ECRONICON OPEN ACCESS

EC NUTRITION
Mini Review

A Non-Thermal Alternative to Preservation of Soluble Liquid Foods- A Short Review

JS Ghosh*

Department of Microbiology, Sandip University, Nashik, India

***Corresponding Author:** JS Ghosh, Department of Microbiology, Sandip University, Nashik, India.

Received: July 13, 2019; **Published:** October 10, 2019

Abstract

It is no doubt interesting to note that like all industries, even the food processing industries have become conscious about energy conservation. There are scattered reports on how other physical methods can reduce the heat consumption during processing, especially of liquids other than milk. This review deals with such a method and brings out the advantages and disadvantages of such a method wherein by use of shear force it is possible to kill the microbes which are not only responsible for spoilage but also capable of causing disease in the consumers.

Keywords: *Preservation; Non-Thermal Methods; Shear Stress*

Introduction

Food safety is now catching up in the developing nations, with more and more consumers realizing the fact that safe food is the word of the day. In order to produce safe foods there are several treatment given to the food. These include, thermal treatment (hot or cold) and chemical treatment where in the manufacturers use different preservatives. The term safe food implies that the processed food item should not be of any harm to the health of the consumer. However, it has also been realized that sometime the consumers buy food in excess of their immediate requirements preferably to economize on the cost factors. Such excess food when stored (as specified by the manufacturer) should not get spoiled within its life span. It should be able to show virtually the same acceptable sensory and quality characters as it was at the time of procurement.

The second important aspect is that the consumers are recognizing the sensory qualities of the processed foods to be as close to the ones of the natural raw material from which it has been produced. The physical treatment like thermal processing can sometime alter these characters [1].

The third important factor to be borne in mind is that the nutritional values, especially with respect to RDA of some the nutrients should be maintained and not lowered in a suitable intake size (as in case of the unprocessed raw materials). It has been observed that in many safe processed foods this is not so and hence to get the required RDA of some the nutrients, the consumers are required to have a larger intake of the basic food [1].

The last but not the least important factor is the cost of energy (that is showing many a times, a steep trend) which adds to the cost of the processed food [2].

Keeping all these above mentioned factors in mind, one needs to see if there is any alternative treatment other than thermal processing to prepare safe-processed foods especially some of the liquid foods like fruit juices/concentrates [3]. Preservation of solid foods will not be discussed here as there are other methods like pickling, drying and dehydration methods are adopted.

Short term preservation of liquid processed foods

One such methods is the pasteurization (usually flash pasteurization) of liquid food like juices. This is a preservation method which coupled with refrigeration or chilling not only during processing but also during storage. Sometime it is also coupled with other methods like, high osmotic pressure, lowering of pH and addition of other chemical preservatives to inhibit the growth of mainly microbes, which have escaped the pasteurization process and is capable of causing spoilage [2].

Again, in this review the discussion would be limited to foods which are homogenous solutions and not colloidal suspensions like liquid milk or milk based products like flavored milks.

One such method involves developing high shear force by passing the liquid under very high pressure such that the microbes are killed by shear action [4]. In order to do so we must have certain microorganisms, that can be considered as index microorganisms. Secondly, one must know the tensile strength of the cell wall and cell membrane of these microbes which must be overcome to break open these membranes to let out the protoplasms. The average tensile strength of *E. coli* cell wall is anything between 50MPa to 150 MPa and that of *Bacillus subtilis* and *Pseudomonas aeruginosa* is 100MPa to 200 MPa [5]. The tensile strength of cell wall of *Saccharomyces cerevisiae* is about130Mpa [14]. However, the spores of Bacillus have tensile strength is in the range of 225 Mpa [5,6].

It means that one has to apply pressure to such an extent which would produce shear strain more than these values in order to kill these organisms [7].

The internal osmotic pressure required to burst the cells of E. coli is about 2 atmosphere [8]. However, here it is not the osmotic pressure that one is concerned about. It is the shear strain which should be near 300 MPa in order to bring about the breakage of the cell boundaries (especially the cell wall) [9,10].

It is known from the Newton's law of viscosity that "Viscous force 'F', opposing motion at the interface between two liquid layers, flowing with a velocity gradient 'dv/dx', is given by the equation:

$F= \mu A (dv/dx)$ or $F/A = \mu A(dv/dx)$ [11]

Where μ is the viscosity; A is the area over which the liquids are flowing and x is the separating distance between the liquids.

F/A is the shear stress (τ) and $A(dv/dx)$ is the shear rate (γ). The above equation becomes as

$\tau = \mu\gamma$

Now since all the juices are aqueous in nature, it is essential to know the relationship of the shear stress to density of the solution. This is given by the equation as:

$\tau = \mu\beta DSw$ or $\mu\gamma = \mu\beta DSw$ or $\gamma = \beta DSw$ or $A(dv/dx) = \beta DSw$ [11]

where β is the density of the aqueous solution; D is the average depth of the solution and Sw is the water surface slope. It can now be seen that velocity gradient (dv/dx) of the solution is directly proportional to β, D and Sw and inversely proportional to A [11,12].

It implies that if one increases the value of β then the shear rate (γ) will proportionally increase in the same average values of shear stress (τ) and viscosity (μ) for certain limits of β. Beyond this one would observe that μ too will increase and the calculation would become complex. This is exactly what will happen in case of fruit juice and fruit concentrate.

Since microorganisms are insoluble particles in the solution, these can be considered as Bed Load [13]. When the drag force of the flowing solution is greater than the gravitational force then this bed load start to move with improved shear rate. This implies that there will be a better death rate of the microbes present (bed load) in the solution due to increased shear rate. In order to increase the drag force, it is not advisable to increase the values of 'Sw' or 'D' as by doing so, the liquid will flow at random channels [11]. It is better to increase the value of 'β' and then gradually apply a limited increased force externally.

Therefore, it can be concluded that by using alone shear force which is more than the tensile strength of the microorganism, it is possible to bring about breaking of the cells thus killing the cells. Such a cidal effect will no doubt kill the cells but still doesn't make the food safe. When the cells are lysed, it is possible that the cytoplasmic contents may contain endotoxins which will not be denatured by shear stress and hence, can damaging to the health of the consumers. Similarly, many of the already existing spoilage enzymes will still remain active and can bring about spoilage.

Secondly, the viruses that can be dangerous to the health of the consumers will not be affected by any shear stress. Nor these will lose their affinity or alter their chemotaxic behaviour by such stress.

Finally, this sort of treatment cannot be applied to whole milk (liquid) as it can damage the casein molecules and the fat globules which will break the colloid resulting in separation of water and other suspended components.

The only advantage will be the net energy consumption (mostly by sheer heat treatment) can be reduced to some extent if not significantly, when it is combined with such measures like shear stress. Secondly the sensory qualities will not get altered to that extent as compared to what would have happened if heat alone was to be used.

Conclusion

Many researchers have tried to advocate such alternatives to heat treatment of liquid food but have not aptly discussed at length, the limitations involved. Such research activities have remained at the preliminary stage as of date. It is therefore, imperative to optimize such methods of food preservations and safety measures with specific processed food items. In all likelihood such methods might have to be used in combination with other methods to get a better efficiency.

Bibliography

1. Food Processing an Overview – Flashcards.
2. Roohinjad S., *et al*. "Sustainable food systems from Agriculture to Industry, improving production and processing". Elsevier, Frankfurt (2018): 191-243.
3. Nan L., *et al*. "Emerging microfluidic devices for cell lysis: A review". *Lab Chip* 14.6 (2014): 1060-1073.
4. Thomas WE., *et al*. "Bacterial Adhesion to Target Cells Enhanced by Shear Force". *Cell* 109.7 (2002): 913-923.
5. Thwaites JJ and Mendelsont NH. "Biomechanics of bacterial walls: Studies of bacterial thread made from Bacillus subtilis". *Proceedings of the National Academy of Sciences of the United States of America* 82.7 (1985): 2163-2167.

6. Hayhurst EJ., *et al*. "Cell wall peptidoglycan architecture in Bacillus subtilis". *Proceedings of the National Academy of Sciences of the United States of America* 105.38 (2008): 14603-14608.

7. Tuson HH., *et al*. "Measuring the stiffness of bacterial cells from growth rates in hydrogels of tunable elasticity". *Molecular Microbiology* 84.5 (2012): 874-891.

8. Persat A., *et al*. "The mechanical world of bacteria". *Cell* 161.5 (2015): 988-997.

9. Islam MS., *et al*. "A Review on Macroscale and Microscale Cell Lysis Methods". *Micromachines* 8.3 (2017): 83.

10. Lasagna D., *et al*. "Multi-time delay, multi-point linear stochastic estimation of a cavity shear layer velocity from wall-pressure measurements". *Physics of Fluids* 25.1 (2013): 1-4.

11. https://physics.info/viscosity/

12. Nepomuceno HG and Lueptow RM. "Pressure and shear stress measurements at the wall in a turbulent boundary layer on a cylinder". *Physics of Fluids* 9.9 (1997): 2732-2740.

13. Wang L., *et al*. "Influence of Type I Fimbriae and Fluid Shear Stress on Bacterial Behavior and Multicellular Architecture of Early Escherichia coli Biofilms at Single-Cell Resolution". *Applied and Environmental Microbiology* 84.6 (2018): e02343-17.

14. Alberts B., *et al*. "Molecular Biology of the cell 4th edition". Garland Science, NY (2002).

Volume 14 Issue 11 November 2019