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Novel Method for Milk Sterilization Using Visible Laser System

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Abstract: In this study, we proposed a novel method to milk sterilization based on laser technology, the design method was practically implemented and tested under different operating conditions. The milk treatment sample with LD laser (650 nm) was investigated. Inactivation of different microbial can be achieved at process time (0.5-2) min at laser power level (50-70 mw), the study showed that the maximum microbial reduction (100%) was obtained at 1.5 min with 70 mw. There was no significant variation in physical chemical properties of treatment sample in comparing with control milk sample.

INTRODUCTION

Non-thermal technologies such as laser technology are being applied in food processing as a viable alternative to thermal processing. Laser light was used as inactivation tool for many type of microorganisms because its ability to cells in activation based on damage of nucleic acid. And as a results the microorganisms cannot replicate. Good-quality raw milk is required to make good-quality dairy products. Once raw milk is defective, it cannot be improved during processing and defects often become more pronounced. Therefore, it is important that raw milk be produced and handled from farm to plant under conditions that do not reduce its quality or consequently, the quality of the product. Many factors can influence the quality of raw milk. Following is a summary of raw milk quality parameters, esting procedures and limits. Man has known milk, since, ancient as a natural food integrated because of the contain most of the basic nutrients[1]. The search for several ways to prolong the storage time but there are some problems stand in the way of interested such as the flavor of oxidation and taste semi-cartons or lipids[2] which develops over time because of the storage is not good and therefore, the composition of volatile compounds resulting from oxidation of fat or taste cooked by high temperature[3] in addition to the atmosphere and many types of microorganisms can be observed in milk which affects the quality and quality as well as the negative impact on consumer health and safety, so, sought many researchers have developed methods of pasteurization thermal and non-thermal sterilization[4].

As a results the side effects results from heat sterilization, researchers have resorted to the use of non-heat sterilization in the preservation of raw milk and its products. The most important method of cold sterilization is the use of laser radiation in the visible area[5]. The laser in the visible and ultraviolet region has the potential to cause chemical reaction[6]. The aim of the research is to use laser in the visible area of the continuous pattern with low capacity (50, 60, 70 mw) and time meet

Table 1: The experiments

Manufacture company	Scientific term	Parameters
Himedia-India	Nutrient agar	Medium solid nitrites
Himedia-India	Maconkey agar	*E. coli* medium
Himedia-India	Salmonella shigella agar	Salmonella medium
Himedia-India	Raw milk	Raw milk
Himedia-India	alt extract M	Fungi and yeast medium

(0.5, 1, 1.5, 2 min) ability of each and compare them to determine the best time and the ability to achieve the survival Hlakih 100% for the total number of bacteria and intestinal bacteria and yeast and molds[7] (Table 1).

MATERIALS AND METHODS

Devices and tools: The proposed device was implemented using the following apparatus listed in Table 2.

Working methods

Microbiological tests: All microbiological tests on milk samples were performed before and after sterilization process. We take (11 mL) samples from sterilized and raw milk all samples added 99 mL of peptone water with well mix and we take 1 mL from each sample to perform dilution, number of it six dilution. The fifth dilution was used for agriculture. Sterile test tubes and tubes were used for this purpose, according to Ward *et al*.[8].

Determination of the total bacterial account: In this study, we use nutrient Agar from India's Himedia company[9] 28 gm which was dissolved in 1 L of distilled water and sterilized at 121c for 15 min a gro-medium to calculate the total number of bacteria and then incubated at 37c for 24-48 h. Then, the developing bacterial setting is calculated.

Determination of colon bacteria: Equip the Macon key agar from India's Himedia company and attend to dissolve 51.5 gm of it in one liter of distilled water and then sterilize with a 12c cascade for 15 min. Then, incubate at 37c for 48-24 h. The developing colonies are then counted.

Determination of yeasts and modules: The medium Malt Extract Agar extract malt was prepared from India's Himedia company and was attended to by dissolving 39 of it in one liter of distilled water and then sterilized with a 212c for 15 min. Then incubate at 28-25c for 72-48 h. Then the developing setting is calculated.

RESULTS AND DISCUSSION

Effect of Laser power and hold time: To determine the best effect of laser power, hold time that achieve the highest inactivation of microbial in milk sample, the effect of the laser at wavelength 650 nm was studied at different power levels (50, 60 and 70 mw) with hold time (0.5, 1, 1.5 and 2 min) the results of study shows as.

Total account of bacteria: Table 3 show the total number of bacteria after laser sterilized of milk sample. The results of the statistical analysis showed a decrease in the number of total bacteria from 11×10^5 CFU to $(7.333, 4.333, 2.333, 0.667)\times10^5$ CFU at the hold time (0.5, 1, 1.5 and 2 min), respectively, at 50 mW while if we use 60 mW the reduction reach to $(6.333, 4.333, 2.333, 0.333)*10^5$ C.FU. At 70 mW, the number decreased to $(3.667, 0.667,0)10^5$ CFU. This reduction ratio results because the laser in the visible has low absorption properties of the milk sample but its highly absorbed by the ring compounds of the nucleic acids that make up the microbial cell DNA causes the formation of compounds that disrupt the genetic structure of the cell such as (cyclobuty). The formation of these compounds loses the cell's ability to split and feed.

***E. coli* bacteria:** The results of the statistical analysis showed a reduction in colonic bacteria to (5.66, 4.333, 1.33, 0) at the hold time (0.5, 1, 1.5, 2 min), respectively and 50 mW. While at 60 mW, the number of colon bacteria decreased to 5.333, 2.667, 0.333, 0 and 10^4CFU. At 70 mW, the number of colon bacteria decreased to $(5, 2, 0, 0)\times10^5$C.F.U. The increasing laser power and hold time will effect on inactivation process of microorganism. But the overlap between capacity and time of survival did not have a significant effect.

Salmonella account: The results of the statistical analysis showed a decrease in Salmonella in the milk sample from 9×10^5 CFU to $4.33, 2.333, 0, 0)\times10^5$ CFU at the same time and 50 mW. When the laser power 60 mW the number of Salmonella bacteria decreased

Table 2: The proposed device

Device name	Origin
Laser diode	America
Sensitive balance	Germany
Incubator	China
Autoclave	China

Table 3: Shows the effect of the power and time on the total number of bacteria in cow's milk

		Time (min)			
Wave length (nm)	Power (mW)	0.5	1	1.5	2
650	50	7.333	4.33	2.33	0.667
650	60	6.333	4.33	2.33	0.333
650	70	3.667	0.66	0.00	0.000
l.s.d t*p = 1.47 1ns		l.s.d t = 0.849s	l.s.d p = 0.736s		

Table 4: Showing the combined effect of power and time on *E. Coli* bacteria

		Time (min)			
Wave length (nm)	Power (mW)	0.5	1	1.5	2
650	50	5.667	4.333	1.333	0.000
650	60	5.333	2.667	0.333	0.000
650	70	5.000	2.000	0.000	0.000
l.s.d p*t = 1.255 nsec		l.s.d t = 0.725 sec		l.s.d p = 0.627 sec	

Table 5: Time and laser power

		Time (min)			
Wave length (nm)	Power (mW)	0.5	1	1.5	2
650	50	4.333	2.333	0.000	0.000
650	60	3.333	1.333	0.000	0.000
650	70	2.667	0.333	0.000	0.000
lsd (p*t) = 1.052 n sec		l.s.d (t) = 0.607 sec		l.s.d (p) = 0.526s	

Table 6: Show the interaction between the laser power and hold time for milk sample

		Time (min)			
Wave length (nm)	Power (mW)	0.5	1	1.5	2
650	50	6.667	3.3	1.3	0
650	60	4.2	3.3	0.33	0
650	70	5	2.0	0	0
l.s.d p*t = 1.255 nsec		l.s.d t = 0.725 sec		l.s.d p = 0.627 sec	

to (3.33.1.33, 0, 0)×10^5 CFU, respectively and at 70 mW the number of Salmonella bacteria in the sample (2.667, 0.333, 0, 0)×10^5 CFU. The loss was increased by increasing hold time and laser power as shown in Table 4-6.

Yeasts and modules: The number of yeasts and molds in milk decreased from 11×10^5 (CFU/mL) to (6.667, 3.333, 1.333, 0) at the hold time (0.5, 1, 1.5 and 2 min), respectively and 50 mw power. At 60 mw for the same previous conditions. The total number decreased to (4.2, 3.3, 0.3, 0)×10^5 CFU, the laser with 70 mw, wavelength of 650 nm produce a significant influence for hold time of 1.5 min with 100% reduction ratio. While the reduction at laser power 60 mw for the same hold time the number of yeast and mold to 0.33×10^5 CFU, the 50 mw laser power has reduced the total number to 1.33×10^5 CFU the hold time and laser power has affected significantly in the number of microbial. The overlap between laser power and hold time was not significant effect.

CONCLUSION

The results shows maximum reduction ratio 100% of microorganism of the milk sample at laser power 70 mw with hold time 1.5 min. The laser sterilization system provide stable operation with low consumption power and high reduction ratio as a results of sterilization process. The shelf life of milk treated under proposed laser system will increases shelf life treated milk sample.

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