&UV for three minutes (n=20)

*Microbial count log mea*n ±*S.E.*	Counts before treatment	Counts after TSP& UV treatment	Log red.
Aerobic plate count	4.76±0.38	3.32±0.30*	1.44
Enterobacteriaceae count	4.41±0.04	2.87±0.48*	1.54
Coliform count	3.36±0.90	1.85±0.30*	1.51

DISCUSSION

In this study the achieved results showed that the inactivation of bacterial contamination on chicken breast fillets by UV and/or TSP increased significantly (P< 0.05) with increasing UV radiation time or dipping in TSP, where the results in table (1) declared that 10% TSP reduce the APC, *Enterobacteriaceae* and MPN of *coliforms* counts from 4.83±0.80, 4.38±0.72 and 3.32± 0.48 to 4.08±0.70, 3.60±0.30 and 2.73±0.48 with mean log reduction 0.75,0.78 and 0.59 log cfu/gm respectively the results were significantly reduced (P<0.05), these results were in accordance with F.S.I.S. (1992); Somers *et al.* (1994); Federight *et al.* (1995); Wang *et al.* (1998); Zeong *et al.* (1998); Whyte *et al.* (2001) and Capita *et al.* (2002). The results in table (2) suggested that UV radiation can be useful in improving the microbial safety of chicken breast fillets without impairing meat quality where exposure to UV radiation for one minute reduce APC, *Enterobacteriaceae* and MPN of *coliform* counts from 4.66±0.34, 4.26±0.70 and 3.11±0.90 to 4.21±0.65, 3.92±0.60 and 2.76±0.85 with mean log reduction 0.45,0.34 and 0.35log cfu/gm respectively. Meanwhile increasing UV exposure time decrease the population of the examined bacteria on chicken fillets where the germicidal properties of UV radiation on bacteria are due to the DNA damage done by UV radiation which causes damage to cross-linking between neighbouring pyrimidine bases In the same DNA strand Sastry *et al.* (2000). Thus, the formation of hydrogen bonds to the purine bases on the opposite strand is impaired due to the mutation, thereby blocking DNA transcription and eventually leading to cell death Unluturk *et al.* (2008). The results of bacterial decontamination in table (3) were 4.71±0.53, 4.34± 0.90 and 3.53±0.84 which reduced to 3.92±0.70, 3.70± 0.30 and 2.86 ± 0.78 with mean log reduction 0.79, 0.64 and 0.67 log cfu /gm for APC, *Enterobacteriaceae* and MPN of *coliforms respectively.* The results in table (2) & table (3) were reduced significantly when compared with those recorded before decontamination (P<0.05) and similarly to those obtained by Bachman (1975); Stermer *et al.* (1987); McDonald *et al.* (2000); Kim *et al.* (2002); Guerrero and Babosa (2004);

Lamikanra *et al.* (2005); FDA (2007); Isohanni and Lyhs (2009); Chun *et al.* (2010); Sommers *et al.* (2010); Haughton *et al.* (2011) and Keklik *et al.* (2011).

Our results in table (4) clearly showed that UV&TSP decreased the bacterial population on chicken fillets where the counts after dipping in 10%TSP and exposure to UV radiation for one minute reduced from 4.80±0.95, 4.58±0.75 and 3.34±0.78 to 3.50±0.40, 3.27±0.65 and 2.20±0.30 with mean log reduction 1.30,1.31 and 1.14 log cfu/gm for APC, *Enterobacteriaceae* and MPN of *coliforms* respectively and after dipping in 10%TSP and exposure to UV radiation for three minutes in table (5) the counts were reduced from 4.76±0.38, 4.41±0.04 and 3.36±0.90 to 3.32±0.30,2.87±0.48 and 1.85±0.30 with mean log reduction 1.44,1.54 and 1.51 log cfu/gm respectively, the results were significantly reduced in comparison with those recorded before decontamination ($P<0.05$) and were in accordance with those obtained by Gabriela *et al.* (2001); Kim *et al.* (2002); Isohanni and Lyhs (2009) and Haughton *et al.* (2011) However few studies have been conducted on the application of UV&TSP for the inactivation of bacterial contamination in chicken fillets.

In summary, the germicidal effect of 10% TSP & UV treatment applied on the surface of raw boneless skinless chicken breast fillets reduce the number of bacterial cells significantly. Thus 10 %TSP & UV radiation process could be used in raw poultry processing plants to lessen the contamination chances of fully prepared poultry products.

REFERENCES

American Public Health Association (APHA) (2001): Compendium of methods for the microbiological examination of food, Washington, DC

Anang, D.M.; Rusul, G.; Bakar, J. and Ling, F.H. (2007): Effect of lactic acid and lauricidin on the survival of *L. monocytogenes, S. entertidis* and *E. coli* O_{157}; H_7 in chicken breast stored at 4^0c. Food control, 18 (8), 961-969.

Bachman, R. (1975): Sterilization by intense UV radiation. Brow Boveri Rev. 62: 206-209.

Berrang, M.E.; Ladely, S.R. and Buhr, R.J. (2001): Presence and level of *Campylobacter, Coliforms, E. coli* and total aerobic bacteria recovered from broiler parts with and without skin. J. Food protection, 64; 2: 184-188.

Capita, R.; Alonso-Calleja, C.; delCaminoGarcia-Fernandez, M. and Moreno, B. (2002): Activity of trisodium phosphate compared with sodium hydroxide wash solutions against *L. monocytogenes* attached to chicken skin during refrigerated storage. Food Microbiology. 19 (1), 57-63.

Chun, H.H.; Kim, J.Y.; Lee, B.D.; Yu, D.J. and Song, K.B. (2010): Effect of UV-C irradiation on the inactivation of inoculated pathogens and quality of chicken breasts during storage. Food Control, 21: 276-280.

Federight, M.; Cappelier, J.M.; Rossero, A.; Coppen, P. and Denis, J.C. (1995): Evaluation de l 'effect d'un traitment de decontamination de carcasses de poulets, vis-à-vis des *Campylobacter* thermotolerants. Sci. Aliment. 15: 393-401.

Food and Drug Adiministration (FDA) (2005): Staphylococcus aureus, Bad Bug Book, Foodborne Pathogenic Microorgaisms and Natural Toxins Handbook (1992 / updated 2005), USFDA/FDA, Center for Food Safety & Applied Nutrition.

Food and Drug Adiministration (FDA) (2007): Irradiation in the production processing and handling of food;21 CER. Part 179.39. Code of Federal Regulations, 3: 439-440.

Food Safety and Inspection Service (F.S.I.S.) (1992): Permits Trisodium Phosphate in poultry plants. Food Safety and Inspection Service Background Document. October**.**

Gabriela, Z. Favier; Maria, Escudero E. and Ana, M.De Guzman (2001): Effect of chlorine, sodium chloride, Trisodium phosphate and Ultraviolet radiation on the reduction of *Yersinia enterocolitica* and mesophilic aerobic bacteria from eggshell surface. J. of Food Protection, 64; 10: 1621-1623.

Guerrero-Beltran, J.A. and Babosa, G.V. (2004): Review; advantage and limitations on processing food by UV light. Food Sci. Technol. Int. 10: 137-147.

Haughton, P.N.; Lyng, J.G.; Cronin, D.A.; Morgan, D.J.; Fanning, S. and Whyte, P. (2011): Efficacy of UV light treatment for the microbiological decontamination of chicken associated packaging and contact surfaces. J. Food Protection, 74; 4: 565-572.

Hong, Y.H.; Ku, K.J.; Kim, M.K.; Won, M.S.; Chung, K.S. and Song, K.B. (2008): Survival of *E. coli* O_{157};H_7 and inoculated on chicken by aqueous chlorine dioxide treatment. J. Microbiology and Biotechnology, 18(4): 742-745.

Isohanni, P.M. and Lyhs, U. (2009): Use of Ultraviolet irradiation To reduce *C. jejuni* on broiler meat. Poultry Sci. 88: 661-668.

Keklik, N.M.; Demirci, A. and Bock, R.G. (2011): Surface decontamination of whole chicken carcasses using Pilot-Scale pulsed UV light system transactions of the ASABE.54; 4: 993-1000.

Kim, T.; Silva, J.L. and Chen, T.C. (2002): Effect of UV irradiation on selected pathogens in

peptone water and on stainless steel and chicken meat. J. of Food Protection, 65; 7: 1142-1145.

Lamikanra, O.; Kueneman, D.; Ukuku, D. and Bett-Garber, K.L. (2005): Effect of processing under ultraviolet light on the shelflife of fresh cut cantaloupe melon. J. of Food Science, 70; 9: 534-539.

McDonald, K.F.; Curry, R.D.; Clavenger, T.E.; Unklesbay, K.; Eisenstark, A.; Golden J. and Morgan, R.D. (2000): A comparison of pulsed and continuous UV light sources for the decontamination of surfaces. IEEE Trans. Plasma Sci. 28: 1581-1587.

Sastry, S.K.; Datta, A.K. and Worobo, R.W. (2000): Ultraviolet light, Journal of Food Science Supplement. 65, 12: 90-92.

Somers, E.B.; Schoeni, J.I. and Wong, A.C.L. (1994): Effect of trisodium phosphate on biofilm and planktonic cells of *C. jejuni, E.coli* $O_{157}H_7$*; L. monocytogenes* and *S. typhimurium.* Int. J. Food Microbiology. 22: 269-276.

Sommers, C.H.; Sites, J.E. and Musgrove, M. (2010): Ultraviolet light (254nm) inactivation of pathogens on foods and stainless steel surfaces. J. Food Safety 30; 2: 470-479.

Stermer, R.A.; Lasater-Smith, M. and Brasington, C.F. (1987): Ultraviolet radiation and effective bactericide for fresh meat. J. Food Protection 50: 108-111.

Susan S. Sumner; Eva, A. Wallner-Pendleton; Glenn W. Froning and La Verne E. Stetson (1995): Inhibition of *S. typhimurium* on agar medium and poultry skin by ultraviolet energy. J. Food Protection, 59; 3: 319-321.

Unluturk, S.; Atilgan, M.R.; Baysal, A.H. and Tari, C. (2008): Use of UV radiation as a non-thermal process for liquid egg products (LEP) Journal of engineering. 85; 4: 561-568**.**

Wallner-Pendleton, E.A.; Sumner, S.S.; Froning, G.W. and Stetson, L.E. (1994): The use of Ultraviolet radiation to reduce *Salmonella* and psychrotrophic bacterial contamination on poultry carcasses. Poultry Sci., 73: 1327-1333.

Wang Weichi; Li Yan Bin; Slavik, M.F. and Hua Xiong (1998): Trisodium phosphate and Cetylpyridinium chloride spraying on chicken skin to reduce attached *S. typhimurium.* J. Food Protection. 60; 8: 992-994.

Whyte, P.; Collens, DJ.; McGill, K.; Monahan, C. and O'Mahony, H. (2001): Quantitative investigation of the effects of chemical decontamination procedures on the microbiological status of broiler carcasses during processing. J. Food Protection. 64; 2: 179-183.

Zeong P.Y.; Yanbin, L.I. and Michael, S. (1998): Use of antimicr- obial spray applied with inside-outside bird washer to reduce bacterial contamination on prechilled chicken carcasses. J. Food Protection 61; 7: 829-832.

تأثير الأشعة فوق البنفسجية وثلاثي فوسفات الصوديوم علي إزالة التلوث البكتيري لفيلية الدواجن

حاتم فتحي أحمد الدسوقي ، شيرين سامي مصطفى ، صالح شفيق محمد احمد

اشتملت الدراسة على عدد مائة عينة لفيلية الدواجن تم تجميعها من احدى المجازر الألية بمحافظة الدقهلية بعد انتهاء مراحل الاعداد و قبل التغليف مباشرة حيث تم تقسيمها إلى خمسة مجموعات (عشرون عينة لكل مجموعة) الأولى: تم معالجتها بغمسها في محلول ثلاثي فوسفات الصوديوم 10% لمدة ثلاثون ثانية حيث تم اختزالها بمقدار75 ,0 ، 78 ,0و59 ,0، الثانية: تم تعريضها للاشعة فوق البنفسجية لمدة دقيقة عند 192 ,0 جول/سم^2 وتم اختزالها بمقدار45 ,0 ، 34 ,0و35,0، الثالثة: تم تعريضها للاشعة فوق البنفسجية لمدة ثلاث دقائق عند 192 ,0 جول/سم^2 وتم اختزالها بمقدار79 ,0 ، 64 ,0و67,0، الرابعة: تم معالجتها بغمسها في محلول ثلاثي فوسفات الصوديوم 10% لمدة ثلاثون ثانية ثم تم تعريضها للاشعة فوق البنفسجية لمدة دقيقة عند 192 ,0 جول/سم وتم اختزالها بمقدار30 ,1 ، 31 ,1و14 ,1 والمجموعة الاخيرة: تم معالجتها بغمسها في محلول ثلاثي فوسفات الصوديوم 10% لمدة ثلاثون ثانية ثم تم تعريضها للاشعة فوق البنفسجية لمدة ثلاث دقائق عند 192 ,0 جول/سم^2 وتم اختزالها بمقدار44 ,1 ، 54 ,1و51 ,1/جم علي الترتيب لكل من العد الكلي للميكروبات الهوائية والعد الكلي للميكروبات المعوية والعد الاحتمالي للميكروبات القولونية دون تغير في الصفات الطبيعية للحوم المعالجة.