Persistence of Excessive Peroxyacetic Acid and Hydrogen Peroxide (from Perasan MP-2) on Submerged Poultry

Tina Rodrigues B.Sc.
Courtney Mesrobian B.A.
Henry Na Ph.D
Enviro Tech Chemical Services, Inc.
R & D Department
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Background

The contamination of food products by pathogenic organisms such as *Salmonella or Campylobacter (spp)* is an on-going problem that is addressed within the processing plant using antimicrobial products. If excessive levels of chemicals are inadvertently applied to the food product, poultry processors are rightly concerned about the fate of their products. Peroxyacetic acid's function and longevity is included in this topic of concern and is the basis of this study.

Prior to the poultry chiller, application of unintended but excessive amounts of peroxyacetic acid are not a concern, as the poultry carcasses are exposed to a down-stream wash (submersion) in the water chiller that contains a far lower concentration than the ceiling limit of the food contact substance (FCS). However, there is a current trend to apply the FCS in post-chiller applications (finishing chillers) that is applied prior to further processing to aid in removing chiller debris, and to give the poultry an extra elevated exposure to the FCS in order to improve efficacy. Therefore, if an over-exposure should occur in this post chill application, it is important to establish what would be the expected longevity time-line or persistence of the peroxyacetic acid.

This study examines a worst-case scenario situation under controlled laboratory conditions, and demonstrates what would actually happen if higher than approved levels of peroxyacetic acid (PAA) and hydrogen peroxide from Perasan MP-2® were inadvertently applied to poultry products as described above.

Currently, FCN 887 permits Perasan MP-2® at up to 220 ppm PAA to be applied to poultry carcasses, but if Perasan MP-2® is applied incorrectly the concentration may exceed the levels permitted by the FCN. Therefore, the goal of the study was to examine the persistence of PAA and H_2O_2 on poultry carcasses that had inadvertently been treated with an elevated level of Perasan MP-2 in the final stages of pre-package processing. The volume of exterior water vs. surface area associated with a poultry carcass as it emerges from the chill tanks is low (<2%). Therefore, this study uses a solution volume to carcass weight ratio that is at least *10 times more* than what would be experienced in actual processing conditions, and utilizes a concentration of PAA that would be almost 5 times *higher* than allowed for FCN 887 in order to determine the expected time line for the FCS to decay to near zero. This extreme exposure test would give the processor confidence that the food product would be saleable under normal conditions.

Methods

This study was designed to model worst-case scenario conditions and employed submersion of a chicken carcass at a concentration of peroxyacetic acid five times greater than currently approved under FCN 887. In this study, the volume of solution used to submerge the chicken carcass was calculated to be approximately 10 times more than the average amount of solution retained on a chicken carcass after it emerged from the poultry chill tank.

Five whole, uncooked chickens were purchased from a local grocer. The organs were removed from each chicken and subsequently each chicken was cut in half evenly down the back leaving ten equal halves which contained a back, breast, thigh and leg, See Image 1. Each chicken half was then weighed, and it was determined that the average weight of the ten chicken halves was 1052 g.

Image 1

A 1,000 ppm PAA solution was prepared in city water (1987 g) by adding Perasan MP-2® (12.8 g). The solution was tested using the modified DPD method to speciate the amount of peroxyacetic acid and hydrogen peroxide present. Table 1 displays the weights and concentrations of the solution.

Table 1

Raw Materials	Actual Wt. (g)	Measured Concentration	
		ppm PAA	ppm H_2O_2
City Water	1987	1070	223
Perasan MP-2®	12.8		

Each chicken half was individually placed in sterile poultry rinse bags. 100 g of the 1000 ppm PAA stock solution was placed into the bag. The initial residual concentration was measured after 1 minute, which became the basis of the "initial" concentration graphs and figures used below. Initially, the poultry rinse bags that contained the chicken half was gently agitated every 5 minutes to ensure even distribution of the solution. Later in the experiment the bags were agitated every 15 minutes. The solution in contact with the chicken carcass was sampled over time to monitor the decay profile of PAA and H_2O_2. The study was terminated when the levels were close to the detection limit of the method.

Results & Discussion

Figure 1 illustrates the instability of PAA in contact with the chicken halves. After exposure to the 1,000 ppm PAA solution the average initial test concentration of the solution was 635 ppm PAA. An initial decay of PAA was obvious and immediate. The study was terminated after approximately 3 hours due to the depletion of peroxyacetic acid to an average 7.85 ppm PAA. The average initial test exposure concentration of H_2O_2 was 67 ppm. The H_2O_2 analysis was terminated after only 10 minutes when it was determined that there was no longer H_2O_2 present.

Figure 1

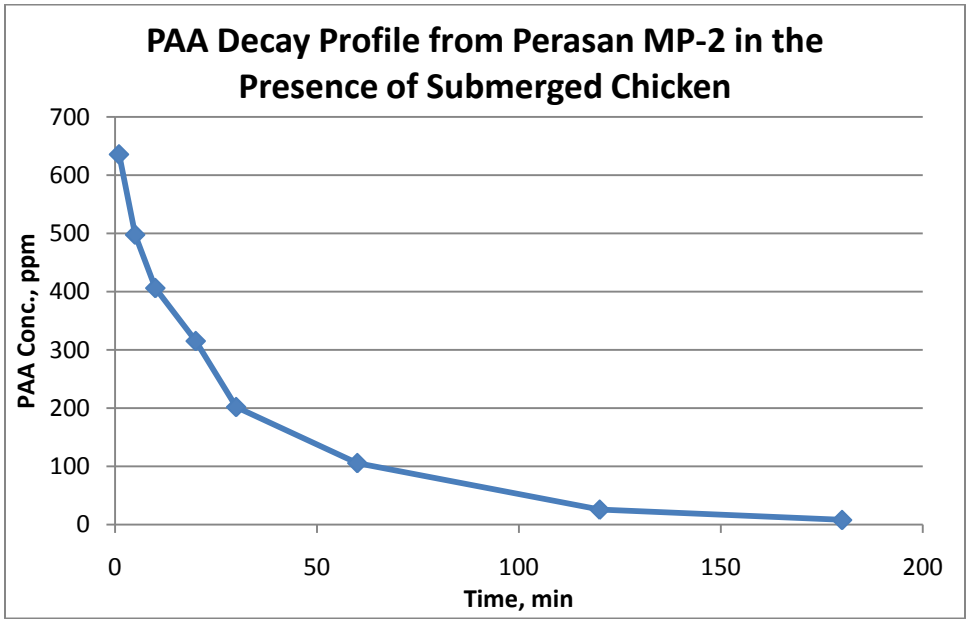
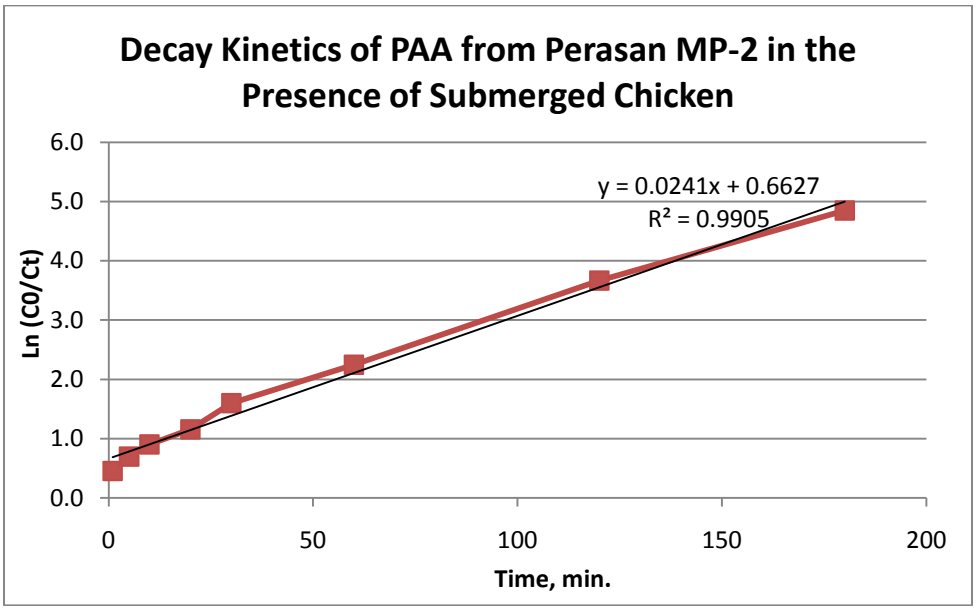


Figure 2 uses the data from Figure 1 for determination of the kinetic decay constants. When the results are plotted as the natural log of the ratio of the initial concentration of PAA to the concentration at time t as a function of time, there is a straight-line relationship. Linear regression yielded a slope of 0.0241. This indicates that the PAA solution decayed with a rate constant of 0.0241 min^{-1} corresponding to a half-life of **28.7 minutes**. The correlation coefficient (R^2 value) was calculated at 0.9905. Thus, the decay corresponds very closely to a mechanism of pseudo first-order decay (if perfect first order decay, $R^2 = 1$).

Figure 2



Conclusion

- Currently, FCN 887 permits Perasan MP-2® at < 220 ppm PAA to be applied to poultry carcasses, but if Perasan MP-2® is applied incorrectly, the concentration may exceed the levels permitted by the FCN. Therefore, the purpose of the study was to examine the persistence of PAA and H_2O_2 on poultry carcasses that had been treated with an elevated level of Perasan MP-2 in later stages of processing.

- This study demonstrates that PAA is unstable in the presence of poultry products. Even at an artificially high concentration of around 1000 ppm PAA, the PAA decayed steadily with a pseudo-first order decay constant.

- The half-life of the PAA is **28.7 minutes**. As expected, there was no H_2O_2 present in the solutions after ten minutes. Despite applying Perasan MP-2® at 5 times higher concentration than is permitted under FCN 887, the short half-life of the components demonstrates there is no possibility of their presence by the time the product could reach the consumer.

- All animals and fowl produce peroxidase and catalase enzymes as a function of their physiological metabolisms. Peroxyacetic acid is resistant to these enzymes. However, it can be clearly seen in this study that hydrogen peroxide (H_2O_2) is quickly and efficiently destroyed by these enzymatic reactions.