Determining the temperature-time profile on yogurt synthesis

Yogurt is a dairy product produced when certain bacteria ferment milk – usually cow milk or goat milk. The fermentation of the milk sugar (lactose) produces lactic acid, which gives yogurt its characteristic taste and which acts on the milk protein to produce its thick texture. Although several bacteria can be involved, it’s not proper yogurt without *Streptococcus thermophilus* and *Lactobacillus bulgaricus*.

Yogurt is preserved by its acidity which inhibits the growth of putrefactive or pathogenic bacteria. With lids intact, yogurt will keep at least a month or two in the refrigerator. After that time, especially if your refrigerator is on the "warm" side, a layer of non-pathogenic white mold may form on the top.

There are many strains of *S. thermophilus* and *L. bulgaricus*; different strains produce slightly different-tasting yogurts. The various strains of *S. thermophilus* and *L. bulgaricus* also have different optimum growth temperatures¹, so the temperature profile and length of incubation period have a strong effect on the flavor of the resulting yogurt. Other variables include the milk used and the other bacteria present.

Recipes for yogurt all include heating the milk to a warm temperature, inoculating it with a starter that includes the necessary live bacteria, and letting the milk ferment in a warm place for several hours. The favored final acidity is around a pH of 4.2.

*S. thermophilus* and *L. bulgaricus* generally won’t grow much below 35 C and are killed above 50 C, so that determines the temperature range.

Build a yogurt maker to maintain the temperature of a milk culture at 37, 42, and 45 degrees C for 6, 8, and 10 hours. Compare the taste and acidity of the resulting yogurt. (Alternately, build a well-insulated container for the culture and chart its temperature profile.)

Supplies:
For the yogurt:

Milk
Commercial or home-made yogurt to use as a starter.

Be sure to get a plain yogurt with active cultures such as Stoneyfield Farm or Fage. Yogurt starter must have live bacteria for this to work. Some yogurts also contain other "Probiotic" cultures such as *Lactobacillus acidophilus*, *Bifidobacterium longum*, and *Bifidobacterium infantis*, which are bacteria normally found in your intestines. There are some indications that

these additional bacteria make the yogurt reach a thicker consistency faster; this may be a way for the manufacturers to shorten their incubation time.

For the yogurt maker:

Glass container, to hold about a liter/quart
Insulating container
Temperature probe
Cartridge heater and feedback control
Temperature data readout and logging to computer

For the test:

Spoon

Technique:

Warm a liter of milk to 50 C. Add two spoonfuls of your active yogurt culture to 1 cup of the warm milk; return the mixture to the bulk of the milk and place in your insulated glass container and its warming mechanism. Maintain the temperature of the milk culture at 37, 42, and 45 C for 6, 8, and 10 hours. Compare the taste and texture of the results, using criteria of your choice.

Thermistor response: $\frac{1}{T} = a + b \log R$
Thermocouple response: $V = k(T-T_0)$