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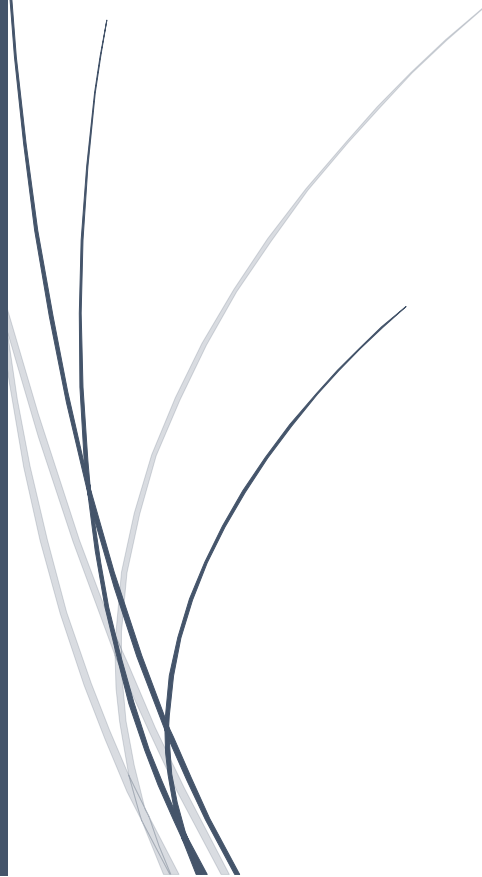
Homogenization and the Importance of Extending the Shelf Life of Dairy Products

University of Minnesota Duluth

University Honors Capstone Research

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Homogenization and the Importance of Extending the Shelf Life of Dairy Products

Background

Milk or any dairy products are transported to different dairy product processors all around the country. These trips could take from a couple of minutes to several hours, hence these products could encounter bacteria growth, more known as spoiling if industries do not work on extending their lifetime. These products go through trips, processes ending up on the road, or storage room for about a week or more. Therefore, extending the shelf life of dairy products will enhance the quality of it when consumers buy it. Not forgetting that it will also give a larger window for the products to reach consumers. Usually, dairy industries focus on pasteurization of the milk in order to extend the lifetime of the products because pasteurization inactivates most of the vegetative pathogens and spoilage bacteria in milk^[1]. However, homogenization is one of the processes that can make the products last longer because it inactivates bacteria in milk and increases the quality of dairy products.^[2] Therefore, ensuring a good homogenization process will help to obtain good quality and long-lasting products.

Objectives

This project aims to make industries aware of the importance of an adequate homogenization treatment for the conservation and good quality of dairy products. As well as to show the different homogenization processes that can be used to improve the quality of dairy products.

Theory

Homogenization is defined as the capability of producing a homogeneous mixture in which the size distribution is reduced to avoid suspension of them in a liquid. This is done by

forcing the liquid under pressure through a homogenization valve.^[3] In the dairy industry, homogenization is the process to break down the fat particles to form a homogenous liquid, thus it avoids creaming or fat globule clumps in milk. Homogenization is performed at high velocity and high pressure to reduce the size of the fat particles from an average of 3.5 μm in diameter to below 1 μm . Usually, the temperature at which the milk is homogenized is 50-80 $^{\circ}\text{C}$ and the pressure is between 10 and 25 MPa (100 – 250 bar).^[4]

**The Effects of 2-stage Homogenization
on Fat Globule Size Distribution as Seen
Under the Light Microscope**

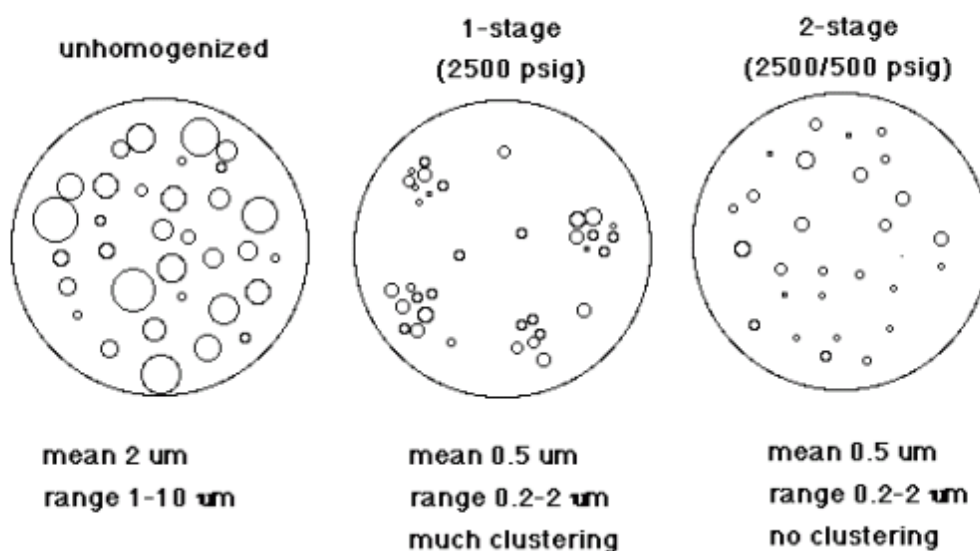


Figure 1. Fat particle size distribution in 2-stage homogenization. Retrieved from Food Science, University of Guelph

A 1-stage homogenizer consists of a pump and a homogenizing valve. The fluid is forced into the valve by the pump. Once the fluid is in the homogenization valve, it is forced under pressure through a small orifice between the valve and the valve seat. The pressure can be

adjusted by changing the distance between the valve and the valve seat. ^[3] Also, the process can be operated in two stages. The first stage is where most of the fat reducing particle is achieved and the second stage makes sure that any clumping fat globule separates from the clusters and into individual fat globules. ^[5] If the pressure is increased, the size of the particle will be smaller. Therefore, the pressure can be modified depending on the result it is expected to obtain.

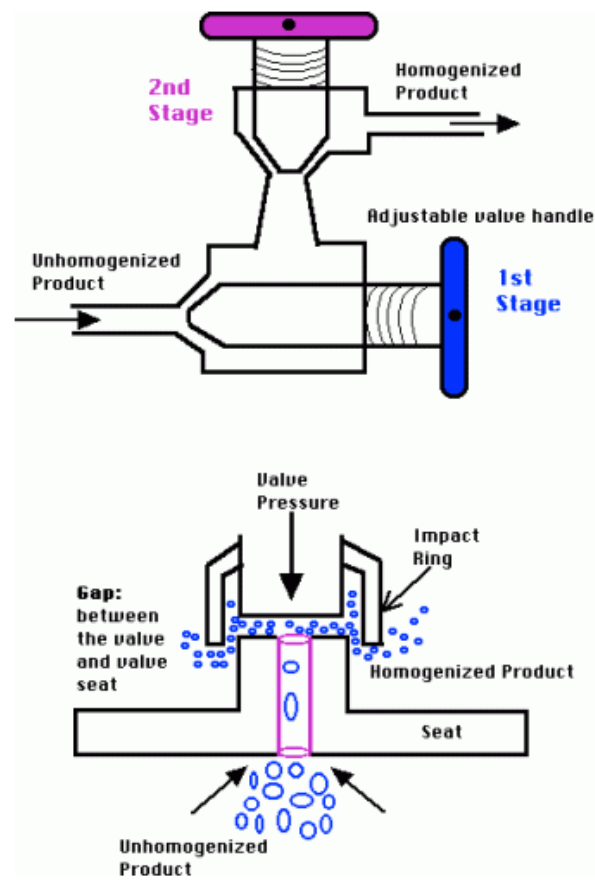


Figure 2. Homogenizer. Retrieved from University of Guelph

Methods and Material

This experiment was done in the chocolate lab at the University of Minnesota Duluth. The homogenization process was performed using a Nutri Ninja Pro Single Serve Blender. 2 gallons of milk were used for this experiment but only 1 gallon was homogenized. The purpose of only homogenizing one gallon of milk was to see the difference between the homogenized

milk and the non-homogenized. There were 8 trials performed and each one had 250m ml of raw cow's milk. Table 1 shows the run numbers and how long they were homogenized. Since the mixer is not the most appropriate equipment for homogenization every trial was done in sets of 1 min for up to five times. Homogenizing in sets of 1 minute avoided to over warmed the mixer, thus causing it to stop or spill milk all over. The procurement of raw milk had many difficulties and it took a long time to acquire the milk. Finally, it was obtained from the Amish community.

Table 1.

Run order	Homogenization/min
1	5
2	5
3	5
4	2
5	2
6	2
7	2
8	5

Methods industrially used

Industrially, homogenization is performed using specific equipment called homogenizer. As explained before, it consists of a pump and a homogenizer valve. Generally, the operating parameters for homogenization are pressure between 10 and 25 MPa (100 – 250 bar) and temperature between 50-80 °C.^[4] The pressure at which the homogenization is done affects the fat particle size, hence making an impact in the sensory characteristics in milk and its shelf life

High-Pressure Homogenization (HPH)

Some processes use high-pressure homogenization, the parameters for this type of procedure are pressure at 250 MPa and temperature at 45 °C. This treatment has shown to

deactivate spoilage microorganisms from raw milk, thus extending the shelf life of it.

“Inactivation of bacteria by HPH treatment occurs through mechanical destruction of cells.”^[6]

HPH might not be enough to make a significant change in the extension of the lifetime of milk but combining it with pasteurization, sterilization or ultra-high temperature treatment may allow an extended shelf-life of milk.

Results

For this research, homogenization was done for 2 and 5 minutes. The main difference in these two settings is the appearance of the milk after one day in the refrigerator. The runs homogenized for 2 minutes look creamy and the fat particles clumps. In contrast, the runs homogenized for 5 minutes look more appealing. They have a bright white color similar to the color of the milk in the stores. This comparison can be seen in figure 3.

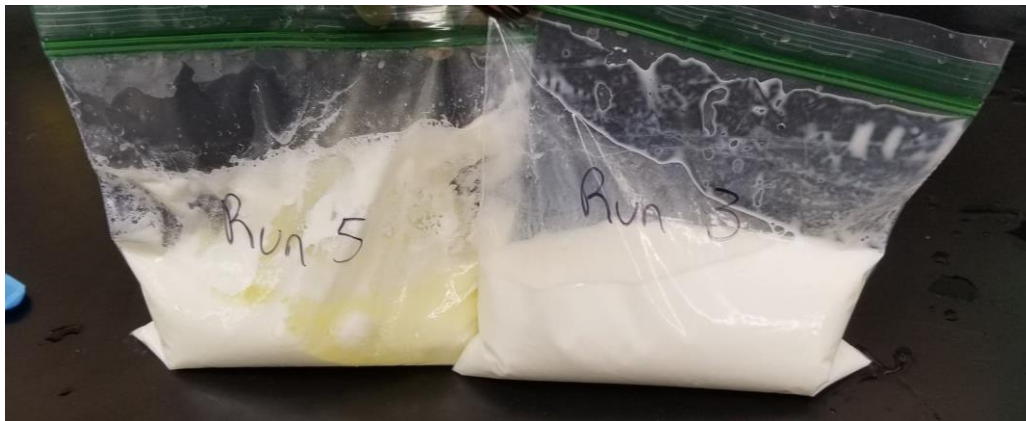


Figure 3. Run 5 homogenized for 2 minutes and run 3 for 5 minutes

Additionally, this trend is shown in homogenized and non-homogenized milk. As mentioned before, the homogenized milk has a more appealing appearance than the non-homogenized milk. The non-homogenized has a darker color due to the big fat particles that are

not homogenized with the liquid milk. Figure 4 shows a batch of homogenized and a batch of non-homogenized milk.

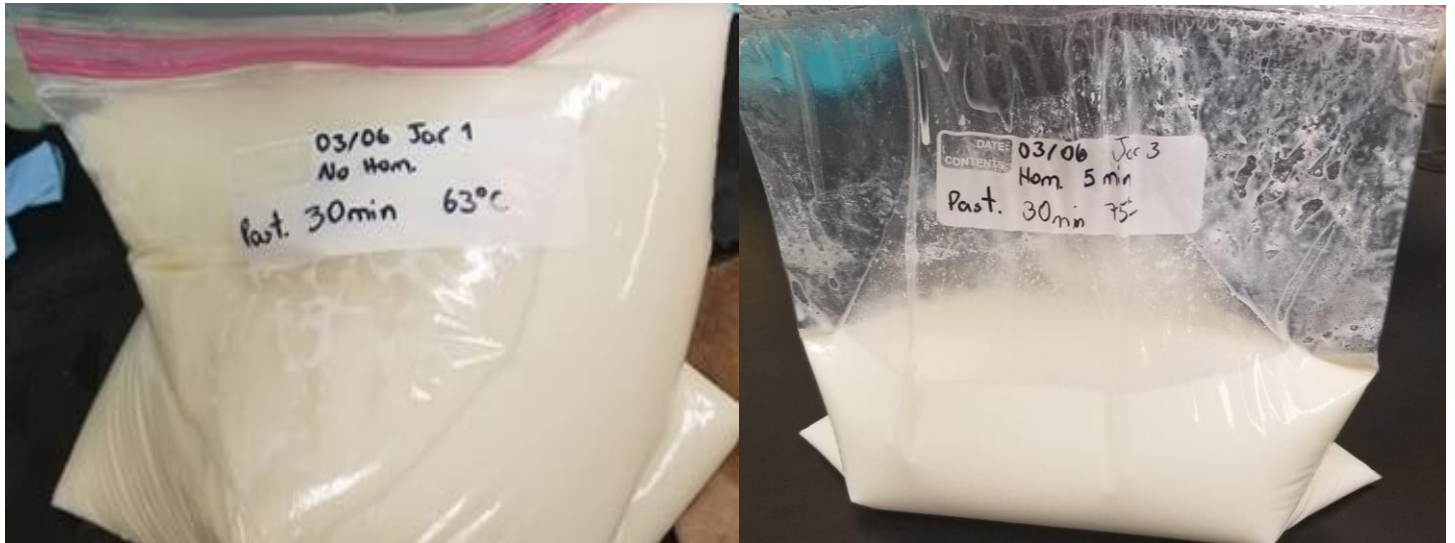


Figure 4. On the left, non-homogenized milk. On the right, homogenized milk

In order to see better the impact of homogenization in the appearance of milk, it was pasteurized at 75 °C for 45 minutes. Figure 5 displays how fat from the milk rises to the top after pasteurization. It looks like oil spots in the milk and the separation of the fat from the milk is due to the high temperature and to the big size of the fat particles.

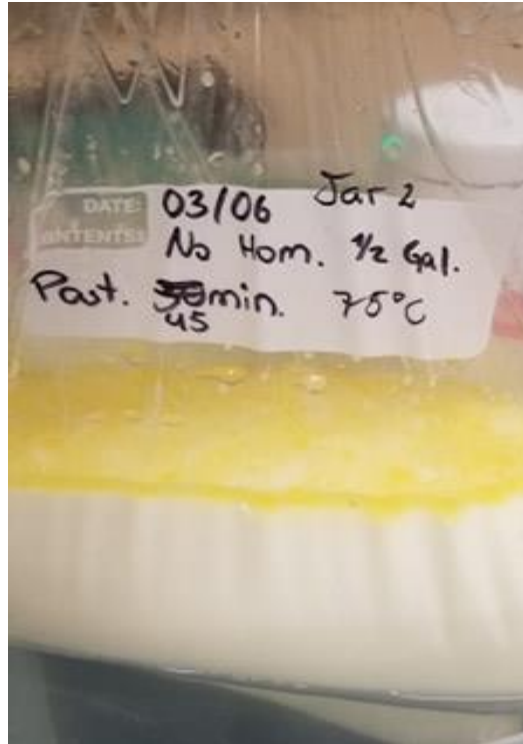


Figure 5. Non-homogenized milk after pasteurization

Conclusion

The results in this research only show the effect of homogenization in the appearance of milk. Due to the closure of the University, the research could not be done. However, the photos taken show that homogenization changes the look of milk, thus improving the sensory quality of it. As stated, other similar research proves homogenization inactivate bacteria in milk, hence extending the shelf-life of it. Homogenization is a good alternative to extreme pasteurization treatments. Some consumers do not accept ultra-pasteurized milk because it changes the flavor of milk.^[7] For this reason, there is the need for extending the shelf life of milk without negative changes in its flavor profile and maintaining the nutritional and sensory quality of milk. Therefore, combining the traditional methods to deactivate spoilage microorganisms with homogenization will not only extend the shelf life of milk but it will also avoid the reduction of its nutritional and sensory quality.

Acknowledgments

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