International Journal of Advanced Research in Physical Science (IJARPS)
Volume 4, Issue 12, 2017, PP 1-4
ISSN No. (Online) 2349-7882
www.arcjournals.org

Monitoring pH During Pasteurization of Raw Cow's Milk using Nd:YAG Laser

Ali A. S. Marouf[1,*], Sara I. Elmhal[2]

[1]*Institute of Laser, Sudan University of Science and Technology, Khartoum, Sudan*

[2]*College of Science, Sudan University of Science and Technology, Khartoum, Sudan*

Corresponding Author:** ***Ali A. S. Marouf, *Institute of Laser, Sudan University of Science and Technology, Khartoum, Sudan*

Abstract: *The main objective of this work is to investigate pasteurization of caw's milk by laser and its effect on Milk's pH. In this pilot study, Nd: YAG laser was used to irradiate raw cow's milk in order to kill bacteria and fungi; then its effect on the milk's pH has been studied. Six samples of cow's milk were taken from the farm directly, without any additions of preservatives, five of these six samples were treated with Nd: YAG laser (1064 nm) using different output powers specifically (10, 20, 30, 40 and 50) Watts for two minutes and the sixth sample was left without irradiation as a control. Samples were then analyzed for surviving bacteria and fungi. The results revealed that complete sterilization of bacteria and fungi was achieved using maximum output laser power 50 W for two minutes. During this experiment it was found that the pH of milk was reduced from 6.18 for the control sample in the first day down to 4.50 for the highest laser-treated sample after five days.*

Keywords: *Cold pasteurization; Lactic acid bacteria; Laser milk interaction; Milk acidity; Spoilage bacteria.*

1. INTRODUCTION

Pasteurization is one of the most importance processes in the food industry due to its important in preserving dairy products and increasing their shelf life. There are many physical methods used in pasteurization such as raising temperatures, decreasing of temperatures suddenly, drying and irradiation. Recently, pasteurization of milk using lasers has gained much attention due to promising properties of lasers, near infrared laser can be used in non-destructive methods of pasteurization of milk because it does not cause molecular ionization and is not detrimental to the quality of milk. Different lasers have been widely used in pasteurization and have been documented in the literature. For example, Ward et al. investigated the pasteurization effectiveness of a high-power Nd: YAG laser beam, on *Escherichia coli* in saline and reported that the action of the Nd: YAG laser beam at 50˚C was due partly to thermal heating and partly to an additional undefined mechanism (Ward et al., 2000). In 2002 Wayne L. Smith et al. used UV light (248 nm) emitted from a pulsed excimer laser for cold pasteurization of bovine milk (WAYNE, 2002). Moses Elisha Kundwal et al. in 2015 explored the extent of using laser and other pulsed light systems for phototherapy and other microbial disinfections to which two pulsed laser parameters (wavelength and pulse frequency) affect deactivation of two pathogenic bacteria; *Escherichia coli* (*E. coli*)and *Listeria monocytogenes* (Moses, 2015). It has been shown by Tubasa Nakata et al. that pasteurization by far-infrared (FIR) heating was more effective than thermal conductive heating (Nakata, 2015). Moreover, José et al. in 2015 reported that pasteurized and ultra-high temperature milks are kept protein and lactose content similar to raw milk, they reported also pasteurization and sterilization altered the composition of milk slightly, decreasing total fat and total solids and increasing urea, their processes changed essentiality short-chain fatty acids. High proportions of palmitic acid, oleic acid, stearic acid and myristic acid were found in all milks analyzed (José et al, 2015). Furthermore, the rate of spoilage of many dairy foods is slown by the application of reducing the pH by fermenting the lactose to lactic acid (William and Michael, 2009). Almost all processes containing water have a need to measure pH. Most living organisms depend on the proper pH level to maintain their life.

The main focus of this article is to investigate near-infrared laser to kill three types of bacteria (*Salmonella spp, Escherichia coli* and *Pseudomonas aeruginosa* (*P.aeruginosa*)) as well as fungi in raw cow's milk, and to investigate changes in the pH of the milk during these processes.

2. Methods

2.1. Raw Material

Fresh cow's milk was collected in a sterile manner from the dairy facility at Soba Farms South Khartoum, Sudan. Was aseptically collected then it was utilized as the raw material, and it was used in experiments within 2 hours.

2.2. Bacterial Isolates and Inoculations

Salmonella spp, *Escherichia coli* and *Pseudomonas aeruginosa* were used to inoculate raw milk prior to Nd: YAG laser exposure. To dilute milk samples, 10 fold peptone water medium was used.

2.3. Laser Exposure and Bacterial Recovery

Milk sample was divided into six parts; the first sample was used as obtained and was referred as control sample. The other five samples were exposed to continuous Nd: YAG laser (DORNIER med Tech Medilas 5100 fibertom GlassI) with wavelength of 1064 nm and output power of (10, 20, 30, 40 and 50) Watts for 2 minutes in sterilized beaker under magnetic stirring.

For counting fungi and bacteria numbers; all samples were inoculated into tryptic soy agar plates (for bacteria) and sabouraud dextrose agar plates (for fungi). Bacteria were incubated in (35-37) °c for 2 days and fungi were incubated in 25-27°c for 5 days. Three types of bacteria were targeted following the analysis; *Salmonella spp*, *Escherichia coli* and *Pseudomonas aeruginosa*.

For *Salmonella spp* xylose lysine deoxycholate agar medium was used and MacConkey agar medium for *E.coli* and cetrimide agar medium for *P.aeruginosa*, these media work as selective differential media. Milk samples were cultured into those media and incubated in (35.37)°c for 3days , and for *E.coli* detection the samples were inoculated into tubes of MacConkey broth medium and incubated in 43°c for 24 hours and after that cultured into plates of MacConkey agar medium. Results were expressed as CFU/ml.

2.4. Measurements of pH

Milk samples were examined after exposing to laser then they were kept at refrigeration temperature for 5 days and the milk's pH examined daily at room temperature 23°c.

3. Results and Discussion

3.1. Estimation the Number of Viable Bacteria or Fungal Cells

Obtained results showed the effect of the continuous Nd: YAG laser on the viability of bacteria and fungi inoculated into raw milk. Obviously, results showed that the effectiveness of pasteurization by continuous Nd: YAG laser beam increased with increasing of the output power of the laser. Most investigators agree that laser beam has very strong effect on the damage of bacteria (inactivation, inhibition growth) (Almahal, 2016)

Figure 1 summarizes the average dose response for Nd: YAG laser (λ=1064 nm) treatment of bacteria and fungi. Due to interaction of the laser with the bacterial and fungal cells; the population of the bacteria was decreased linearly, and the population of the fungi was almost decreased linearly, the number of surviving fungi was the same with 10 W and 20 W output power, but it was less than the number of surviving fungi in the control sample. To reach the maximum killing effect of laser irradiation the treatment required 50W.

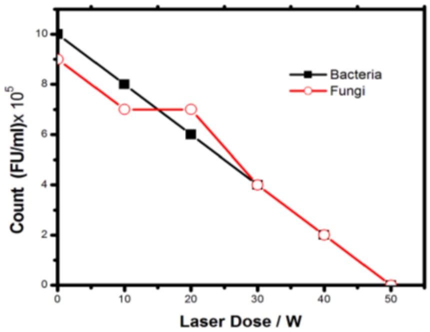

Figure1. *Laser dose effect on Bacteria and Fungi*

3.2. The Value of pH

The pH of milk determines whether it is considered an acid or a base. Milk is slightly acidic or close to neutral pH. Fresh cow's milk usually has pH between 6.5 and 6.7. The pH of the milk changes over time. As the milk goes sour, it becomes more acidic and the pH gets lower. This occurs as lactic acid bacteria in milk convert lactose sugar into lactic acid. In this work; the obtained results of pH value of the control and laser-treated milk samples during pasteurization induce gradual decline in pH. The pH results of the milk samples in the first five days at room temperature 23°c were illustrated in figure 2.

Results showed the effects of laser milk interaction on the pH of the milk. It causes decline in the value of milk's pH from 6.55 for the control sample down to 6.18 for the milk sample treated with 50 W in the first day.

Changes in the pH value of the milk samples over the time were also recorded, figure 2 showed the reduction of milk's pH over days; in the first day varied from 6.55 to 6.18, with difference of 0.37 and about 0.34, 0.20, 0.46 and 0.36 for the second , third , fourth and fifth day respectively. It was noted The difference between pH values in the fourth day and the fifth day was greater than the differences between the four previous days.

Changes in pH of the six samples was followed up for five days, figure 2 clearly showed the decrease of pH in the milk samples from 6.55 for the control sample in the first day down to 4.86 in the fifth day with difference of 1.69, this difference is about 1.73, 1.65, 1.65, 1.66 and 1.68 for sample 1, 2, 3, 4 and 5 respectively.

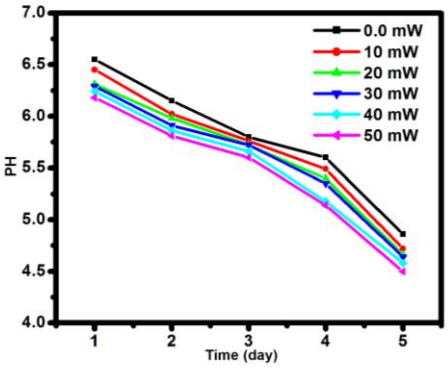

Figure2. *Reduction of pH over laser dose and days*

4. CONCLUSION

As a conclusion, interaction of continues Nd: YAG laser with raw cow's milk was investigated, it was found that the maximum output power required to achieve pasteurization is 50 W for 2 minutes. The possibility of complete sterilization of bacteria and fungi by laser was showed. While pasteurization process is charring out by choosing different laser doses it was found that the pH of milk was reduced when increasing laser output power.

When using continues Nd: YAG laser in pasteurization or any other application, its effect on the pH should be considered.

ACKNOWLEDGMENTS

First of all authors would like to express their heart full appreciation to almighty God. Secondly gratefully acknowledge Institute of Laser, Sudan University of Science and Technology, Khartoum, Sudan and ABDELMONIEM MEDICAL INDUSTRIES, Khartoum, Sudan, for providing equipments for this work. Thanks are also granted to Mr. Mohamed Ahmed Mahgoub Mohamed Salih Baba (Lab. assistant).

REFERENCES

[1] Almahal, S.I., 2016. Study of the Effect of Nd: YAG Laser on the Raw Cow's Milk Characteristics and its Sterilization (Master dissertation, Sudan University of Science and Technology).

[2] José Miguel Pestana, Adriano Gennari, Bruna Wissmann Monteiro, Daniel Neutzling Lehn and Claucia Fernanda Volken de Souza. (2015). Effects of Pasteurization and Ultra-High Temperature Processes on Proximate Composition and Fatty Acid Profile in Bovine Milk. American Journal of Food Technology 10 (6): 265-272, 2015 ISSN 1557-4571 / DOI: 10.3923/ajft.

[3] Moses Elisha Kundwal, Abd Rahman Tamuri and Mohd Nizam Lani, (2015), The Role of LAser Wavelength and Pulse Frequency in Inactivation of Escherichia and Listeria monocytogenes, ARPN Journal of Engineering and Applied Sciences, Vol 10(11) : 4748-4753

[4] Nakata, T. , Okamoto, A. , Sawai, J. and Kikuchi, M. (2015) Effects of Far-Infrared Irradiative Heating Pasteurization on Fungi. *Journal of Biosciences and Medicines*, 3, 60-65. doi: 10.4236/ jbm.2015. 37007.

[5] Ward, G. D., Watson, I. A., Stewart-Tull, D. E., Wardlaw, A. C., Wang, R. K., Nutley, M. A., et al. (2000). Bactericidal action of high-power Nd: YAG laser light on Escherichia coli in saline suspension. Journal of Applied Microbiology, 89, 517−525. http://dx.doi.org/10.1046/j.1365-2672.2000.01144.x

[6] WAYNE L. SMITH, MANUEL C. LAGUNAS-SOLAR and JAMES S. CULLOR. (2002) Use of Pulsed Ultraviolet Laser Light for the Cold Pasteurization of Bovine Milk. Journal of Food Protection 65:9, 1480-1482.

[7] William H. Sperber and Michael P. Doyle. (2009). Compendium of the Microbiological Spoilage of Foods and Beverages, Food Microbiology and Food Safety, DOI 10.1007/978-1-4419-0826-1_2, C Springer Science + Business Media, LLC

Citation: *A. Marouf & Sara I. Elmhal "Monitoring pH During Pasteurization of Raw Cow's Milk using Nd:YAG Laser", International Journal of Advanced Research in Physical Science (IJARPS), vol. 4, no. 12, pp. 1-4, 2018*