Sudan University of Science and Technology
College of Graduate Studies

Effect of Laser Pasteurization on Production of Yoghurt

تأثيرالبسترة بالليزر في انتاج الزبادي

A dissertation Submitted as Partial Fulfillment of the Requirements for the Degree of Master of Science in Physics.

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بسم الله الرحمن الرحيم

الآية

السَّمَاوَاتِ وَالأَرْضِ مَثَلُ نُورِهِ كَمِشْكَاةٍ فِيهَا مِصْبَاحٌ
احُ فِي زُجَاجَةٍ الزُّجَاجَةُ كَأَنَّهَا كَوْكَبٌ دُرِّيٌّ يُوقَدُ مِن
بَارَكَةٍ زَيْتُونَةٍ لاَّ شَرْقِيَّةٍ وَلا غَرْبِيَّةٍ يَكَادُ زَيْتُهَا يُضِيءُ
لَمْ تَمْسَسْهُ نَارٌ نُّورٌ عَلَى نُورٍ يَهْدِي اللَّهُ لِنُورِهِ مَن يَشَاء
رِبُ اللَّهُ الأَمْثَالَ لِلنَّاسِ وَاللَّهُ بِكُلِّ شَيْءٍ عَلِيمٌ)

(صدق الله العظيم)

(35 النور)

Dedication

Dedicate this effort to:

My Mother:

Who taught me how to type the first letter and prepared me to life all the love and tenderness and stood beside me at first my steps with full force and determination and were given me my life, yes, and it has always been a strong bond represent me in life.

My Father

Who stood next to me in all my steps and gave me will be all of the moral and material support, and it was always encourages me and motivates me to succeed with confidence ahead

My Father is to instill in me love for science and learning and make it my hobby.

Brothers and sisters:

Who supported me all the love and gave me will be all the support and advice.

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Thanksgiving before and after to God and then to

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And to each of the characters taught me.

ABSTRACT

This research was undertaken to compare yogurt produced from unpasteurized milk, laser pasteurized milk and heat pasteurized milk.

Milk samples were obtained from SUST farms-Shambat-North Khartoum-Sudan. ND: YAG laser used to pasteurize the first sample, the second sample pasteurized by heat and the third one was left as obtained to be control sample. Yogurt is produced by bacterial fermentation of milk.

The results showed that the use of laser in pasteurization is not differ from heat pasteurization, while the production of yogurt from laser pasteurized milk is slightly better than that of heat pasteurized milk.

مستخلص البحث

تم إجراء هذا البحث لمقارنة الزبادي المنتج من الحليب غير المبستر ومن الحليب المبستر بالليزر ومن الحليب المبستر بالحرارة.

تم الحصول على عينات اللبن من مزارع جامعة السودان للعلوم والتكنولوجيا- شمبات- الخرطوم بحري- السودان. استخدم ليزر النيوبديوم ياغ في بسترة العينة الأولى، وتم استخدام الحرارة لبسترة العينة الثانية بينما تركت العينه الثالثة كما تم الحصول عليها لتكون عينة مرجعية. تم إنتاج الزبادي عن طريق التخمير البكتيري من الحليب.

أظهرت النتائج أن استخدام الليزر في البسترة لا يختلف عن البسترة الحرارية، في حين أن إنتاج الزبادي من الحليب المبستر بالليزر أفضل قليلا من إنتاجه من الحليب المبستر بالحرارة.

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Chapter One

Introduction and Literature Review

1.1 Introduction

Sudan ranks the top place among the countries of Middle East and second in Africa regarding the animal wealth. It has been estimated that 2.9 million tons of milk is produced, of which 2.5 million tons (82%) were cow's milk, the bulk of which is in the hands of the nomadic tribes (AOAD, 2012).

The ratio for the use of significantly milk products in the human diet devised many ways to kill the microbes that attack the milk during times the conservation and these processors or roads is heating normal heat in traditional ways or advanced.

Yoghurt is one of the more milk products used in human food, so in addition to the use of heat to kill germs and microbes we use laser rays effective in disinfection and sterilization and genocide microbes of food product of various kinds.

Electromagnetic radiation in general has long been known been used against germs live and harmful micro-organisms to humans, has been used in a very large to sterilize drinking water and an example of its ozone and ultraviolet radiation, which to them Avery strong impact in killing germs.

Ray laser surgery has been used my time nowadays in most industrial and medical fields, as well as the food industry and draw a trademark on them.

In this research also will examine one of the laser uses in the food area and its effect on DNA an entrepreneur to transform milk into Yoghurt and works on fermented and converted to a new food consumed in very large in human societies to a source of food with high nutritional benefit, with its high nutritional value.

1.2 Research Problem

Pasteurization of milk by Heat decrease its nutritional value (Tamime et al., 1999), in this research laser used to pasteurized milk before make yoghurt and compare it with yoghurt made of heat treatment milk.

1.3 Research Objectives

The specific objective of current work is to:

1. Study laser interaction with food components of milk.
2. Investigation of the effect of the laser pasteurization on the nutritional components of yoghurt.
3. Compare laser pasteurization with heat pasteurization affecting on producing yoghurt.

1.4 Literature Review

Tubasa Nakata, *et al* (2015) quantitatively evaluated the effect of far-infrared (FIR) irradiation pasteurization on fungi and compared it with the effect of thermal conductive heating. After the bulk temperature of the sterile saline irradiated by FIR reached a steady given temperature, yeast cells (Candida albicans NBRC 1950 and Saccharomyces cerevisiae NBRC 1067) or fungal spores (Aspergillus Niger NBRC 4781) were inoculated and FIR heating was conducted. A mullite cylinder FIR heater, with a main wavelength of 4 - 7 μm, was used for FIR heating. Death of fungi by FIR heating and by thermal conductive heating both followed first-order reaction kinetics, and the apparent death rate con- stants under different temperature conditions were obtained. For the same bulk temperatures, pasteurization by FIR heating was more effective than thermal conductive heating. The activation energy for the death of fungi by FIR irradiation was slightly lower than thermal conductive heating, indicating differences in the mechanism of action.

Infrared (IR) radiation is easily absorbed by water and organic materials. IR heating is used widely for the drying, dehydration, blanching, thawing and pasteurization (Rosenthal, I. et al, 1996), (Rosenthal, I.et al, 1996) , (Paakkonen, K., et, 1999) , Mongpraneet, S.et al, 2002), (Krishnamurthy, K.et al, 2008), (Khurana, H.K., Soojin, J. et al, 2007), (Rastogi, N.K. 2012), as well as for medical treatment (Hatayama, H., et al, 2008), (Tuchina, E.S., et al, 2014).

The importance of microbial decontamination is increasing owing to outbreaks of food poisoning and the emergence of drug-resistant bacteria. As well as providing clean working areas, IR heating can save space because no heat- transfer medium is needed. Although the IR radiation cannot penetrate deep and heats up only a few millimeters below the surface of the sample, the main effect of IR is due to heating of a thin layer of food material on the surface (Rastogi, N.K. 2012).

The IR heating process improves the shelf life of foodstuffs (Ha, J.W.et al, 2o15), (Wang, B., et al, 2014) and is a promising method for the efficient inactivation of microbes (James, Z. et al, 2002), (Ansari, I.A. et al, 2003), (Hebbar, H.U., et al, 2003). During IR heating operations such as drying, blanching, roasting frying and cooking of food products, the pasteurization has progressed at the same time. Previous studies have reported the use of IR, especially far-infrared (FIR), for pasteurization (Hashimoto, A., et al, 1991), (Hashimoto, A., et al, 1992), (Hashimoto, A., et al, 1993), (Sawai, J., et al, 1995), (Sawai, J., et al, 1997), (Sawai, J., et al, 2000), (Sawai, J., et al, 2003), (Sawai, J., et al, 2006). Com-pared with thermal conductive heating, FIR irradiation was found to be more effective in pasteurizing vegetative bacterial cells (Hashimoto, A., et al, 1991), (Sawai, J., et al, 1995), (Sawai, J., et al, 2006).

Furthermore, FIR irradiation caused heat activation and death of Bacillus subtilis spores in a temperature range where spore viability was not affected by thermal conductive heating (Sawai, J., et al, 1997). Hama- naka et al. (Hamanaka, D. et al, 2003) also reported heat activation and the inactivation of bacterial spores by FIR irradiation.

The pasteurization effects of FIR may be attributed to the absorption of radiative energy by the bacterial suspension in a very thin layer near the surface and an increase in the bulk temperature of the suspension (Hashimoto, et al., 1992), (Sawai, et al., 2000).

Although the effectiveness and validity of IR heating were confirmed in these studies, a quantitative evaluation of the FIR pasteurization effect against fungi was not performed, and pasteurization kinetics of fungi by FIR heating were not elucidated. In the present study, they evaluated the disinfection and pasteurization of liquid media and investigated the pasteurization kinetics of fungi suspended in saline by FIR heating under isothermal conditions.

1.5 Thesis Layout

This thesis is consist of four chapters, chapter one consist Introduction and Literature Review, and chapter tow consist theoretical background , chapter three consist material and method ,and chapter four results and recommendations and Conclusion and lastly references.

Chapter Two

Theoretical Background

2.1 Introduction

This chapter is consist of the first definition of laser, Properties of laser, how laser works, type of laser, uses a laser beam, and applications of laser in the telecommunications and communications.

The second is definition of milk, importance of Milk and Milk Products in Diet, the economic importance of Sudan livestock sub-sector, nutritional value of milk, and fermented milk products.

The finally is yoghurt definition, processing of yoghurt product , standardization of milk component, heat treatment , laser treatment , nutritional value of yoghurt , and method of cooling and storage the yoghurt .

2.2 Laser

No other scientific discovery of the 20th century has been demonstrated with so many exciting applications as laser acronym for (Light Amplification by Stimulated Emission of Radiation). The basic concepts of laser were first given by an American scientist, Charles Hard Townes and two Soviet scientists, Alexander Mikhailovich Prokhorov and Nikolai Gennediyevich Basov who shared the coveted Nobel Prize (1964). However, TH Miamian of the Hughes Research Laboratory, California, was the first scientist who experimentally demonstrated laser by flashing light through a ruby crystal, in 1960. Laser is a powerful source of light having extraordinary properties which are not found in the normal light sources like tungsten lamps, mercury lamps, etc. The unique property of laser is that its light waves travel very long distances with e very little divergence. In case of a conventional e source of light, the light is emitted in a jumble of e separate waves that cancel each other at random and hence can travel very short distances only. An analogy can be made with a situation where a large number of pebbles are thrown it into a pool at the same time. Each pebble generates a wave of its own. Since the pebbles are thrown at random, the waves generated by all the pebbles cancel each other and as a result they travel a very short distance only. On the other hand, if the pebbles are thrown into a pool one by one at the same place and also at constant intervals of time, the waves thus generated strengthen each other and travel long distances. In this case, the waves are said to travel coherently. In laser, the light waves are exactly in step with each other and thus have a fixed phase relationship. It is this coherency that makes all the difference to make the laser light so narrow, so powerful and so easy to focus on a given object. The light with such qualities is not found in nature. A high degree of directionality and monochromatic is also associated with these light beams. Therefore, in a laser beam the light waves not only are in the same phase but also have the same color (wavelength) throughout their journey. The beam of the ordinary light spreads out very quickly. On the other hand, the laser beam is highly collimated and spreads very little as it 'Fig. travels through space; even after traveling to the , surface of the moon the spread of laser light has been found to be only about 3 km across. Hypothetically, if ordinary light was able to travel to the so moon, its beam would have fanned out to such an extent leading to a diameter of the light on.

The moon as much as 40.000 km, another remarkable feature of laser is the concentration of its energy to extremely high intensities, the intensity remaining almost constant over long distances because of low divergence. If a laser beam with a power of a few megawatts (106 W) is focused by a lens at a spot with a diameter of 1/1000th of a centimeter, the beam intensity increases to a few hundred billion watts per sq. cm. This concentrated energy is so intense that it easily ionizes the atmospheric air to create sparks. With the beam focused from a high power laser, even the hardest material like "diamond can be melted in a fraction of a second. These unique characteristics of laser have made it an important tool in various applications. The initial notable application of laser was made c on the lunar ranging experiment of Apollo II Mission of 1969, when an array of retro reflectors was mounted on the surface of the moon and pulses from a ruby laser were sent from the earth. The reflected beams were received by suitable detectors and by measuring the time taken by the pulses in going from the earth to the moon and back, the distance of the moon from the earth was calculated to an accuracy of 15 cm. After the first demonstration of laser in 1960, new applications of lasers in the various fields are announced almost every day. Laser finds applications in the fields of communication, Industry, medicine, military operations, scientific research, etc. Besides, laser has already brought great benefits in surgery, photography, holography, engineering and data storage. Though it is not possible to illustrate all the laser applications reported so far in this small book, the more important ones are covered in the Chapters on Laser Applications.

2.2.1 Properties of laser

1- Monochromaticity

Is a unique property of laser light, results from the circumstance that light oscillation sets in at one resonance frequency of the optical cavity, and owing to the balance between gain and loss in CW operation the line width ΔvL of the oscillating mode is ultimately limited by quantum noise.

2- Coherence

The coherence of the laser radiation refers to the time period Δt in which the phase undergoes random changes, and the coherence length is a measure of the propagation distance over which the beam stays coherence.

3- Directionality

The directionality of the laser beam is due to the fact that the gain medium is placed inside an open optical resonator

4- Brightness

The brightness of laser radiation is closely related to the directionality and stems from the capability of a laser oscillator to emit a high optical power in a small solid angle of space.

2.2.2 How Laser Works

2.2.2.1 Laser Action & Quantum Theory

Laser action is based on well-established principles of quantum theory. Arthur Leonard Schawlow extended the maser principle (acronym for Microwave Amplification by Stimulated Emission of Radiation), of using a laser amplifier and an optical mirror cavity to provide the multiple reflections necessary for rapid growth of light signal into an intense visible beam.

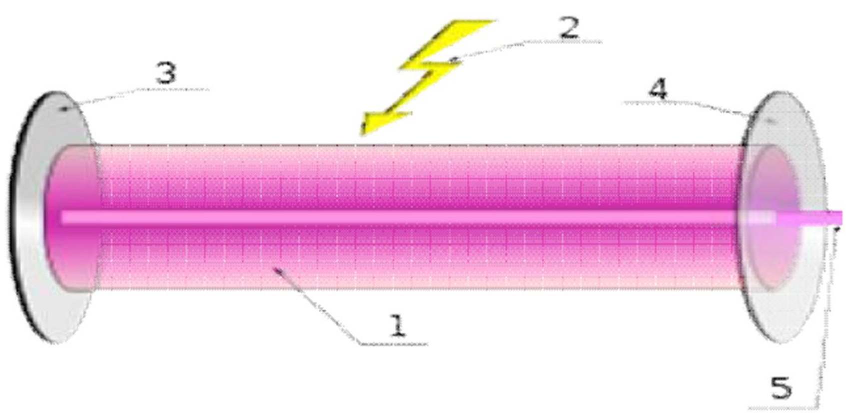


Figure (2.1), Laser Device.

I. Principle of Laser Action

Normally, the atoms are in the lowest energy state or ground state. When light from a powerful source like a flash lamp or a mercury arc falls on a substance, the atoms in the ground state can be excited to go to one of the higher levels. This process is called absorption. After staying in that level for a very short duration (of the order of 10-8 second), the atom returns to its initial ground state, emitting a photon in the process, this process is called spontaneous or an emission. The two processes, namely, absorption and spontaneous, or emission.

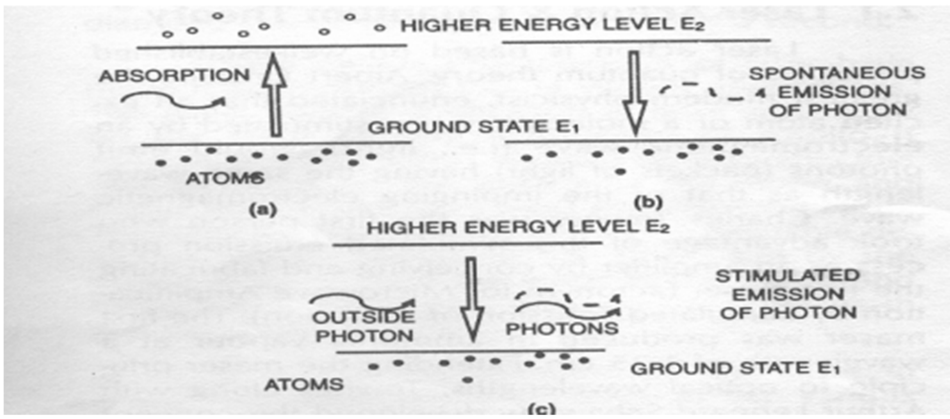


Figure (2.2) Principle of Laser Action

This process, called stimulated emission, is fundamental for laser action (Fig, 2.2).

II. Amplification & Population Inversion

When favorable conditions are created for the stimulated emission, more atoms are forced to give up photons and produce amount of energy, This results in rapid buildup of energy of emitting one particular wavelength (monochromatic light), traveling coherently in a precise, fixed direction. This process is called amplification by stimulated emission.

III. Designing a Laser

A laser generally requires three components for its operation:

(a) An active medium in the form of a laser rod, with energy levels that can be selectively populated;

(b) A pumping process to produce population inversion between some of these energy levels; and

(c) A resonant cavity containing the active medium which serves to store the emitted radiation and provides feedback to maintain the coherence of the radiation (Fig. 2.3).

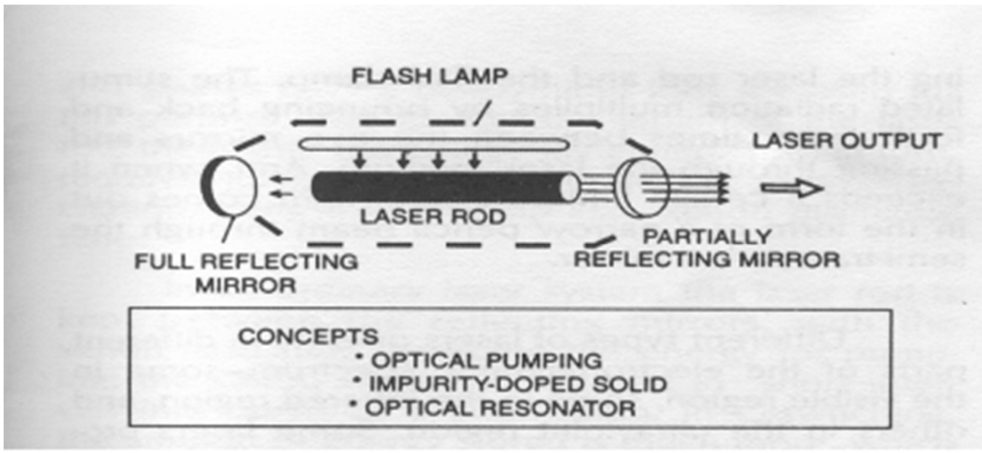


Figure (2.3) Designing a Laser

The main problem in designing a laser is to involve produce a sufficiently high population of atoms in the cent re excitation is by sending an intense beam of light from a flash lamp or a continuous source of light excited state. For this, many ingenious ways fully all have been evolved, the most common method of through the material in the form of a cylindrical rod or a container tube with a suitable gas.

IV. Increasing the Laser Power

The power of an ordinary pulsed laser can be Increase enormous by Q-switching or Q-spoiling, a technique known to be used for some of its applications in range finding, drilling, and cutting, the tremendous energy released in this way can pierce through not only thick metallic plates but also the hardest material like diamond.

XI. Inversion Mechanisms

Population inversion, which gives rise to laser action, is brought about in different media by various mechanisms. In gases, metal vapors, and plasmas, the inversion is brought out by applying a voltage drop across the elongated gain medium thereby producing an electric field that accelerates the electrons. These rapidly moving electrons then collide with gas atoms and excite them to a number of excited energy levels.

A flash lamp is used to excite the ions to a large number of upper energy levels. Inversions in semiconductors are produced when a p-n junction is created by joining two slightly different semi conducting materials, viz., n- and p-type materials (similar to a transistor). Then-type materials have an excess of electrons whereas the p-type materials have an excess of holes (missing electrons). When they are joined, excess electrons of the n-type materials are pulled over into the p-region causing the electrons and holes in those regions to recombine and emit radiation. If an external electric field is applied in an appropriate direction.

V. Laser Beam Properties

The use of a laser for various applications depends upon the beam properties of laser, such as direction, divergence, and wavelength or frequency characteristics, which can be adjusted by the laser components.

2.2.3 Types of Laser

The first laser action was demonstrated in a ruby crystal by Miamian, in 1960. Since then, a large number of materials in various media have been found to give laser action at wavelengths in the visible, ultraviolet and infrared regions. These include various gases, solids, liquid, glasses, plastics, semiconductors, and dyes. In addition to the ruby crystal, many other crystals doped (introduced as an impurity) with rare earth ions have light been found to give extremely good laser output The crystals are grown in specially designed furnaces with the desired compositions and then cut and polished into cylindrical laser rods with the faces optically flat and parallel to each other. The numerous types and designs of lasers are steadily increasing and can be broadly classified according to their production techniques. The broad categories are:

(i) Optically Pumped Solid-State Lasers

(ii) Liquid (Dye) Lasers

(iii) Gas Lasers

(iv) Semiconductor Lasers

(v) Free Electron Lasers

(vi) X-ray Lasers, and

(vii) Chemical Lasers

(viii) Infrared laser

ND: YAG Laser

ND:YAG lasers are optically pumped using a flashtube or laser diodes. These are one of the most common types of laser, and are used for many different applications. ND: YAG lasers typically emit light with a wavelength of 1064 nm, in the infrared However; there are also transitions near 940, 1120, 1320, and 1440 nm. ND: YAG lasers operate in both pulsed and continuous mode. Pulsed ND: YAG lasers are typically operated in the so-called Q-switching mode, an optical switch is inserted in the laser cavity waiting for a maximum population inversion in the neodymium ions before it opens. Then the light wave can run through the cavity, depopulating the excited laser medium at maximum population inversion. In this Q-switched mode, output powers of 250 megawatts and pulse durations of 10 to 25 nanoseconds have been achieved. The high-intensity pulses may be efficiently frequency doubled to generate laser light at 532 nm, or higher harmonics at 355, 266 and 213 nm Figure (2.4).

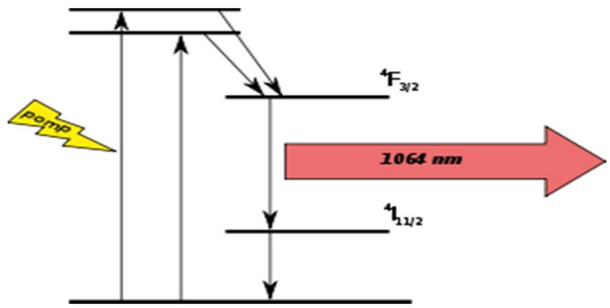


Figure (2.4) energy state of ND: YAG laser

2.2.4 Uses a Laser Beam

Lasers currently used in multiple areas, including:-

1. CDs and electronics industry and measure distances (dimensions of space objects) and communications.
2. in the field of medicine:

2.1 Treatment of eye diseases

Where it is to shed a laser beam in the form of high-energy flashes at a certain point for a short time (less than a second), one of these diseases:-

1. Diabetic retinopathy.
2. Holes retina.
3. Blockage or vein thrombosis website Glaucoma(glaucoma) ·
4. Refractive optical defects in the eye (or the length of Myopia and astigmatism).
5. Blockage of the tear ducts.
6. Bedalouram inside the eye.

7. Plastic surgery around the eye ·
8. Cases of macular demise.

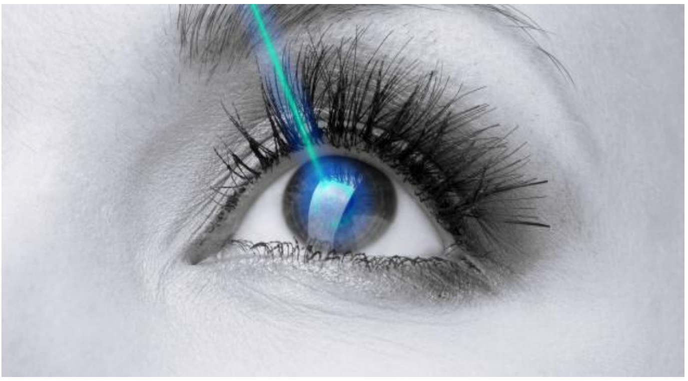


Figure (2.5) Laser Vision Correction

2.2 surgeries

Such as the brain and cardiovascular surgery in which a device that uses a laser beam with a single color and trend this was discovered in 1960 AD

2.3 Industry

1. Production of electrical energy from the lithium and tritium heavy hydrogen using the phenomenon of the emission of photons by atoms and which works to stimulate the laser device and the events by ringing.
2. Welding solids by using the same as the previous phenomenon.

2.2.3 Applications of lasers

The most significant applications of Lasers included Telecommunications, medicine, manufacturing, the military, consumer goods and basic research:

1. **Telecommunications**

1- telecommunications is one of the most important uses of lasers Light from diode lasers is modulated by the signal that contains the information .which is then transmitted through a network of optical fibers.

2- Future developments will most likely include tune able lasers Compatible with wavelength division multiplexing, a technique which will even further enlarge the band width of fiber optic systems.

2. Basic research

1. Lasers are the product of basic research, and researchers around the world are still developing new types of lasers.

2. Physicists, chemists, biologists are major users of lasers, in areas such as spectroscopy, biology (e.g. the human genome program) laser fluorescence, holography, etc.

3. Some experiments aiming to achieve controlled nuclear fusion, which one-day may produce abundant and clean energy, also rely on lasers. A technique called laser induced fusion, in which light from lasers is used to raise the temperature of a deuterium and tritium pellet to 109°C.

3. Intrusion Alarm

A gallium arsenide diode laser can be used to set up an invisible fence to protect an area.

An infrared laser beam (in combination with an optical detector) can seal a path, an area or a volume against infiltrators. When the invisible beam is interrupted by an intruder trying to approach the protected area, it sets off a remote alarm. The laser alarm has many advantages over the conventional electric alarm. The infrared beam, being invisible, Cannot be spotted by the intruder. The narrowness of the beam minimized false alarms by the passage of birds, small animals and objects floating in the air.

4. Fire Detection

Laser's application in fire detection is based on the principle that a laser beam is affected by hot gases emanating from a' fire. A focused laser beam is directed across an open space near ceiling level from one side of the room to the other. It is reflected back to a photocell from a mirror fixed on the opposite wall. Any fire starting below this level will cause turbulent hot air to rise. The laser beam, normally steady, is refracted by the temperature gradients in the hot gases and is displaced from its usual position on a photocell. The deflection can be made to trigger an alarm. Results have indicated that the laser beam system is at least as fast as the most sensitive fire detection systems in use worldwide.

5. Military

1. So far, (mercifully) lasers have been found to make poor weapons. On the other hand, they are extensively used in guiding missiles to their destination, range finders and other target designators.
2. It is suggested that in future 'star-wars' applications lasers will be used in space-based weapons and other airborne systems.
3. Lasers can be used also as a source of the transfer under the water is radiation Green-Blue is the optimal because it is up to the far regions of the sea from his belongings:-
4. Absorbing materials in the water.
5. Scattering of suspended particles.
6. The difference in the optical density along the light path.

6. Communications

A very useful and interesting application of laser is in the field of communications, which takes advantage of its wide bandwidth and narrow beam width over long distances. The laser beams can be created in a range of wavelengths from the ultraviolet to the infrared regions of the electromagnetic spectrum. The color of the emitted light is relatively not important. The infrared region is preferred by the military, as it is more difficult to detect.

The advent of semiconductor lasers has made possible the use of lasers for signal transmission. They are excited directly by electric cur-rent to yield a laser beam in the invisible infrared region.

Now, a laser is used in various applications and scientific aspects and in all areas of life marked expansion in military and industrial fields and studies are still under way in the application of laser science in the food industry because of its enormous capacity to kill germs and viruses that cause disease.

2.3 Milk

Milk is a white creamy suspension secreted by all species of mammals to supply nutrition and immunological protection to their infants. In its processed form may be whole full fat, semi skimmed and low fat milk (NZFSA, 2003).

2.3.1 Importance of Milk and Milk Products in Diet

Fluid milk is not only nature's food for a new born infant, but also a source for a whole range of dairy products consumed by mankind. Fluid milk is about 87% water and 13 % solids. The fat portion of the milk contains fat-soluble vitamins. The solids other than fat include proteins, carbohydrate, water-soluble vitamins, and minerals. Milk products contain high quality proteins. The whey proteins constitute about 18% of the protein content of the milk. Casein, a protein found only in milk, contains all of the essential amino acids and accounts for 82 % of the total proteins in milk. Milk also contains calcium, phosphorus, magnesium, and potassium. The calcium found in milk is readily absorbed by the body; Vitamin D plays a role in calcium absorption and utilization. Milk is also a significant source of riboflavin (vitamin B_2), which helps promote healthy skin and eyes (Dairy Facts, 2003). Dairy products such as yogurts, cheeses and ice creams contain nutrients such as proteins, vitamins and minerals. Consumption of dairy products been associated with decreased risk of osteoporosis, hypertension, colon cancer, obesity and insulin resistances Syndromes (IRS), the main dietary source of calcium and vitamin D are dairy products (Weaver, 2003).

2.3.2 The Economic Importance of Sudan Livestock Sub-sector

This subsector is considered as a leading subsector of Sudan economy. It is the main source of government revenue in the form of both direct and indirect taxes. The average annual share of this sub-sector to the GDP was found to be about 20%. Its relative share to the agricultural sector in terms of GDP stood at 45.4% in year 2006. The annual growth rate of livestock subsector in year 2006 was 1.1%. It was expected to achieve greater growth rate after the end of Darfur conflict which deprived the economy from the contribution of about 20% of Sudan animal wealth presented in Darfur region. It also contributes to the total foreign earnings by about 121.7 million US$ in 2006 which represents about 2% of the total foreign earnings. It provides job opportunities to 40% of the Sudanese citizens. Furthermore, it contributes to national food security by meeting domestic demand for meat and approximately about 70 % of milk supplies. In addition to that there are merchants trading in animal and animal products, and farmers that cultivate and sell fodder to peri-urban milk producers. Finally, livestock contributes to the national foreign exchange earnings from the export of live animals, hides, skins and meat by about 131.5 million US$ in year 2006 (FAO, 2002).

2.3.3 Nutritional Value of Milk

Milk composition is affected by various factors, including stage of lactation, breed differences, number of calving (parity), seasonal variations, age and health of animal, feed and management effects including number of milking per day and herd size (Jenkins and McGuire, 2006).

1. Protein

Protein availability is defined as the amount of protein available to be absorbed and utilized in the human body, to the protein intake. Casein and whey proteins are the two major types available in milk in a ratio of 80 % to 20 % Figure 1. Whey proteins (20 % in milk) digest rapidly compared to casein proteins thus providing greater quantities of essential amino acids (Haug *et al.*, 2007).Cow’s milk generally contains 30–35 g/L protein which is commonly divided into two classes on the basis of the solubility at pH 4.6: the insoluble caseins, which represent 80% of total milk protein, and the soluble whey (or serum) proteins, which represent 20% of total milk protein (Tammie, 2009). There is no important difference in cow’s milk and goat’s milk protein composition. But the physical characteristics of the curd that these proteins formed under the action of rennin (the principal enzyme secreted by the newborn stomach) is significant. The curd of cow’s milk is harder than the curd of goat’s milk. Size also has something to do with its digestibility- and the curd of cow’s milk is large and dissolves more slowly. The finer curd of goat’s milk dissolves more rapidly. This means that for some people with digestive difficulties, goat’s milk may be more easily digested (Saxelin *et al.*, 2003).

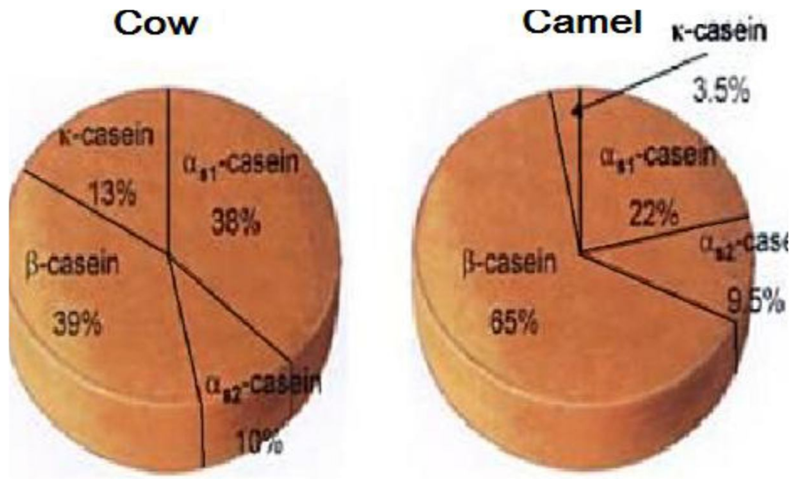


Figure 2.6: Relative amount of casein in cow and camel milk (Farah *et al.*, 2004).

2. Fat

Milk fat is a concentrated form of energy and protects the body by insulating it against temperature and environmental changes. Milk fat is a carrier for fat soluble vitamins and essential fatty acids (Adolf son, 2004).The bulk of the fat in milk exists in the form of small globules, called fat globules they have size ranging from 0.1 to 22 microns and dispersed as oil in water type emulsion. The surface of each fat globule is coated with an adsorbed layer of material, called fat globular membrane. This membrane consist a phospholipid-protein complex that stabilities fat emulsion by keeping the globules separately (Eckles and Macy, 2002), the high proportion of butte.

3. Lactose

Lactose in milk has comparatively lower glycemic index compared to glucose or sucrose thereby making it suitable for diabetic people (Adolf son *et al.,* 2004). It also helps in the absorption of calcium and magnesium and is less carcinogenic compared to other sugars. Lactose prevents infection by stimulating bifid bacterium in the colon thus improving colon health (Adolf son *et al.,* 2004). Active cultures in yogurt help digest lactose thereby making it suitable for lactose intolerant people (Saxelin *et al.*, 2003). It is the sugar seen only in milk and hence called as milk sugar. In milk lactose exists in true solution. Chemically lactose is composed of one molecule each of glucose and galactic. Souring of milk is due to the production of lactic acid from lactose by lactose fermenting bacteria and it is important in the preparation of fermented milk products (Kitty, 2004).

4. Minerals

Milk contains a number of minerals; however, the total concentration is less than1%. Mineral salts occur in solution in milk serum or in casein compounds. The most important salts are those of calcium, sodium, potassium and magnesium (Saxelin *et al.*, 2003).

5. Milk Enzymes

Indigenous milk enzymes are found in, or associated with various, casein micelles, milk fat globule membrane, milk serum or somatic cells and may originate from blood, somatic cells, the milk fat globule membrane (MFGM) or the cell cytoplasm. These milk enzymes can be used as indices of animal health or thermal history the milk, they can result in quality deterioration or induce desirable changes in milk and dairy products or they may also offer protective effects.

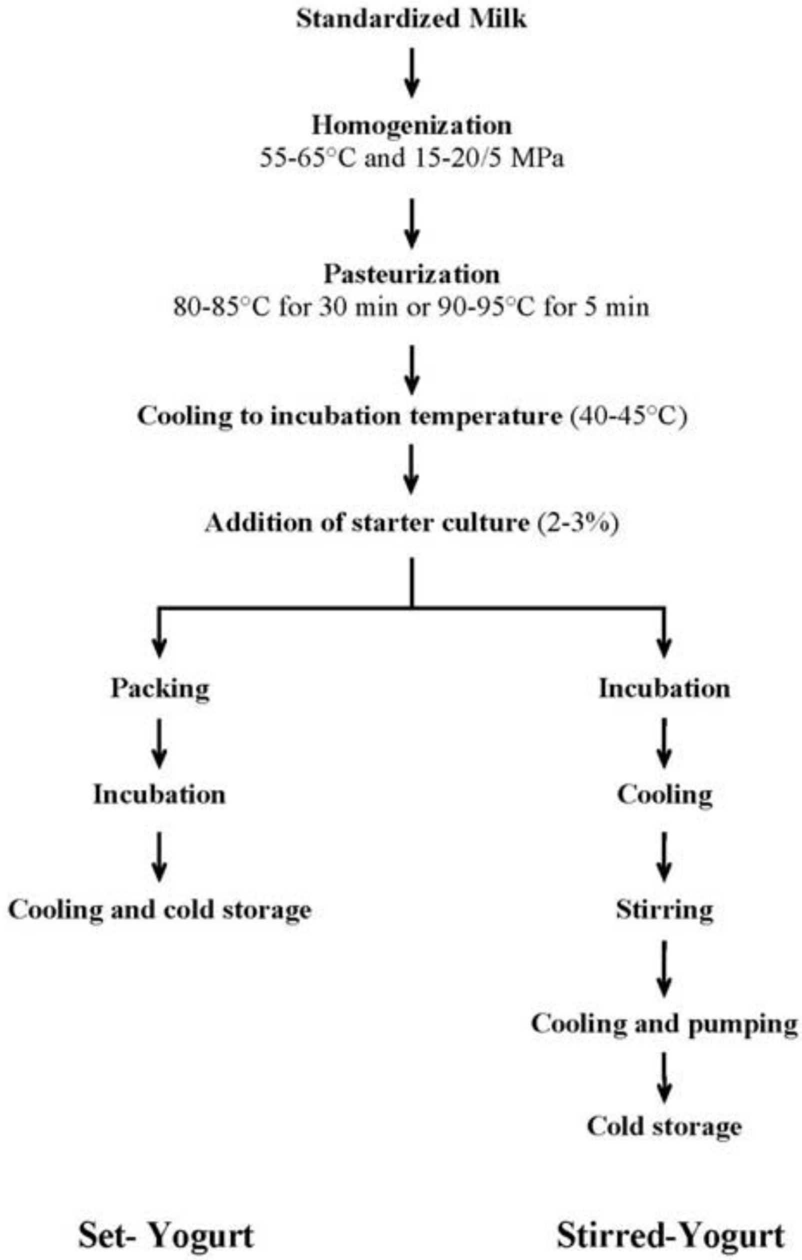
Important indigenous milk enzymes, e.g.: plasmin, lipoprotein lipase, alkaline phosphatase and lacto peroxidase (Tammie, 2009).

2.2.4 Fermented Milk Products

The International Dairy Federation (IDF 1992a, IDF 1992b), published general standards of identity for fermented milks that could be briefly defined as follows: ‘Fermented milks are prepared from milk and/or milk products (e.g. any one or combinations of whole, partially or fully skimmed, concentrated or powdered milk, butter milk powder, concentrated or powdered whey, milk protein (such as whey proteins, whey protein concentrates, soluble milk proteins, edible casein and caseinates), cream, butter or milk fat-all of which have been manufactured from raw materials that have been at least pasteurized) by the action of specific microorganisms, which results in a reduction of the pH and coagulation. Many traditional fermented milk products were made in Asia, Africa, the Middle East, and northern and eastern Europe (Ghana standard, 2003).

2.4 Yoghurt definition

The Code of Federal Regulations (CFR 131.200) definition of yogurt is ‘‘Yogurt is the food produced by culturing one or more optional dairy ingredients with a characterizing bacterial culture that contains the lactic acid-producing bacteria, Lactobacillus delbrueckii subsp. bulgaricus and Streptococcus thermophiles.



2.4.1 Processing of Yoghurt

Yogurt comes in two types, distilled and set, in which there is a difference in the yogurt manufacturing process (Chandan *et al.,* 2006). The fermentation of the lactic acid bacteria generates lactic acid and a structure of continuous gel is formed in the container that is purchased by the consumer. In the processing of the stirred yogurt, the acid gel formation takes place during the stage of maturation in the large tanks for fermentation and then undergoes disruption through the process of stirring in the agitation process (Sodini et al., 2005). After stirring, pumping of the product takes place through a screen in which the product is given a viscous and smooth texture. The physical attributes of the yogurt are inclusive of perceived viscosity and the overall quality and sensory acceptance of the product by the consumers (White, 1995**)** .In dairy industry, no matter which manufacturing process is applied, the fermented dairy product must be appropriate to national and international standard protocol. The large scale yogurt manufacturing process entirely depend on the type of yogurt is being produced as well as the factory conditions (Chandan et al., 2006). The basic manufacturing steps for any types of yogurts are as follows:

2.4.2 Filtration

Filtration is needed to separate any cellular matter and other contaminants present in milk (Tammie and Robinson, 1999).

2.4.3 Standardization of milk component

The standardization of milk refers to the standardization of fat and solid-non-fat content (SNF). Bovine milk fat content varies from 3.2%-4.2% w/w. The fat content of the milk is adjusted to range from <0.5%, for skim milk, to 1.5%-2%, for semi-fat milk, to 3.5% for full fat milk. As far as yogurt is concerned, the fat content ranges from 0.1%-10% according to consumer demands. In practice, to achieve the designed fat level, either the addition of skim milk or milk fat or the separation of fat from milk via centrifuge and mixing milk fat with skimmed milk is carried out (Tammie and Robison's, 2007). The standardization process is of paramount importance, because the fat content of the milk influences the yogurt characteristics; increasing the fat content of milk results in an increase in the consistency and viscosity of yogurt (Chandan *et al.*, 2006).

2.4.4 Homogenization

Milk is homogenized before heat treatment to prevent lipolysis that causes some chemical changes in milk like: fat globule size reduction, casein micelles destruction thus helps to increase in water binding capacity. At the end of the homogenization process (Chandan et al., 2006).

2.4.5 Heat treatment (Pasteurization):

Heat treatment of milk also known as pasteurization can be defined as the eliminating process of pathogens and other un wanted undesirable microorganisms, thus stimulates the starter bacteria providing less competition for the starter culture and increasing the solid level of milk. Since heating of milk greatly influences the physical properties and microstructure of yogurt, so therefore the most commonly used heat treatment in the yogurt industry include 85°C for 30 minutes or 90-95ºC for 5 minutes (Tamime et al., 1999).

But in addition to thermal pasteurization, it has been used in this research pasteurization by a laser beam and the known high ability to kill germs in a very short time have been offered to other sample radiation strongly 60 watts for 10 seconds. It is a device used in many applications by laser IR (ND:YAG) fig(3.3) Indicator restaurant by fiber which is commonly used as a short pulse length of continuous wavelength equal to 1064 nm It was used in this study for the pasteurization of milk sample to 60 watts power for 10 minutes.

There are of course advantages of pasteurization for instance killing germs which is the best advantage and disadvantages like killing some of the elements that live in milk.

2.4.6 Inoculation

Soon after pasteurization, milk is allowed to cool to 40-45 °C and Inoculated with the fresh starter culture bacteria Streptococcus thermophiles and Lactobacillus bulgaricus in 1:1ratio in general. Although inoculation level varies between 1- 4%, the optimum level is 2%. If inoculation level is less than 2%, the lactic acid production decelerates leading longer periods of fermentation causes contamination risk. Apart from that immoderate inoculation levels result in fast and too much acidity production that causes unfavorable conditions like unwanted aroma formation, break down of yogurt texture. Depending on the capacity of yogurt manufacturing plant, inoculation pattern may vary for example:

-The most common method of inoculating the starter culture into yogurt vessels is one by one in small-scale plants.

-The second one is the inoculation of starter cultures in large milk tanks and then filled to yogurt vessels which leads to the production of more homogenous yogurts.

-Another method is the direct injection of yogurt starter cultures in sterile milk tanks and immediately filled into vessels (White, 1995).

2.4.7 Cooling and Storage

If yogurts are not cooled immediately at the end of the fermentation, starter cultures continue to grow. The acidity continues to decrease and causes syneresis on the surface of yogurts. Yogurts are generally cooled by two different ways. One-phase cooling where yogurts are cooled to 5 or 10 ºC just after fermentation and stored until distribution to the market. Two-phase cooling where the temperature decreases to 37 ºC and then 10 ºC, Finally, all yogurts are stored at 4 ºC for 1-2 days before sale due to maturation of viscosity and aroma of yogurt (White, 1995).

2.4.8 Nutrition value of yoghurt

Nutritional content of yogurt is similar to the nutritional content of milk but varies in the quality of yogurt depend on the type of milk (McKinley *et al.*, 2005). Therefore milk has to be standardized in order to prevent these compositional variations of milk (Tammie *et al.*, 1999).

1. **Protein**

The proteins of yogurt are easily digestible than the proteins found in other dairy product like milk although the protein contents of milk and yogurt are quite similar as lactic acid bacteria partially hydrolyze proteins and the amount of free amino acids in fermented dairy products increase. Therefore, this makes yogurt more preferable and safe than liquid milk (White, 1995).

2. **Fat**

Milk fat, though quite bland in taste, imparts richness and smoothness to fat-containing dairy products. Fat content of milk varies from 3.4% to 5.1%, depending on the breed of the cow (Aziznia *et al.*, 2008). Most of the milk used for yogurt production typically contains an average of 3.5-3.6% fat. Variability of milk fat also depends upon the individuality of animal, stage of lactation, feed, environmental factors, and stage of milking (Keogh, 1998). The fat content of yogurt varies from 0.1% to 10% depending on the yogurt standards described by each country in the World. Among the fat content in yogurt conjugated linoleic acid (CLA) is considered one of the essential fatty found exclusively in the fat of dairy products, can be obtained only through the diet because human body cannot produce it (Tamime and Robinson, 1999*;* Nushrat**,** 2015**).** Skim milk has smaller fat globules left over as a result of separator action and their diameter is around 1.3um. Cream layer is observed in products with relatively large fat globules, while the homogenized dairy products show virtually no cream layer during the shelf life of such products (Chandan, 2006).

One of the most important steps in production of low-fat and fat-free yogurts are to increase the total solids content to prevent specific textural defects such as poor gel firmness and surface whey separation (Lucey, 2002). It is common to use NFDM to fortify yogurt milk, but other dried dairy ingredients such as calcium caseinate, sodium caseinate, whey protein concentrate, and other milk protein-based ingredients have gained acceptance as a viable way to increase total solids in fat-free or low-fat yogurts (Tamime and Robinson, 1999).

3. Carbohydrates

The range of carbohydrates content found in yogurt is quite low (lactose content 3- 4%) as a few amount of milk lactose is being used during the yogurt fermentation especially by Streptococcus thermophiles. Among the carbohydrates, lactose is the dominant disaccharide in milk comparing to other mono- and disaccharides present in yogurt (Tamime and Robinson, 1999).

4. Vitamins and Minerals

Yogurt is a good source of calcium, magnesium, potassium, phosphorus, iodine, iron, vitamin B_2, zinc, selenium, and chloride. It is also a prime source of protein, conjugated linoleic acid (CLA), vitamin B_{12}, folic acid (vitamin B_9) tryptophan (an essential amino acid), potassium, vitamin B_5, zinc and molybdenum. According to a study published in the British Journal of Nutrition in 2007, vitamins and minerals naturally found in milk are better utilized by the human body when in the form of yogurt due to the fermentation process involving Lactobacillus bulgaricus, L acidophilus and Streptococcus thermophiles. The vitamin content of yogurt depends on milk type, animal feeding, manufacturing process, fermentation conditions and starter culture activation (Tammie and Robinson, 2007).

Chapter Three

Materials and Methods

3.1 Introduction

This chapter is consist of materials is using in the research, method of yoghurt productions and analytical methods.

3.2 Materials and Apparatus

1. Milk

Fresh cow’s milk was obtained from the College of Agriculture and Animal Production, Department of Animal Production, Sudan University on a farm in a Bahri city. The milk is a three samples containing 2 pounds of fresh cow's milk and quoted two of the three samples on the spot to the Department of Animal Products (National Center for Food Research NFRC) where chilled in 4 ± 1 °C. It was obtained milk samples from dairy Faculty of Animal Production and stored at room temperature at 37 °C. The purchase of skimmed milk powder obtained from the local market in the Bahri city. Has been getting chemicals and reagents used by the Central Laboratory of the National Center for Food Research shop (NFRC) and the other transferred to the Sudan University of Science and Technology Institute of Laser for irradiation by the laser, and then transferred to the Department of Animal Products (National Center for Food Research NFRC) for testing them.

Figure (3.1), Samples of Milk.

2. Water Path

It used to keep water at a consistent temperature for incubating samples in a laboratory, also used for food canning, according to the national center for home food.

Figure (3.2) water path (HH-4China)

3. ND:YAG Laser

ND: YAG lasers are optically pumped using a flashtube or laser diodes. These are one of the most common types of laser, and are used for many different applications.

ND: YAG laser Figure (3.1) typically emit light with a wavelength of 1064 nm, and maximum output power 100 Watt, adjusted 1 Watt in step, the ND: YAG laser mode lDORNIER med Tech Medilas 5100 fiber tom Glass I.

Figure (3.3), (ND: YAG) Laser.

4. Magnetic Stirrer

The magnetic stirrer device Figure (3.4) is used to make homogenous solution by mixing the milk compound with ND:YAG laser radiation .A rotation field of magnetic force is employed to induce variable speed a stirring action within either closed or opened vessels .The stirring is accomplished with the aid of small permanent magnets sealed in Pyrex glass. This device was manufactured by Scott science and healthcare limited it speed 60 to 1500 pm. The magnetic stirrer is hot plate stirrer (Model L M S -1003 Scott science U k.)

Figure (3.4), Magnetic Stirrer (HI190M-1(115V)).

3.3 Method

Yogurt been produced according to this scheme:

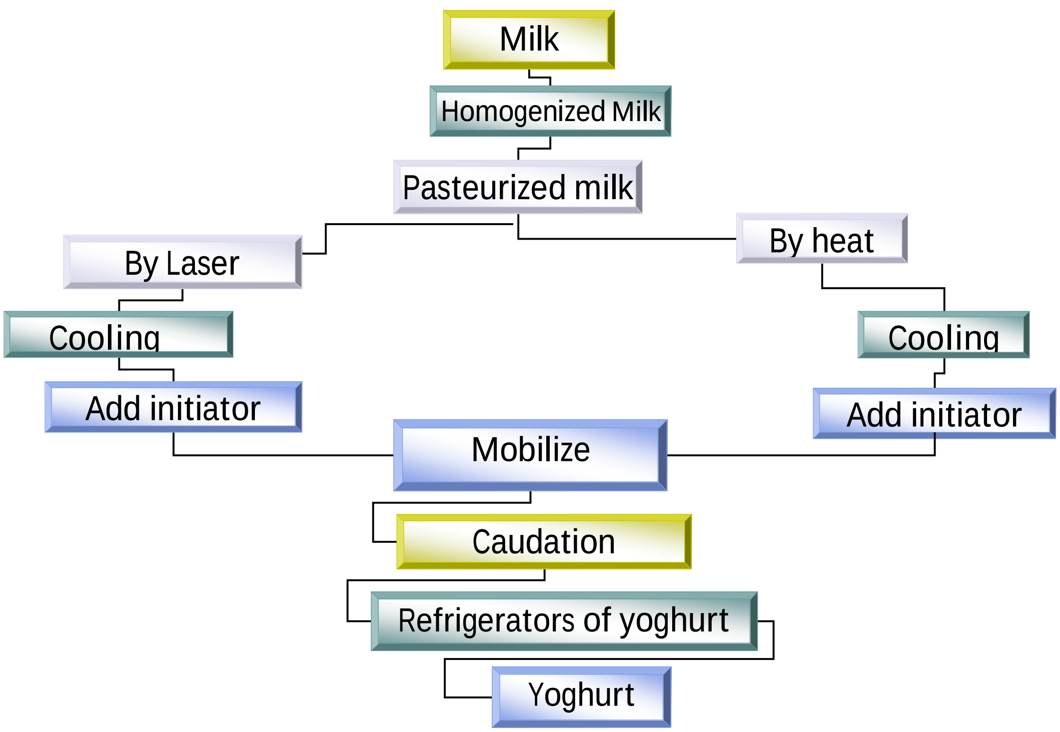


Figure (3.5): Diagram of Yoghurt Production.

3.4 Chemical Analysis

The moisture content was determined according to the standard method of the Association of Official Analytical Chemists (AOAC, 2003), protein content was determined in all samples by micro-Kjeldahl method using a copper sulphate or sodium sulphate catalyst according to the Official Method of the (AOAC,2003), fat in the product was determined according to the standard analytical method of A.O.A.C, (2003). The standard analytical method of A.O.A.C, (2003) and total solids of the samples calculated and expressed as a percentage (AOAC, 2003).

Lactose = Total solids- (fat+ protein+ ash), Solids-not-fat = Total solids-fat

1. Moisture content

The moisture content in a weighed sample is removed by heating the sample in an oven (under atmospheric pressure) at 105 ± 1Cº.Then, the difference in weight before and after drying is calculated as a percentage from the initial weight.

Procedure

A sample of 5 ml ± 1 ml was weighed into a pre-dried and tarred dish. Then, the sample was placed into an oven (Kat-NR.2851, Elektrohelios (Sweden) and left to dry at 105±1Cº until a constant weight was obtained. After drying, the covered sample was transferred to a desiccator and cooled to room temperature before reweighing. Triplicate results were obtained for each sample and the mean value was reported to two decimal points according to the following formula:

Calculation

Moisture content [%] $= \frac{[m2-m3]}{[m2-m1]} \times 100$

Where:

m1 = mass of dish + cover

m2 = mass of dish + cover + sample before drying

m3 = mass of dish + cover + sample after drying

5. Crude protein determination

The principle of method consists of sample oxidation and conversion of nitrogen to ammonia, which reacts with the excess amount of sulphuric acid forming ammonium sulphate. The solution is made alkaline and the ammonia is distilled into a standard solution of boric acid (2%) to form the ammonia-boric acid complex, which is titrated against a standard solution of HCL (0.1N). Accordingly, the crude protein content is calculated by multiplying the total N % by 6.25 as a conversion factor for protein.

Procedure : 10 ml ± 1ml sample was accurately weighed and transferred together with 2-3 glass pellets, kjeldahl catalyst (No 33064, BDH, England) and 25 ml concentrated sulphuric acid (No 18474420, Mark AG, Germany) into kjeldahl digestion flask. After that, the flask was placed into a kjeldahl digestion unit (Tecator, Sweden) for about 3 hours, until a colorless digest was obtained. Following, the flask was left to cool to room temperature, and then deleted by distilled water; the distillation of ammonia was carried out in 10 ml boric acid (2 %) and 15 ml sodium hydroxide solution (40 %). Finally, the distillate was titrated with standard solution of 0.1N HCL in the presence of 2-3 drops of indicator (Bromocreasol green and methyl red) until a brown reddish color was observed.

Calculation

Crude protein

Nitrogen (%) = T × 0.1 x 0.014 × 100/ Weight of sample

Protein (%) = Nitrogen % × 6.3

Where:

T = Titration figure.

0.1 =Normality of HCl.

0.14 = Atomic weight of Nitrogen.

Crude protein:

Protein (%) = Nitrogen % × 6.38

Protein conversion factor = 6.38

6. Fat content

Ten ml sulfuric acid (density 1.815 gm/ml at 20^oC) were poured into a clean Gerber tube, followed by the addition 10 ml of sample then 1 ml of amyl alcohol was added to the tube followed by addition of distilled water. The tubes were then thoroughly mixed till no white particles were see, centrifuged at 1100 revolution per minute (rpm) and transferred to a water bath at 65^oC for 3 minutes. The columns of the fat were then recorded immediately.

Figure (3.6) Centrifuge

7. Ash content

Was used for determination of ash content in the sample, The inorganic materials which are varying in concentration and composition are customary determined as a residue after being ignited at a specified heat degree.

Procedure: 2ml was weighed into a pre- heated, cooled weighed and tarred porcelain crucible. Before ashing, the sample was pre-washed on an electrical pre-Asher and placed into a muffle furnace (Carbolite, Sheffield, England) at 525 to 600 C °until a constant weight was obtained. The weight of the residue after ashing was defined as ash.

Figure (3.7) ash determine (Kat-NR.2851, Elektrohelios)

Content Calculation

The ash content was calculated as follow:

Ash (%) = W_1 / W_0 X 100

Where

W_1= Weight of ash

W_0= Weight of sample

8. Total solids T.S

Two grams (2ml) of yoghurt was weighed into each of three previously washed, dried and weighed glass crucibles. The crucibles with the samples were then placed in a thermostatically controlled oven at 105^{0}C for 5 hours till a constant weight of solid material was obtained. The crucibles were then removed and cooled in a desiccator and then weighed, Used to dry oven the samples after pasteurization and also for drying food stuffs after the sort of milk and yoghurt.

Figure (3.8) drying oven (kjeldahl digestion unit)

Then total solids content was calculated from the flowing equation:

Total solids (%) = $W_1/W_0 \times 100$

Where

W_1 = Weight of sample after drying

W_0= Weight of sample before drying

9. The PH Measurement

The PH of the mixture was measured by using a recalibrated pH meter model (HI 8521 microprocessor bench pH / MV / C˚ meter). This has been calibrated with two standard buffers (6.8 and 4.0).

Figure (3.9), pH measurement.

10 Titratable Acidity Measurement

This test was carried out according to method described by A.O.A.C (2003) Ten grams of samples were weighed in to a small beaker, the sample was mixed well, 2-3 drops of phenolphthalein were added, and the sample was titrated against 0.1N NaOH till a faint pink color, the titration figure divided by ten.

Figure (3.10), acidity calibration.

3.5 Statistical Analysis

The statistical analysis was done as per Steel and Torrie (1980), using Completely Randomized Design (CRD). Analysis of variance test was done to find out the statistical difference within the quality of the three types of cow milk.

Chapter Four
Results and Discussion

4.1 Introduction

This chapter consists of results and discussion, Conclusions, notes, recommendations and references.

4.2 Results and Discussion

4.2.1 Nutrition value of milk

Table 4.1 shows the nutrition value of the milk samples as obtained (control sample) and pasteurized milk with heat and with laser. The results shows significant changes in pH value and acidity, while there are no significant changes in the other properties.

Table (4.1) Results Natural Value of Milk

Parameter	Control	Pasteurize Milk Average	Irradiation Milk Average
Moisture	85.5	85.3	85.5
Protein	5.0	4.8	4.9
Fat	3.5	3.9	3.9
Ash	1.5	1.3	1.1
Lactose	4.7	4.6	4.6
T.S	14.7	14.5	14.5
pH	6.6	6.6	6.6
Acidity	1.2	1.1	1.2

4.2.2 Statistical Analysis

Table 4.2 Descriptive Statistics for milk samples

	N	Minimum	Maximum	Mean	Variance
Heat Pasteurize Milk Average	8	1.1	85.3	15.263	818.380
Laser pasteurized Milk Average	8	1.1	85.5	15.287	822.490

Table 4.3 Paired Samples Test for milk samples

		Paired Differences					t	Sig. (2-tailed)
					95% Confidence Interval of the Difference			
					Lower	Upper		
Pair 1	Control - Pasteurize Milk Average	.075	.2053	.0726	-.097	.247	1.033	.336
Pair 2	Control - Irradiation Milk Average	.050	.2268	.0802	-.140	.240	.624	.553

The statistical analyses show significance value of 0.33 when comparing the control sample with the heat pasteurized sample which is greater than 0.05 I.e. sig > 0.05 and mean of 0.075, whereas a significance value of 0.553 when comparing the control sample with the laser pasteurized sample which is greater than 0.05 I.e. sig > 0.05 and mean of 0.050, which is mean that there is no significant change in using heat or laser in pasteurization process, with a preference for heat pasteurization.

4.2.3 Time of producing yogurt

Time needed to convert milk to yogurt from the control sample was five hours and twenty minutes, while yogurt produced from laser pasteurized milk was three hours and forty five minutes and yogurt produced from heat pasteurized milk was three and minutes.

4.2.4 Nutrition value of yoghurt

Table 4.2 shows the nutrition value of the yoghurt samples as obtained (control sample) and pasteurized milk with heat and with laser. The results shows significant changes in Ash value while there are no significant changes in the other properties.

Table 4.4 Results Nutrition Value of Yoghurt

Parameter	Control Average	Pasteurize Average	Irradiation Average
Moisture	86.1	86.53	85.92
Protein	5.26	5.53	5.68
Fat	4.59	4.12	4.18
Ash	1.99	1.7	1.88
Lactose	2.40	2.15	2.37
T.S	13.90	13.47	14.08
pH	4.45	4.36	4.54
Acidity	0.99	1.12	1.20

4.2.5 Statistical Analysis

Table 4.5 Descriptive Statistics for yogurt samples

	N	Minimum	Maximum	Mean	Variance
Heat Pasteurize yogurt Average	8	1.1	86.5	14.873	853.526
Laser pasteurized yogurt Average	8	1.2	85.9	14.981	837.990

Table 4.6 Paired Samples Test for yogurt samples

		Paired Differences					t	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
					Lower	Upper		
Pair 1	Control - Pasteurize yogurt Average	.087	.3325	.1176	-.190	.365	.744	.481
Pair 2	Control - Irradiation yogurt Average	-.021	.2594	.0917	-.238	.196	-.232	.823

The statistical analyses show significance value of 0.481 when comparing the control yogurt sample with the heat pasteurized yogurt sample which is greater than 0.05 I.e. sig > 0.05 and mean of 0.087, whereas a significance value of 0.823 when comparing the control yogurt sample with the laser pasteurized yogurt sample which is greater than 0.05 I.e. sig > 0.05 and mean of 0.021, which is mean that there is no significant change in using heat or laser in pasteurization process, with a preference for laser pasteurization.

4.3 Conclusions

1. It is noted that the pasteurized milk by heat turns into Yogurt with a time of 3 hours and 10 minutes, while laser pasteurized milk needs to 3 hours and 45minutes for switching to Yogurt.

2. The use of laser in pasteurization is not differ from heat pasteurization, while the production of yogurt from laser pasteurized milk is slightly better than that of heat pasteurized milk

3. Yogurt output of the laser pasteurized milk contains a large proportion of protein.

4.4 Recommendations

1. Awareness using laser in the pasteurization of milk in residential communities.
2. The use of food products laser companies in the pasteurization and production yoghurt rather than heat.
3. Many Scientific researches will be done on this subject in the future.

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