

Use of Peracetic Acid in Fruit and Vegetable Processing

Fruits and vegetables are divided into two main classes during processing. The first class, Raw Agricultural Commodities (RACs), is defined by 40 CFR § 180.1(d) fresh fruits, whether or not they have been washed and colored or otherwise treated in their unpeeled natural form; vegetables in their raw or natural state, whether or not they have been stripped of their outer leaves, waxed, prepared into fresh green salads, etc.; grains, nuts, eggs, raw milk, meats, and similar agricultural produce. It does not include foods that have been processed, fabricated, or manufactured by cooking, freezing, dehydrating, or milling. The other classification is non-raw agricultural commodity which is simplistically defined as fruits or vegetables that are altered from their natural state such as; peeled, sliced, diced, etc. The two classes become important during processing because the Environmental Protection Agency (EPA) regulates antimicrobial interventions used on RACs and the Food and Drug Administration (FDA) regulates non-RACs.

The three primary PAA formulas manufactured by Enviro Tech Chemical Services, Inc. approved for use in fruit and vegetable process water are; Perasan A, BioSide HS 15%, and Perasan MP-2. The limitation of the individual PAA formulas varies depending on whether the fruit or vegetable product is a RAC or non-RAC. The chart below specifies the maximum concentration of PAA approved for RAC and non-RAC products as well as the corresponding regulation for Enviro Tech's PAA products.

Applications	PERASAN [®] A	BIOSIDE [®] HS-15%	PERASAN [®] MP-2	
Raw Agricultural Commodity (RAC)	500 ppm PAA	500 ppm PAA	NA	FCN 1738/EPA Label
Non-RAC "processed"	500 ppm PAA	500 ppm PAA	500 ppm PAA	FCN 1738/EPA Label
Approved for Organic Production	✓	✓	✓	7 CFR 205.605(b) & OMRI

Selecting a Peracetic Acid Treatment Parameters

Selecting treatment parameters such as contact time and concentration for PAA can be difficult. There are many variables that must be taken into account when selecting PAA treatment parameters such as;

Microbial Load - Does the product contain high counts of organisms?

Type of Application - Spray, dip, etc.?

Organic Load - Process water containing a high organic load such as dirt can increase the demand for PAA therefore, higher concentrations of PAA are required.

Target Organism(s) - Different organisms can respond differently to antimicrobial interventions.

Product aesthetics - In some cases the organoleptic properties of a product may be affected by higher concentrations of PAA or longer contact times. While a change in the organoleptic properties of a product poses no food safety risk, it is undesirable to customers.

Desired Results - Depending on the application a certain bacterial reduction must be achieved.

Compliance - It is very important that when choosing a concentration that it does not exceed the maximum limit set by the governing bodies. The label, FCNs, and Code of Federal Regulations are the best sources of information on the highest allowed concentrations of peracetic acid on fruits and vegetables

Each of the aforementioned variables as well as other variables that may not be listed can influence the concentration of PAA needed as well as the treatment time.

The best and only way to determine sufficient treatment parameters for a certain plant is with in-plant microbiological testing. While there are numerous laboratory studies on the efficacy of PAA, plant applications will differ due to variables that are difficult to replicate in laboratory studies. Therefore, while laboratories can give suggested parameters, having in-plant microbiological results are necessary in order to determine if the antimicrobial intervention being employed is efficacious against pathogens and/or spoilage organisms. Most microbiological validation studies are simple and relatively inexpensive.

Special Considerations

There are certain produce products that are susceptible to oxidation such as high starch containing produce and leafy greens including but not limited to; peel potatoes, peeled/sliced apples, lettuce, spinach, carrots etc. If a produce product is susceptible to oxidation, the use of *Perasan MP-2* is recommended, if applicable. The lower hydrogen peroxide concentration in the *Perasan MP-2* aids in reducing the instances of browning due to oxidation.



Recommended Treatment Parameters*

Product	PAA Conc.	Contact Time	Product Recommendation
Apples (Whole)	30-80 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Apricots	30-60 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Avocados	30-60 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Bananas	30-60 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Bell Peppers (Sliced)	30-50 ppm	30-60 Seconds	Perasan MP-2
Bell Peppers (whole)	25-70 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Blue Berries	25-50 ppm	20-50 Seconds	Perasan MP-2
Broccoli	30-70 ppm	25-60 Seconds	BioSide HS 15% and Perasan MP-2
Cabbage	25-60 ppm	20-50 Seconds	BioSide HS 15% and Perasan MP-2 (cut)
Cantaloupes	60-120 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Carrots	20-60 ppm	30-45 Seconds	Perasan MP-2
Celery	30-60 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Cherries	40-80 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Cucumbers	30-80 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Garlic	30-60 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Grapes	30-80 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Kiwi	30-60 ppm	25-60 Seconds	BioSide HS 15% and Perasan MP-2
Lettuce	25-50 ppm	20-50 Seconds	Perasan MP-2
Mangos	30-60 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Onion (sliced)	30-80 ppm	30-60 Seconds	BioSide HS 15%, Perasan MP-2
Onion (whole)	30-80 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Oranges	30-80 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Plums	40-80 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Pomegranates	30-70 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Potatoes (Whole)	30-80 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Radishes	30-60 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Spinach	25-50 ppm	20-50 Seconds	Perasan MP-2, BioSide HS 15%
Sprouts	25-50 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Squash	30-60 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Strawberries	25-60 ppm	30-60 seconds	BioSide HS 15% and Perasan MP-2
Tomatoes	30-80 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2
Watermelons	40-80 ppm	30-60 Seconds	Perasan A, BioSide, Perasan MP-2

*It's important to the note that the table above is strictly recommendations based on scientific studies and actual application rates currently employed at various processing plants. Actual applications rates can vary depending on the processing plants and in-plant validation studies are strongly encourage to determine the best application rates for a specific processing plant.