# CONTROLLING MICROBIAL POPULATION IN SAP SYSTEMS

**Locations:** Cornell Uihlein Sugar Maple Research Laboratory, Lake Placid, NY, Arnot Forest, Van Etten, NY and private maple operations throughout New York

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**Objectives**

**1.** To document microbial populations in commercial sap systems.

**2.** To determine the effectiveness of disinfectants, tubing washing and UV radiation

**RESEARCH RESULTS**

**Objective 1. Microbial populations in commercial sap systems**

Over the course of one maple sap season in Western New York that started approximately March 8, 2005 and ended April 9, 2005, four maple sap locations were sampled to determine the levels and diversity of microbial populations contained in the different sap samples. The various sap samples were analyzed for yeast and total aerobic plate counts using acidified Potato Dextrose Agar (PDA) and Plate Count Agar (PCA), respectively. Samples were collected from virgin tapped trees, various points in the tap lines and in central collection points ie. storage tanks. The lowest level of bacteria and yeast were from virgin tapped trees, followed by sap lines and finally collection vessels. This indicates that

the majority of the contamination that is observed in the sap at the sap house originates from tubing and the residence time from the tree to the boiling pans allows for multiplication of the contaminating bacteria and yeast. Environmental temperature was also observed to have an effect on the levels of bacteria and yeast which was expected. The warmer environment temperatures observed later in the sap season had higher levels of bacteria and yeast. The growth rate of bacteria and yeast increases (doubles every 10$^{O}$C) as temperatures increase up to the microorganisms maximum growth temperature.

From the numerous samples collected, the bacterial counts were typically higher than yeast counts. The level of bacteria ranged from undetectable (<1 colony forming unit/ml) to a high of 760,000 cfu/ml. From the data, it appears that the wide variation was dependent upon the location it was collected which could be explained by the different conditions of the tubing ie. cleanliness condition, and residence time of the sap. Yeast levels were much lower on average (approximately 2 orders of magnitude) with a range of <1 cfu/ml to a high of 76,000 cfu/ml). HIghest levels were observed in collection tanks and later in the sap season.

From the large number of samples taken, the results confirmed the importance of cleaning sap tubing to prevent contamination of sap and the control of the microorganisms during sap holding prior to evaporation either through inactivation ie. thermal processing, UV or ozone treatment of

the sap; or control of their growth by refrigeration to less than 40°F. Recommendations to limit the residence time in the sap tubing, proper cleaning of tubing and sap contact equipment and possibly an in-line treatment such as UV treatment prior to entering the collection vessel would reduce the level of microorganisms which has a direct effect on the finished quality of maple syrup due to the conversion of the disaccharide sugars (sucrose) normally contained in sap into two monosaccharide molecules (glucose & fructose) that when exposed to heat and low levels of amino groups, form caramelization products that impart flavor and darker color. This type of reaction is called a Maillard reaction.

**Objective 2. UV disinfection and tubing sanitization**

Currently, sap tubing is not cleaned by a large majority of the maple syrup producers. At most, a high pressure back flush of water alone or in combination with bleach is passed through the tubing systems. The proper cleaning and sanitization of the tubing will prevent the formation of biofilms on the tubing surface which can release microorganisms continually into the sap as it passes through the tubing. For the food industry, a 5 step cleaning procedure is recommended which is as follows:

1. rinse majority of organic contamination out of lines with water
2. detergent application
3. water rinse
4. sanitizer application at correct levels (50-200 ppm free chlorine at pH <6.0)
5. potable water rinse

Due to the extensive tubing networks, this 5-step procedure is a large time commitment. This is the recommended protocol that the rest of the food industry has to comply with. However, at minimum, a detergent sanitizer as a flush and a final rinse with water would be a minimum. Chlorinated sanitizers showed the broadest spectrum of activity against all bacteria, yeast and molds. The caustic nature of hyochlorites also strips organic build up in the tubing. As a second alternative is hydrogen peroxide as a sanitizer at a maximum allowable level of 1,100 ppm. This is not as broad spectrum of activity and some bacteria, yeast and mold not being sensitive to this sanitizer. The contact time for sanitizers should be at least 2 minutes or as recommended by the chemical supplier to guarantee complete effectiveness.

Detergents should not be carried over for two reasons, firstly, the tubing should be made of food grade plastic which does not allow for leaching of detergents or sanitizers into the plastic. The second reason is that there are three additional rinse steps that will flush all traces of detergent away. Proper detergent and sanitizer levels are extremely important for the effectiveness and preventing any carry over into the concentrated sap. Sufficient volumes of all solutions including water rinses is essential.

Ultraviolet irradiation using a commercial sap treatment system (Sap Steady, FPE Inc., Macedon, NY) was used. A level of approximately 8,000 uWatts of UV exposure was applied to the in coming sap prior to the collection vessel. The UV treatment at this level achieved a 100 fold reduction in bacteria and a 10 fold reduc-

tion in yeast levels compared to the untreated sap at the same time. It was observed that the total levels of yeast and bacteria were lower and the time required to reach the levels of the untreated sap in the collection vessel was significantly extended. This relates to an extended holding time and reduced enzymatic activity that potentially produce darker syrup and more caramelized flavor in the finished syrup.

From this preliminary research, it appears that an in-line UV treatment of sap can improve the microbiological quality of sap that is used in the production of maple syrup. It should be mentioned that the finishing quality of the maple syrup will likely not be improved over the quality of the maple syrup that would be made from the incoming maple sap if it were immediately evaporated to the finished maple syrup. In other words, the use of a disinfection step at the point of sap storage will retain the quality of the sap but will likely not improve the quality but will prevent the deterioration of the maple syrup quality.