CONSORTIUM

History:
Received: February 27, 2018
Reviewed: March 8, 2018
First Published: March 25, 2018
Collection year: 2018
Confirmation of publication:

Identifiers and Pagination:
Year: 2018
Volume: 3
First Page: 1
Last Page: 6
Publisher Id: AdvFood&NutrSci-3-1
DOI:http://dx.doi.org/10.21065/

Corresponding author:
Dr. Nelson A. Cox, Research Microbiologist Poultry Microbiological Safety and Processing Research Unit US National Poultry Research Center USDA-Agricultural Research Service 950 College Station Road Athens, GA 30605 USA. T.: 706-546-3484, F.: 706-546-3633, E.:nelson.cox@ars.usda.gov

Citation:
Nelson Cox, Landrum MA, DE Cosby, ME Berrang, A Hinton Jr., SC Mize, JS Jackson. Reduction of Campylobacter on chicken livers using low acid processing aid. Adv Food & Nutr Sci. Vol. 3. 2018. *p* 1-6

Review Article

REDUCTION OF CAMPYLOBACTER IN CHICKEN LIVERS USING A LOW ACID PROCESSING AID

Landrum MA[1], NA Cox[2], DE Cosby[2], ME Berrang[2], A Hinton Jr.[2], SC Mize[2] and JS Jackson[1]

1. University of Georgia, Athens, GA USA
2. The U.S. National Poultry Research Center, Athens, GA USA

Abstract

Liver has become a prime source for Campylobacter outbreaks and products are needed to allow processors a more efficient way of controlling foodborne pathogens. Campylobacter reductions in livers treated with a low pH processing aid (CMS PoultrypHresh), with and without a surfactant (PoultrypHresh Plus) were studied. Chicken livers (n=13/treatment group) were individually inoculated with a C. coli marker strain (10^7) and each dipped into sterile cups containing 100 mL of water, PoultrypHresh or PoultrypHresh Plus for 15 s, removed and allowed 5 s to drain. Each liver was placed into 50 mL buffered peptone water and hand shaken for 60 s; controls (n=10) same procedure, no treatment. Rinsates were serially diluted and plated onto Campy Cefex agar with 200 ppm gentamicin. Plates were incubated for 48 h at 42°C microaerobically, colonies counted and log transformed. Procedures were replicated 3 times. Significant reductions in treated compared to untreated for PoultrypHresh and PoultrypHresh Plus was 98.1% and 99.4%, respectively and with no change in appearance. Treating with this product may allow processors to meet rising performance standards on poultry livers.

Key words: Campylobacter, broiler livers, sanitizer, CMS Poultry pH resh

1. Introduction

Campylobacter, the third leading cause of foodborne illness in the U.S., continues to be a major concern to the poultry industry. Illness and/or outbreaks often occur from consumption of raw or undercooked products [1],[2] and may cause serious symptoms including diarrhea, abdominal cramping, fever and vomiting. [3] Poultry products are commonly implicated with outbreaks of campylobacteriosis and investigations worldwide have demonstrated how chicken liver is increasingly becoming a prime source for contamination. [1],[4] In the U.S., Campylobacter was found prevalent in 77% of livers [5], while another study reported Campylobacter in as many as 92.9% of commercial chicken livers. [6] The U.K. experienced a substantial increase in campylobacteriosis associated with liver dishes between 2009 and 2011, causing the Food Standards Agency (FSA) to categorize liver as a high-risk food product. [7] The Centers for Disease Control and Prevention (CDC) investigated and reported serious outbreaks of Campylobacter infections from poultry liver in the U.K. and Australia. [8] In Switzerland, Campylobacter was isolated in livers from 10% to 100%, varying by season [5] and England also reported liver as being a prime source for Campylobacter outbreaks. [3] Therefore, microbial contamination of broiler livers is a serious, worldwide concern for the industry.

The presence of Campylobacter in chicken liver has become a widespread problem and a serious public health concern. Often cases of campylobacteriosis go undetected and are not reported; therefore, illness and outbreak numbers are probably even higher than predicted, further increasing the seriousness of this foodborne pathogen. [9] Proper procedures for eliminating Campylobacter from livers is thoroughly cooking until an internal temperature exceeding 70˚C is reached for a minimum of 2 minutes. [5], [10],[11] One factor aiding the problem is many liver recipes recommend cooking by 'flash frying', which allows livers to maintain a pink internal color. [5], [11],[12]

Funding:
The authors received no direct funding for this research.

Competing Interests:
The authors declare no competing interests

Additional information is available at the end of the article.

This cooking method is not adequate to eliminate Campylobacter, allowing it to infect the consumer. [10] This assists in explaining the large number of campylobacterosis outbreaks in individuals who recently attended catered events or consumed restaurant meals. Research has found that caterers or restaurant cooks are likely to undercook livers in an attempt to maintain the pink coloration consumers desire. [11] This, however, allows many individuals to become sick or an outbreak to occur. Hutchinson et al. [11] described a variety of essential oils and antimicrobial ingredients evaluated as additives for liver recipes, although significant reductions were not found.

There are some intervention strategies, which include freezing, alternative cooking methods, boiling, chlorinated water, organic acid treatment or pre-cooking treatments. [3], [5], [4],[9],[11] Further research demonstrated Campylobacter to be more prevalent on a liver's outer surface than internally. [13] This indicates external treatment methods may exhibit greater reductions. Past research evaluating organic acid treatment on livers exhibited changes in the surface coloration post treatment, as surface lightening was described as "bleaching". [11] This study investigates the reduction of Campylobacter on livers treated with a low acid processing aid, CMS PoultrypHresh, and the product containing the addition of a surfactant, PoultrypHresh Plus. Differences in past research and this study include the acid used and the length of immersion. Past research used a duration dip time of 2 minutes, whereas the current research is only 15 seconds. [11] If effective, the treatment could potentially prevent cross contamination in a consumer kitchen and lower Campylobacter prevalence internally, as it is not conclusive whether outer contamination seeps into the liver. This treatment may assist processors in reducing contamination levels within processing facilities, as dip time is rapid and potentially a reasonable addition for processing procedures.

2. Materials and Methods

Bacterial Strain

The bacterial Campylobacter strain used for this research is a gentamicin resistant marker strain, Campylobacter *coli* (Cc^{GR}), obtained from Dr. Nelson Cox, USDA, Athens, GA. [14] Initially, Cc^{GR} was streaked onto Campy Cefex Agar [15] containing 200 ppm gentamicin (Sigma, St. Louis, MO). The culture was incubated microaerobically for 48 h at 42°C (5% O_2, 10% CO_2, 85% N_2). Forty-eight-hour (± 4 h) plates of this culture were used to prepare the inocula for this research.

Inoculation of Parts

Livers were obtained from a local grocery (N=36), livers were divided into 3 groups; Trt 1 – low acid processing aide (LAPA) (n=13); Trt 2 – LAPA w/surfactant (LAPAS) (n=13) and Trt 3 – inoculated untreated control (n=10) (Con). A -10^8 suspension of Cc^{GR} (0.1 mL) was used to individually inoculate the surface of each liver. Livers were left undisturbed for 5 minutes to allow the cells an adequate attachment period.

Treatment

Thirteen livers were placed into separate specimen cups containing 100 mL of either PoultrypHresh or PoultrypHresh Plus for 15 s with no agitation. When removed, livers were allowed to drain for 5 s and placed into individual sterile specimen cups containing 50 mL of buffered peptone water. Each liver was hand shaken for 60 s. The controls were inoculated the same as the experimental groups but were not subjected to any treatment before being placed into the specimen cups for rinsing.

Plating and Incubation

After hand rinsing, each rinsate was collected, serially diluted and plated onto Campy Cefex agar with 200 ppm gentamicin. Plates were incubated microaerobically at 42°C for 48 h. Colonies were counted and CFU/mL data was log transformed. All procedures were replicated 3 times.

3. Results

Since Campylobacter in chicken livers is quickly becoming a major concern in the food industry, this study evaluated a potential treatment option to lower prevalence and chance of infection. Results showed the average recovery of C. coli on livers receiving no treatment was 5.5 log_{10} CFU/mL. After livers were treated with a LAPA 15 s dip, the recovery was reduced to 3.9 CFU/mL. Livers that received a LAPAS 15 s dip were found to have Campylobacter recovery levels lowered to 3.3 log_{10} CFU/mL. These results indicate a 1.7 log_{10} reduction (98.1%) when using a LAPA dip and a 2.2 log_{10} reduction (99.4%) dipping with LAPAS compared to untreated samples (Figure 1). When treated results were compared with a 15 s water dip, LAPA reduced the average log_{10} CFU/mL by 91.9% (1.1 log_{10} CFU/mL), while LAPAS lowered C. coli by 97.5% (1.6 log_{10} CFU/mL). No visible organolyptic damage was demonstrated or reported post treatment. Table 1 shows average recovery of C. coli from all replicates, while Table 2 presents the data by replicate.

Table 1. Average Log_{10} cfu/mL of Campylobacter coli recovered from livers dip treated with no treatment, water, LAPA, or LAPAS for 15 seconds with no agitation (mean±standard deviation)

Treatment	Average Log_{10} (cfu/mL)	Reduction from Untreated (%)	Reduction from Water (%)
Untreated	5.5±0.1		
Water	4.9±0.1	76.0	
LAPA	3.8±0.1	98.1	91.9
LAPAS	3.3±0.2	99.4	97.5

Table 2. Average Log_{10} cfu/mL of Campylobacter coli recovered by replicate from livers dip treated with no treatment, water, LAPA, or LAPAS for 15 seconds with no agitation (mean±standard deviation)

Replicate	Treatment	Average Log_{10} (cfu/mL)	Reduction from Untreated (%)	Reduction from Water (%)
1	Untreated	5.5±0.3		
	Water	4.9±0.4	73.7	
	LAPA	3.8±0.4	98.0	92.4
	LAPAS	3.1±1.0	99.6	98.5
2	Untreated	5.7±0.2		
	Water	5.1±0.3	74.9	
	LAPA	3.8±0.3	98.8	95.2
	LAPAS	3.6±0.3	99.2	97.0
3	Untreated	5.2±0.2		
	Water	4.5±0.2	79.1	
	LAPA	3.7±0.2	96.9	85.2
	LAPAS	3.1±0.3	99.2	96.2

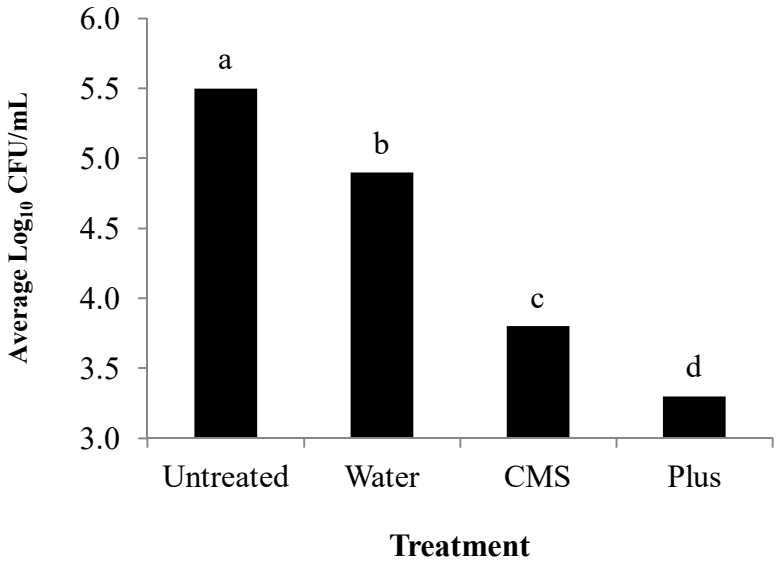

Figure 1. Average log_{10} cfu/mL of Campylobacter coli recovered from livers having been dipped in either no treatment, water, LAPA, or LAPAS for 15 seconds with no agitation.

3. Discussion

A treatment capable of providing such substantial reductions in Campylobacter levels is important for poultry producers and consumers worldwide. Alternate treatment options may include the use of chlorinated water, although Bryan and Doyle [9] found that while chlorine may assist in lowering cross contamination between carcasses, it has little effect on bacteria attached to the skin and muscle surfaces. Harrison et al. [5] reported the method of freezing does reduce the presence of Campylobacter on the skin and muscle of the broiler. It is likely the consumer may prefer what is considered to be a fresh, never frozen product. Such findings, however, contradict those of Fernandez and Pison [6] who found Campylobacter to be highly prevalent in frozen poultry liver.

Additional treatment options include the use of organic acid, which Firlieyanti et al. [4] reported causes color changes/bleaching on the liver surface. Several studies showed it is not effective for internal Campylobacter reduction. [4], [11] Noormohamed and Fakhr [3] discussed how foodborne pathogen resistance to antimicrobials is alarming and may arise from cross contamination during processing, possibly causing serious consequences on human health. Their study also demonstrated that the majority of Campylobacter isolates were resistant to five of the seven antimicrobials researched and 81 isolates were resistant to more than seven antimicrobials. This further increases the need for a treatment to effectively lower and/or eliminate Campylobacter before products are shipped from processing facilities, as Vashin et al. [16] discussed how the likelihood of transferring Campylobacter rises in further stages of secondary processing.

Researchers have demonstrated the serious need to reduce Campylobacter on poultry liver surfaces throughout the world. Illness and outbreaks arising from livers are increasingly becoming more prevalent and research has found the majority of retail livers are contaminated with Campylobacter at varying levels. [4] While the key to Campylobacter elimination is allowing adequate cooking times and temperatures, recipes continue suggesting undercooking or flash cooking which could result in illnesses. Intervention strategies within the processing facility are important to lowering Campylobacter prevalence and the ample reductions demonstrated in this study may potentially provide the industry with an effective means to reduce the presence of this pathogen and hence

human illness. Future research will further evaluate LAPA on a larger scale to reduce Campylobacter contamination of poultry products. LAPA may provide another hurdle Campylobacter must cross in order to infect consumers effectively reducing the number of campylobacteriosis illnesses associated with poultry products.

References

1. Little CL, Gormley FJ, Rawal N, Richardson JF. Short Report: A recipe for disaster: outbreaks of campylobacteriosis associated with poultry liver pâté in England and Wales. Epidemiol Infect 2010; 138: 1691-1694.
2. Simaluiza RJ, Toledo Z, Ochoa S, Fernandez H. The prevalence and antimicrobial resistance of Campylobacter Jejuni and Campylobacter coli in chicken livers used for human consumption in Ecuador. J Anim Vet Adv 2015; 14: 6-9.
3. Noormohamed A, Fakur MK. Incidence and antimicrobial resistance profiling of Campylobacter in retail chicken livers and gizzards. Foodborne Pathog Dis 2012; 9: 617-624.
4. Firlieyanti AS, Connerton PL, Connerton IF. Campylobacters and their bacteriophages from chicken liver: The prospect for phage biocontrol. Int J Food Microbiol 2016; 237: 121-127.
5. Harrison D, Corry JEL, Tchórzewska MA, Morris VK, Hutchison ML. Freezing as an intervention to reduce the numbers of campylobacters isolated from chicken livers. J Appl Microbiol 2013; 57: 206-213.
6. Fernández H, Pisón V. Isolation of thermotolerant species of Campylobacter from commercial chicken livers. Int J Food Microbiol 1996; 29: 75-80.
7. Edwards ES, Milne LM, Morrow K, Sheridan P, Verlander NQ, Mulla R, Richardson JF, Pender A, Lilley M, Reacher M. Campylobacteriosis outbreak associated with consumption of undercooked chicken liver pate in the East of England, September 2011: identification of a dose-response risk. Epidemiol Infect 2014; 142: 352-357.
8. Centers for Disease Control and Prevention (CDC). Multistate outbreak of Campylobacter jejuni infections associated with undercooked chicken livers-northeastern United States 2012. MMWR Morb Mortal Wkly Rep 2013; 62: 874-876.
9. Bryan FL, Doyle MP. Health risks and consequences of Salmonella and Campylobacter jejuni in raw poultry. J Food Prot 1995; 58: 326-344.
10. Whyte R, Hudson JA, Graham C. Campylobacter in chicken livers and their destruction by pan frying. Lett Appl Microbiol 2006; 43: 591-595.
11. Hutchison M, Harrison D, Richardson I, Tchórzewska M. A method for the preparation of chicken liver pâté that reliably destroys Campylobacters. Int J Environ Res Public Health 2015; 12: 4652-4669.
12. Strachan NJC, MacRae M, Thomson A, Rotariu O, Ogden ID, Forbes KJ. Source attribution, prevalence and enumeration of Campylobacter spp. from retail liver. Int J Food Microbiol 2012; 153: 234-236.
13. Thompson, T.M., M.E. Berrang, N.A. Cox and R.J. Meinersmann. Campylobacter prevalence in retail chicken liver. Poult Sci 2018; (Suppl. 1).
14. Cox NA, Richardson LJ, Berrang ME, Fedarka-Cray PJ, Buhr RJ. Campylobacter coli naturally resistant to elevated levels of gentamicin as a marker strain in poultry research. J Food Prot 2009; 72: 1288-1292.
15. Stern NJ, Wojton B, Kwiatek K. A differential selective medium and dry ice generated atmosphere for recovery of Campylobacter jejuni. J Food Prot 1992; 55: 514-517.
16. Vashin I, Stoyanchev T, Ring Ch, Atanassova V. Prevalence of Campylobacter spp. in frozen poultry giblets at Bulgarian retail markets. TJS 2009; 7: 55-57.