TITLE: **Solar pasteurization of fruit and vegetable wash water.**

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On-farm food safety is becoming a critical issue for farmers world-wide as consumers are demanding safer food production and handling. In the US, this issue is being driven by lawsuits stemming from deaths and sicknesses and a US government mandate to reduce potentially harmful behaviors and contamination on farms to as low levels as possible. Killing of harmful pathogens by heat is a function of exposure time and temperature. It is not necessary to boil water to kill bacteria and viruses that causes illness in humans. Published literature indicates that exposure to more than 70°C water for about six seconds is sufficient to kill most pathogenic *E. coli* and other pathogens.

Solar Water Pasteurizers (Safe Water Systems, Honolulu, HI) were developed to pasteurize drinking water when a usable energy supply was not available or was too expensive. Contaminated water enters the heat exchanger where it is preheated by the hot water exiting the system. The preheated water then flows to the solar collector for further heating (Figure 1A). When the water reaches 79°C, the thermal control valve (Figure 1B) opens and allows the disinfected water to flow back into the heat exchanger. The valve closes immediately when water temperature drops below 77°C. Once discharged through the thermal control valve, the hot, pasteurized water gives up most of its heat to the colder incoming contaminated water in the heat exchanger. After being cooled by the heat exchange process, the now disinfected water exits the system, where it is stored in a sanitary holding tank and is ready for distribution. A four panel Solar Water Pasteurizer was set up on Maui and monitored for six months.

A single panel in the Maui test produced 50 to 150 gallons per day (averaged about 100 gal/day) below the 150 to. 250 gallons expected. The lower production rate was possibly due to frequent periods of cloudy weather and higher elevation at Kula. The temperatures measured at various location in the water flow path indicated that the panels were preforming as expected (Table 1). The incoming water was at 21°C, after the heat exchanger it was increased to 59°C and at the sensor placed as close as possible to the pasteurization valve 75°C. The lower than expected production could be due to the cooler location of the site though more likely due the frequent cloud cover. Clouds are expected at the location on most afternoon on normal trade-wind days.

On a typical day, solar radiation began to increase just after 6AM and reached a peak just afternoon (Figure 2). Pasteurized water was not generated until just before noon as the water in the glass solar panels slowly heated up and did not reach the thermal temperature valve opening temperature until about 11.45AM. After the valve opening temperature was reached, there was brief period of high water pasteurization before it declined and showed a variable rate of production until about 3PM. After 3PM, the rate of production declined and ceased at about 5:30PM.

The water after passing through the Solar Pasteurizer had *E. coli* and coliform bacteria below the level of detection (Table 2). The incoming untreated water had significant contamination with these bacteria that are measures of fecal contamination. The non-pathogenic total hetertrophs (plate count) were reduced more than 15 fold. No water standards exist for total plate count, the requirement is that the water be treated.

Figure 1. Solar pasteurization glass tubes mounted in panels (A) with passive movement of water from the bottom of the panel to the top where the thermal control valve (B) that opens when water reaches 79 ºC and closes at 77 ºC. In this photograph the insulation lagging has been removed from the valve.

A.

B.

Figure 2. Solar radiation and water production rate (A) and temperatures at various location in the unit (B).

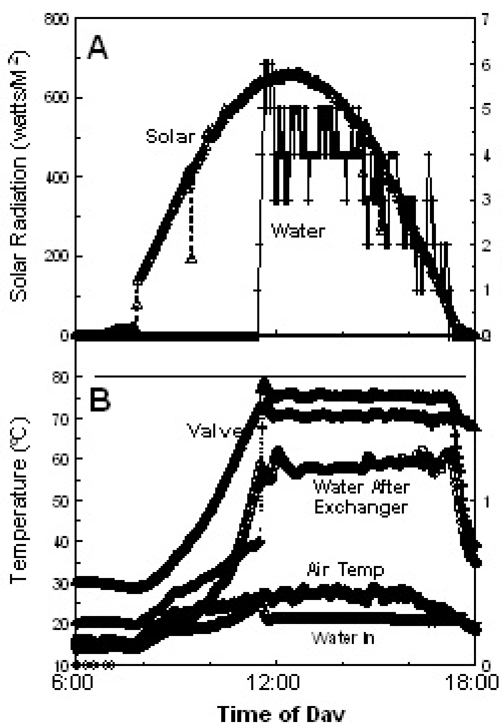

Table 1. Temperatures on the outside of the copper pipe place at various locations in the unit.

Location	**ºC**
Incoming water	21
After Heat Exchanger	59
At Thermal Control Valve	75
After valve	71

Table 2. Microbial counts from water samples taken on the inlet and outlet sides of the solar pasteurization unit. Counts <2 per 100 ml are less than the level of detection.

	Bacterial Counts	
	Inlet water	**Outlet water**
E. coli	29	<2
Coliform bacteria	36	<2
Plate count	1712	112