Biological Food Safety & Quality

Proceedings of the International Conference

BFSQ 2012
Belgrade, Serbia
4-5 October 2012

CIP – Каталогизација у публикацији
Библиотека Матице српске, Нови Сад

63 : 502/504 (082)
631. 147 (082)

PROCEEDINGS of the International Conference Biological Food Safety and Quality, BFSQ 2012, 4-5 October 2012, Belgrade / [editor Sava Bunčić]. - Novi Sad : Faculty of Agriculture, 2012 (Beograd : Naučna KMD). - 208 str. : ilustr. ; 25 cm

Tiraž 200. – Bibliografija.

ISBN 978-86-7520-264-6

a) Здрава храна - Производња - Зборници b) Еколошка пољопривреда - Зборници
COBISS.SR-ID 274176263

The influence of vacuum-packaging and marination on the behaviour of total *Enterobacteriaceae* on chicken breast fillets

Tatjana Baltić, Radmila Mitrović, Ema Todorović, Jelena Ivanović, Jasna Lončina, Milan Ž. Baltić

T. Baltić (tanja@inmesbgd.com), R. Mitrović, Institute for Meat Hygiene and Technology, Kaćanskog 13, Belgrade, Serbia; E. Todorović, J. Ivanović, J. Lončina, M. Ž. Baltić, University of Belgrade, Faculty of Veterinary Medicine, Bul. Oslobođenja 18, Belgrade, Serbia

Introduction

Poultry meat is a highly perishable food and the time it takes to deteriorate varies from 4 to about 10 days after slaughter, in spite of having been stored under chill systems (Marenzi, 1986). Deterioration depends on the microbiological quality of the poultry carcasses, which is a direct reflection of sanitation during slaughtering and handling practices (Moreno Garcia, 1988). Chicken and other types of poultry meat have higher pathogenic and spoilage bacterial counts than almost any other food (Snyder, 1998). For the verification of the effectiveness of HACCP-based system in abattoirs, microbiological testing of carcasses is commonly used. The indicator organisms include aerobic colony count and *Enterobacteriaceae* count in the European Union, or *E. coli* count in the USA (Anonymous, 2005). After chilling, carcasses are cut into different parts. Meat cutting and deboning operations involve relatively intensive manipulation and handling of meat which markedly increases risk of microbial contamination due to: a) microbial cross-contamination via hands and utensils (knives, saws, conveyers, etc.); b) transfer of bacteria from the meat surface to the internal parts. Packaging methods for extending the storage time of poultry meat have been thoroughly surveyed. Vacuum-packaged poultry breasts have generally shown a longer conservation time than poultry breasts packaged in air. Traditionally, meat has been marinated to improve flavor and tenderness and increase product shelf-life. Commercial marination involves addition of a solution of water, salt, phosphate and sometimes flavorings and other ingredients, by means of soaking, blending, tumbling or injecting (Smith at al., 2001). Marination with acids or phosphates may cause pH changes and unfolding of secondary protein structure to allow more water to be absorbed and bound to the protein molecules. Marinades containing phosphates tend to reduce rancidity development and warmed-over flavor, increase shelf- life and improve color of poultry meat. Weak organic acids, such as citric acid, are components of flavored marinades used with meats in limited quantities. The aim of this study was to evaluate the effectiveness of marination and vacuum-packaging on the behaviour of total *Enterobacteriaceae* in chicken breasts fillets.

Materials and Methods

Chicken breasts fillets, without skin, approximately 0.1kg each, were obtained from a local slaughterhouse. They were taken from the production line and transported under refrigerator conditions to the laboratory within a few hours. Chicken breasts fillets, without skin, were divided into four groups. First group (I) of fillets was immersed in 6% NaCl solution. Second group (II) of fillets was immersed in marinade which contained 6% NaCl solution and 2% sodium tripoly-phosphate (STP). Third group (III) of fillets was immersed in marinade which contained 6% NaCl and 2% citrate acid (CA). Fourth group (IV) of fillets was immersed in marinade which contained 6% NaCl, 1% STP and 1% CA. After five hours marination, chicken breasts fillets were individually vacuum-packaged in plastic bags. The air was removed from the bags and they were then heat-sealed. Samples were stored at 4°C and at each sampling period (0, 7th, 14th, 21st and 28th day of storage), 3 packages from each treatment were analyzed for total *Enterobacteriaceae*, according to ISO 21528-1: 2004 and ISO 51528-2:2004.

Results and Discussion

The highest level of *Enterobacteriaceae* on 0 day were found in samples marinated in 6% NaCl solution and 2% STP (4.83±0.50 log CFU/g) and it was significantly higher ($p \leq 0.01$; $p \leq 0.05$) than the *Enterobacteriaceae* count in the other three examined groups. On 0 day, there were no statistically significant differences in the total count of *Enterobacteriaceae* in samples marinated in marinade which

contained 6% NaCl and 2% CA (2.70±0.26 log CFU/g) and samples marinated in marinade which contained 6% NaCl, 1% STP and 1% CA (2.64±0.13 log CFU/g).

Table 1. Changes in total *Enterobacteriaceae* during storage of four groups of chicken breast fillets

Days	Groups			
	I X±Sd	II X±Sd	III X±Sd	IV X±Sd
0	$4.16 \pm 0.43^{a.A.B}$	$4.83 \pm 0.50^{a.C.D}$	$2.70 \pm 0.26^{A.C}$	$2.64 \pm 0.13^{B.D}$
7th	$5.71 \pm 0.13^{A.B.C}$	$4.44 \pm 0.45^{A.D.E}$	$1.01 \pm 0.04^{B.D.F}$	$1.65 \pm 0.63^{C.E.F}$
14th	$4.19 \pm 0.32^{A.B}$	$4.10 \pm 0.05^{C.E}$	$0.54 \pm 0.18^{A.C.F}$	$3.02 \pm 1.00^{B.E.F}$
21st	$5.63 \pm 0.50^{A.B.C}$	$4.72 \pm 0.42^{A.D.E}$	$0.82 \pm 0.40^{B.D.F}$	$3.79 \pm 0.29^{C.E.F}$
28th	$4.42 \pm 0.22^{A.a}$	$4.62 \pm 0.43^{B.C}$	$0.85 \pm 0.32^{A.B.E}$	$3.76 \pm 0.69^{a.C.E}$

$^{A-F}$ Same letters indicate statistical significance $p \leq 0.01$; ^{a} Indicate statistical significance $p \leq 0.05$
Group I- 6% NaCl solution; Group II- 6% NaCl+2% STP; Group III- 6% NaCl+2% CA; Group IV- 6% NaCl+1% STP+1% CA

On the 7th day of investigation, the highest *Enterobacteriaceae* counts were in group I (5.71±0.13 log CFU/g) and in group II (4.45±0.45 log CFU/g). Much lower *Enterobacteriaceae* counts were determined in group III (1.01±0.04 log CFU/g) and in group IV (1.65±0.63log CFU/g). Among the total number of *Enterobacteriaceae* in all four tested groups of breasts fillets, statistically significant differences were obtained ($p \leq 0.01$). On 14th day of examination, there were no statistically significant differences in total count of *Enterobacteriaceae* between samples of group I (4.19±0.32 log CFU/g) and samples of group II (4.10±0.05 log CFU/g). In these two groups, the number of *Enterobacteriaceae* was statistically significantly higher ($p \leq 0.01$), compared to the number of *Enterobacteriaceae* in samples of group IV (3.02±1.00 log CFU/g), as well as in group III (0.54±0.18 log CFU/g). Similar results were obtained on 21st and 28th day of examination, but on 21st day of examination statistically significant difference was obtained between number of *Enterobacteriaceae* in group I (5.63±0.50 log CFU/g) and group II (4.72±0.42 log CFU/g), while no significant differences were obtained between these two groups on 28th day of examination. Marinades are solutions including sugar, spices, oil, acids (from vinegar, fruit juice, wine) and they are used to improve tenderness, juiciness, flavour and aroma and to extend shelf life of meat, poultry, seafood and vegetables (Cadun et al., 2005). Marinades are semi-preserves; the preserving principal is the combination of acetic acid and salt. Keeping quality depends largely upon storage temperatures, as marinades stored at cooler temperatures (4-6°C) keep for a long time. Organic acids have a long history of being utilized as food additives and preservatives for preventing food deterioration and extending the shelf life of perishable food ingredients. Specific organic acids have also been used to control microbial contamination and dissemination of foodborne pathogens in preharvest and postharvest food production and processing. The antibacterial mechanism(s) for organic acid are not fully understood, and activity may vary depending on physiological status of the organism and the physicochemical characteristic of the external environment (Ricke, 2003). Sodium salts of the low molecular weight organic acids, such as acetic, lactic, and citric have been used to control microbial growth, improve sensory attributes and extend the shelf life of various food systems including meat (Sallam et al., 2004), poultry (Wiliams et al., 1998), and fish (Boskou et al., 2000). In addition to their suppressing effect on the growth of food spoilage bacteria, organic salts of sodium acetate, lactate, and citrate were shown to possess antibacterial activities against various food-borne pathogens including *Staphylococcus aureus* and *Yersinia enterocolitica* (Lee at al., 2002), *Listeria monocytogenes* (Qvist at al., 1994), *Escherichia coli* (Lee et al., 2002; McWiliam Leitch et al., 2002), as well as *Clostridium botulinum* (Anders at al., 1989). Furthermore, these salts are widely available, economical, and generally "recognized-as-safe" (McWiliam Leitch et al., 2002).

Conclusions

- Marinade with combined salt and citric acid most effectively reduced the number of total *Enterobacteriaceae* in vacuum-packed poultry meat.
- Level of reduction depended on initial contamination of poultry meat with *Enterobacteriaceae*.

Acknowledgements

Studies were funded via Project TR 31034 and Project III 46009, by the Ministry of Education and Science of Government of Republic of Serbia.

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