Optimization of DNA Fragmentation in an Ultrasonic Bath Using Nanodroplets

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Personalized medicine is an emerging practice in medical decision making that uses an individual’s genetic profile to guide treatment decisions. For example, not all cancerous tumors have the same underlying mutations to the DNA sequence. Knowing an individual’s genome can help physicians choose a treatment that targets the tumor’s unique characteristics and vulnerabilities.

- High throughput sequencing is a technique used to determine the sequence of nucleotides in a sample of DNA.
- The first step to sequencing is random fragmentation of DNA, which can be greatly improved.

Covaris is a commercially available DNA fragmentor that uses high intensity, focused ultrasound to fragment single DNA samples at a time.

- Expensive and time consuming

Our goal is to develop a large scale DNA fragmentor that is both cost and time effective. We propose to accomplish this using a benchtop ultrasonic water bath.

- Study the behavior of a new fragmentation enhancing agent, nanodroplets.
- Optimize the process of fragmentation in the water bath.
Results

We know that cavitation (the destruction of a bubble/droplet while exposed to ultrasound) of the nanodroplets is a mechanism that enhances fragmentation of DNA in the water bath. Cavitation is greatly improved by the presence of nanodroplets and occurs greatest at a water height of 66.7mm (figure 1).

A 1” spaced holder with 3 rows of 8 samples was developed and shown to consistently fragment DNA samples (figure 2). Nanodroplet perfluorocarbon core compositions of DFB, OFP, and DFB-DDFP were shown to be equally effective at fragmentation (figure 3). DFB droplets were used because of their stability and ease of production.

Looking Forward:
Our findings show that a low frequency ultrasound water bath can be enhanced to fragment DNA in a cost and time efficient manner. A procedure for DNA fragmentation in an acoustic water bath can be developed for widespread use in gene sequencing. Gene sequencing tells scientists important genetic information and can be used to look for mutations that cause diseases.