

FDA Recommended Pasteurization Time/Temperatures

For apple juice at pH values of 4.0 or less, FDA recommends the following thermal processes to achieve a 5-log reduction for oocysts of *Cryptosporidium parvum*. Because this parasite is believed to be more heat resistant than *E. coli* O157:H7, these parameters will also control bacterial pathogens.

160 degrees F for at least 6 seconds
165 degrees F for at least 2.8 seconds,
170 degrees F for at least 1.3 seconds,
175 degrees F for at least 0.6 seconds, or
180 degrees F for at least 0.3 seconds

71.7 degrees C (161 degrees F) for 15 seconds (milk pasteurization) is also considered adequate.

Remember to set your Operational Limit higher to assure you meet your Critical Limit!

The complete section on validation of pasteurization treatments for juice is excerpted below from the Juice Hazards Guide

5.2 Validated Pasteurization Treatments for Juice

At this time there are some published studies on pasteurization processes for controlling pathogens in juice that we can comment on to assist you in developing your HACCP plan.

Study #1 Summary: A study done by the NFPA (7) has resulted in a recommended general thermal process of 3 seconds at 71.1 degrees C (160 degrees F), for achieving a 5-log reduction for *E. coli* O157:H7, *Salmonella*, and *Listeria monocytogenes* in fruit juices. The efficacy of this process was measured using single strength apple, orange, and white grape juices adjusted to a pH of 3.9. The authors noted that a pH in the range of 3.6 to 4.0 has been reported as a non-significant variable in the heat resistance of *E. coli* O157:H7. The authors also noted that the heat resistance of these vegetative bacterial pathogens might be considerably greater at pH values of 4.0 and higher. This process assumes that the pathogens will have increased thermal resistance due to their being acid-adapted.

Study #2 Summary: A study done at the University of Wisconsin (8) has shown that treatments of 68.1 degrees C (155 degrees F) for 14 seconds (recommended treatment conditions in Wisconsin) and 71.1 degrees C (160 degrees F) for 6 seconds (recommended treatment conditions in New York) are capable of achieving a 5-log reduction of acid adapted *E. coli* O157:H7 in apple cider (pH values of 3.3 and 4.1). The Wisconsin study also confirmed the adequacy of the treatment conditions of the NFPA study (71.1 degrees C (160 degrees F) for 3 seconds) for achieving a 5-log reduction for *E. coli* O157:H7 in apple cider.

FDA Comments/Recommendations: We believe that the process recommended in the NFPA study is adequate to ensure a 5-log reduction of the three stated vegetative bacterial pathogens, (*E. coli* O157:H7, *Salmonella* and *Listeria monocytogenes*) at juice pH values comparable to those in the study. However, other validation studies may be needed for juices that have pH values greater than 4.0. We also believe that either of the processes evaluated in the University of Wisconsin study is adequate to ensure a 5-log reduction of the three stated bacterial pathogens, (*E. coli* O157:H7, *Salmonella*, and *Listeria monocytogenes*) (at juice pH values comparable to those in the study) if any of these pathogens are the pertinent microorganism in your juice.

Neither of these two studies evaluated thermal processes for achieving a 5-log reduction for oocysts of the protozoan parasite *Cryptosporidium parvum* that has been a cause of illness outbreaks associated with the consumption of apple juice. In fact, the thermal destruction of *Cryptosporidium parvum* oocysts has not been as widely studied in the published literature as it has for the vegetative bacterial pathogens; however, the available scientific literature suggests that *Cryptosporidium parvum* (9) oocysts may be more resistant to thermal processing than the three vegetative bacterial pathogens. Therefore, we recommend that you consider *Cryptosporidium parvum* to be the pertinent microorganism when you are establishing a HACCP plan for apple juice.

For apple juice at pH values of 4.0 or less, we are recommending the following thermal processes to achieve a 5-log reduction for oocysts of *Cryptosporidium parvum* (in addition to the three aforementioned vegetative bacterial pathogens) based upon a conservative evaluation of the available scientific data;

160 degrees F for 6 seconds (recommended treatment conditions in New York),
165 degrees F for 2.8 seconds,
170 degrees F for 1.3 seconds,
175 degrees F for 0.6 seconds, or
180 degrees F for 0.3 seconds

Also, while it appears that *Cryptosporidium parvum* may be more resistant to thermal processing than the vegetative bacterial pathogens noted, in view of the limited data on the thermal destruction of *Cryptosporidium parvum*, processors may designate both *E. coli* O157:H7 and *Cryptosporidium parvum* as the pertinent microorganism in their HACCP plans for apple juice, and use one of the recommended thermal processes given above for the a 5-log reduction of *Cryptosporidium parvum* oocysts, until more definitive data become available on the relative resistance to thermal processing of these two pathogens.

We also believe that the process that is typically carried out for milk pasteurization, 71.7 degrees C (161 degrees F) for 15 seconds, is adequate to achieve a 5-log reduction of oocysts of *Cryptosporidium parvum* and the aforementioned three vegetative bacterial pathogens when this process is used for apple juice (at juice pH values of 4.0 or less).