nBPW Research Update

Gary Gamble, Mark Berrang, Arthur Hinton, Jr.
National Poultry Research Center
Athens, GA

Areas of Concern

1. Acidified sodium chlorite (ASC) is not properly neutralized for recovery of *Campylobacter*
2. Lecithin added to neutralize CPC results in cloudiness and may precipitate due to high concentration
3. High levels of bicarbonate lead to drift toward high pH; complicates production of nBPW due to non-autoclavability

ASC Neutralization

- Previous results on *Salmonella* indicate that nBPW results in high recovery after ASC challenge
- Results on *Campylobacter* suggest a residual action of ASC following recovery in nBPW

	pH initial		pH 24 h	
Residual[2]	BPW[3]	n-BPW[4]	BPW	n-BPW
None	7.09 ± 0.06^{F}	7.96 ± 0.06^{B}	7.14 ± 0.10^{F}	8.13 ± 0.12^{AB}
ASC	6.26 ± 0.08^{J}	7.36 ± 0.06^{E}	6.28 ± 0.11^{IJ}	7.62 ± 0.17^{CD}
CPC	7.11 ± 0.06^{F}	8.00 ± 0.06^{AB}	7.12 ± 0.10^{F}	8.18 ± 0.12^{A}
PAA	6.49 ± 0.07^{GHI}	7.45 ± 0.05^{DE}	6.50 ± 0.10^{GH}	7.70 ± ± 0.11^{C}
BOA	3.54 ± 0.09^{K}	6.36 ± 0.09^{HIJ}	3.55 ± 0.10^{K}	6.66 ± 0.13^{G}

	Log CFU Campylobacter per mL	
Residual[2]	BPW[3]	n-BPW[4]
None	5.3 ± 0.2^{A}	5.0 ± 0.2^{AB}
ASC	1.2 ± 0.7^{C}	1.1 ± 0.3^{C}
CPC	0.1 ± 0.1^{D}	4.4 ± 0.7^{B}
PAA	0.0 ± 0.0^{D}	5.1 ± 0.2^{A}
BOA	0.0 ± 0.0^{D}	5.2 ± 0.3^{A}

$$NaClO_2 + H^+ \Leftrightarrow HClO_2 + Na^+$$

Sodium chlorite

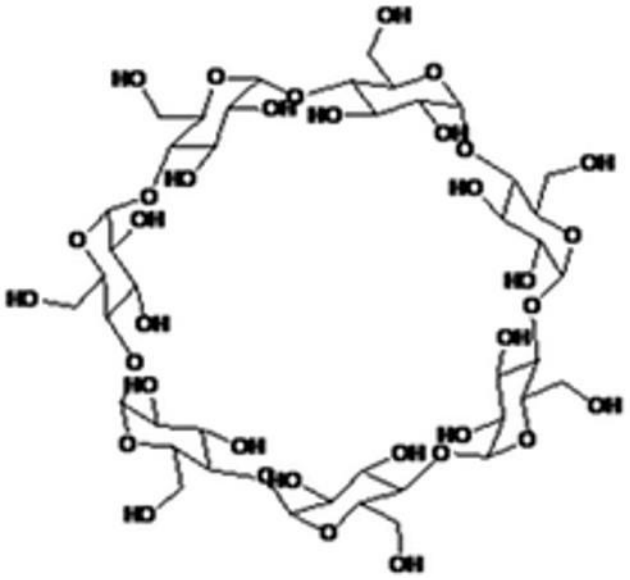
Chlorous acid

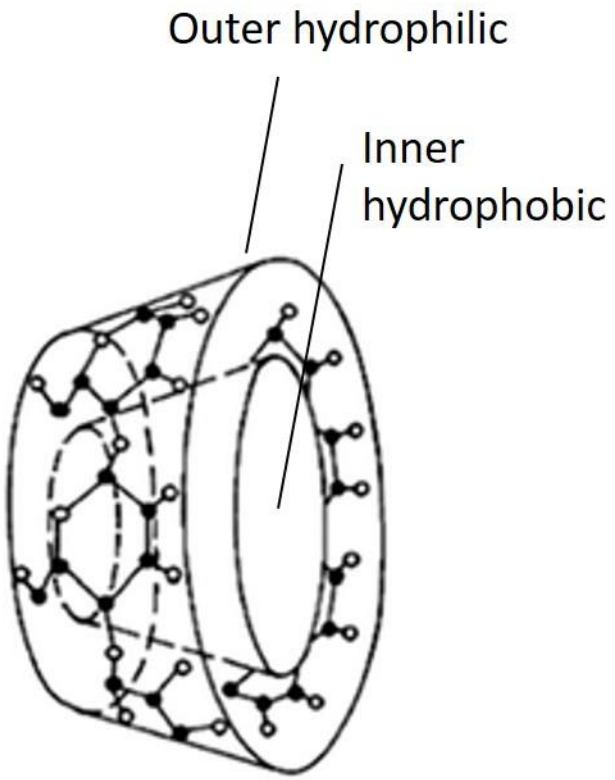
- Chlorous acid is the primary active oxidizing agent in ASC
- Neutralization of pH leads to a shift back to sodium chlorite
- Though not as active as chlorous acid, sodium chlorite still displays high oxidation potential
- Sodium thiosulfate is present in nBPW as a reducing agent
- Based on HPLC results:
  1) chlorous acid is neutralized by sodium thiosulfate
  2) sodium chlorite is <u>not</u> neutralized by sodium thiosulfate
- An alternate reducing agent must be found to replace sodium thiosulfate in nBPW

CPC Neutralization

- Lecithin in nBPW is very effective at neutralizing quaternary ammonium compounds (including CPC) for recovery of *Salmonella* and *Campylobacter*
- Downside to lecithin is a cloudy solution, making contaminated nBPW difficult to detect

β-Cyclodextrin is a cyclic carbohydrate capable of de-activating CPC





- Cyclodextrins are listed as GRAS by FDA
- Highly soluble with no cloudiness
- Cyclodextrins will be evaluated at USDA-ARS-NPRC for their ability to effectively neutralize CPC when incorporated into nBPW as a replacement for lecithin

Acid Neutralization

- Initial study on antimicrobial carry-over, published in 2016, assumed acetic acid as acidulant for ASC.
- To achieve a pH of 2.3, concentration of acetic acid must be 1.5M, or 135 g/L (~ $1.25/L).
- In contrast, using citric acid to reach pH=2.3 requires 0.04M, or 7.7 g/L (~ $0.10/L).

Study on Antimicrobial Neutralization

- Study on antimicrobial neutralization, published in 2017, determined that 12.5 g/L sodium bicarbonate in nBPW is necessary to neutralize pH=2.3 acetic acid carry-over.
- If pH=2.3 citric acid is used, phosphate buffer alone is sufficient to neutralize.

Acetic Acid as a Processing Aid

- Use of acetic acid as an acidulant appears cost-ineffective in terms of processing, though it is an effective antimicrobial on its own at low pH (<4.7).
- Acetic acid at low pH is volatile and may be a respiratory irritant when inhaled over long periods with poor ventilation.

- If it can be shown that no poultry processors are (or will be) using large amounts of concentrated acetic acid in their operations, then the amount of sodium bicarbonate in nBPW can be scaled back or eliminated as a neutralizing agent.
- If acetic acid is retained as a possible “worst case”, then other measures must be taken to address production and stability concerns of nBPW due to the presence of bicarbonate.