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Medical Specimen Incubator Model 2022-2023

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Annotation: The laboratory incubator is considered one of the very important devices in the health aspect.

It is necessary for experimental work in the biology of microorganisms and provides an ideal medium suitable for the growth and reproduction of various types of microorganisms.

Such as bacteria that infect the human body, causing diseases. In some diseases, it is difficult when examining a blood sample or any other fluids of a person's body, once it determines the type of infectious bacteria that causes the disease due to its incomplete growth or lack of density within the sample. In this case the doctor resorts to making a culture of these bacteria to obtain a large number of them, and thus we are able to know the type of bacteria, and accordingly, it is possible to determine its type accurately, and even determine the type of antibiotic suitable for successful treatment with it.

The laboratory incubator is relatively expensive.

In this project, we worked on providing

an ultraviolet sterilization system for the incubator by using low-priced materials. We also provided the incubator with a room that has a temperature system and its own control panel, where it is possible to place more than one sample and more than one type inside the incubator itself. Thus, we exploited the space and time and the cost of making two incubators instead of one incubator. We got very good results compared to other traditional incubators that have one system, the lowest possible cost and the available capabilities.

1-1 Introduction

An incubator is a device used to grow and maintain microbiological cultures or cell cultures. The incubator maintains optimal temperature, humidity and other conditions such as the CO2 and oxygen content of the atmosphere inside.

Four factors are of major importance in incubating artificially: temperature, humidity, ventilation and turning. Of these factors, temperature is the most critical

Incubating the plates to promote growth of microbes is an essential part of any microbiology investigation. Incubating in aerobic conditions, and below human body temperature, reduce the risk of encouraging microorganisms (particularly bacteria) that could be pathogenic to humans.

The primary function of an incubator is to endow a controlled, contaminant-free environment for safe and reliable work with cell and tissue cultures by regulating conditions such as temperature, humidity, and CO2. Laboratory incubators are fundamental for the growth and storage of bacterial cultures, cell and tissue culture, biochemical and hematological studies, pharmaceutical work and food analysis.

1-2 Literature Review

Incubators are used in modern research laboratories to maintain a stable environment for processes such as growing cells and microbiological cultures and incubating antibodies and cells for fluorescence microscopy.

The simplest incubators are little more than temperature-controlled ovens, capable of reaching temperatures of 60 to 65 °C, but usually used at about 36 to 37 °C. However, most modern incubators are also able to generate refrigerated temperatures, and control humidity and CO2 levels. Many incubators also offer features such as automatic shaking, measured by revolutions per minute.

Figure (1-1) The incubator

Laboratory incubators were first properly introduced during the second half of the twentieth century, when doctors realized that they could be used to identify pathogens from the bodily fluids of patients. In this application, a sample is transferred to a Petri dish, placed on a rack inside the incubator and heated to body temperature (37 °C). The appropriate quantity of atmospheric CO2 or N2 necessary for cell growth is then supplied, encouraging the microorganism to multiply, enabling easier and more definite identification.

(1-2-1) 1800

In the 1800s, researchers began searching for the ideal in vitro environment in which to maintain cell culture stocks.

The first CO2 incubator developed consisted of a simple bell jar containing a lit candle. Cultures were placed under the lid of the jar alongside the lit candle, before the jar was moved to a dry, heated oven. This system may be considered the first “air-jacketed” CO2 incubator.

(1-2-2) 1960

During the late 1960, the first dedicated, commercial CO2 incubators were developed. It was during this time that New Brunswick Scientific (NBS) introduced a range of incubator products.

(1-2-3) 2001

In 2001, a patent was granted for an ambient-temperature stabilization control system for laboratory incubators. This device was able to effectively maintain the incubator temperature within a desired range.

(1-2-4) 2003

In 2003, NBS began worldwide distribution of a new line of CO2 incubators featuring a direct-heat, fan less design.

(1-2-5) 2006

In 2006, NBS introduced two new CO2 incubators—the Innova CO-170 and Excella CO-170—which offered greater internal space without increasing external size.

(1-2-6) Future of lab incubators

Laboratory incubators have evolved steadily over the latter part of the twentieth century, and have remained an important piece of laboratory equipment. Experts believe that in the future the

incubator market will derive most of its growth from the bio-technology industry The picture below shows a recent model of the sample incubator fig(1-2).

Another probable area of growth for incubators is within the field of genetic engineering, in which scientists manipulate the genetic materials in explants, sometimes combining DNA from discrete sources to create new organisms. Although genetic engineering is a controversial subject for many, this technology has already delivered tangible benefits, including the manufacture of insulin and other biologically essential proteins. Genetic engineering has also been shown to improve the nutritional content of fruits and vegetables and to increase the resistance of certain crops to disease. Genetic engineering relies heavily on the use of well-controlled and adjustable incubation.

Figure (1-2) An example of an incubator today

1-3 Aim of the project

The aim of this study is to develop a model for the incubator

The best and least expensive way with the possibility of the device to work even in the worst conditions so the primary goal of this research study is

- Development and implement a laboratory incubator that is low in cost and has few flaws.
- Provide a sterilization system inside the incubator Save time as two samples can be placed at the same time in one incubator
- Provides an ideal medium for bacterial growth and reproduction by stimulating favorable conditions.
- Reducing risks and obtaining results with a higher chance of success while keeping up with scientific advancement.

Chapter 2

Theoretical Part

2-1 Introduction

In this chapter, contains the incubator in detail, as well as its types It is an insulated, closed, box-like thermal device, used to preserve and multiply microorganisms or cells, so that it maintains a specific temperature selected according to the type of cultivation used in it, as well as maintains the humidity and gaseous content in it, and it is one of the devices Of great importance in the laboratory, whether in a medical laboratory, pharmaceutical, or any other type of scientific and

research laboratories, and therefore it is important to identify the most important types, and their uses.

Figure (2-1) Types of incubators

2-2 Choosing the right laboratory incubator

There are several things to consider when choosing a laboratory incubator, and it may be up to the type of laboratory to be used in, but in general, the following points are important in that:

1. Capacity, and the size of the incubator, in terms of the number of samples that it can accommodate at one time.
2. Temperature, humidity, and carbon dioxide, which are the necessities of multiplication, and the cornerstone of work.
3. Efficient heat distribution, the need for a water source, or not.
4. The control system used, as there are two types of control, the thermal conductivity detection system, or the infrared sensors system.

The shape and design of the incubator may interest the user, so it must be chosen carefully. There are several distinctive designs that aim to reduce and reduce pollution, by adding HEPA filters, antimicrobial copper, and other additions, such as the presence of a touch screen control., temporary, data storage, and more.

2-3 Principle and operation of incubators

An incubator is based on the principle that microorganisms require a particular set of parameters for their growth and development. All incubators are based on the concept that when organisms are provided with the optimal condition of temperature, humidity, oxygen, and carbon dioxide levels, they grow and divide to form more organisms.

In an incubator, the thermostat maintains a constant temperature that can be read from the outside via the thermometer.

The temperature is maintained by utilizing the heating and no-heating cycles. During the heating cycle, the thermostat heats the incubator, and during the no-heating period, the heating is stopped, and the incubator is cooled by radiating heat to the surrounding.

Insulation from the outside creates an isolated condition inside the cabinet, which allows the microbes to grow effectively.

Variation of the incubator like a shaking incubator is also available, which allows for the continuous movement of the culture required for cell aeration and solubility studies.

2-4 Incubator operation steps

Once the cultures of organisms are created, the culture plates are to be placed inside an incubator at the desired temperature and required period of time. In most clinical laboratories, the usual temperature to be maintained is 35–37°C for bacteria.

The following are the steps to be followed while running an incubator:

- Before using the incubator, it should be made sure that no remaining items are present in the incubator from the previous cycles. However, in some cases, if the same incubator is being used for multiple organisms, and they require the same set of parameters, they can be placed together in the same incubator.
- The door of the incubator is then kept closed, and the incubator is switched on. The incubator has to be heated up to the desired temperature of the growth of the particular organism. The thermometer can be used to see if the temperature has reached.
- In the meantime, if the organism requires a particular concentration of CO2 or a specific humidity, those parameters should also be set in the incubator.
- Once all the parameters are met, the petri dish cultures are placed on the perforated shelves upside down, i.e., media uppermost. This is necessary because if the plates are incubated normally, condensation collects on the surface of the medium and prevents the formation of isolated colonies.
- If it is necessary to incubate Petri dish cultures for several days, the plates are sealed with adhesive tapes or are placed in plastic bags or plastic food containers.
- finally, the door is locked, and the plates are kept inside for the required time before taking them out.

2-5 Types of Incubtor

The most common types of incubators are: –

- ✓ Bacteriological incubators
- ✓ BOD incubators
- ✓ CO2 incubators
- ✓ Shaking Incubator
- ✓ Humidity Incubator

2-5-1. Bacteriological incubators

This type of incubator is used mainly in laboratories usually for the growth of bacteria. A constant temperature set according to the requirement is possible because of having a thermostat that maintains it. Accurate temperature can be visible on the thermometer fixed on incubators. Most of the incubators are programmable which do not need trial and error temperature settings.

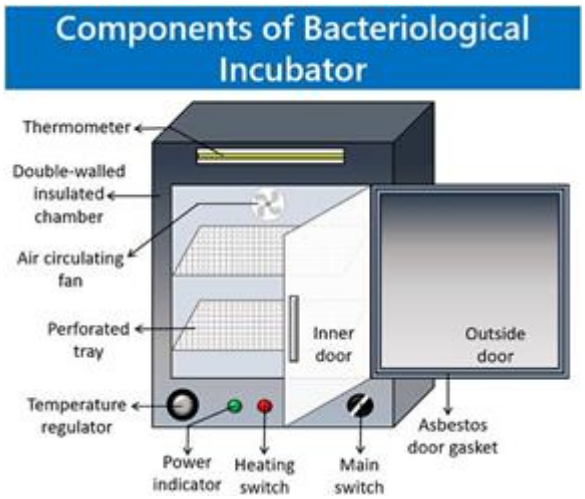


Figure (2-2) Bacteriological incubator

They only hold a heating system that maintains the temperature for the growth of bacteria. Due to the absence of a cooling system, these incubators are affected by the temperature of the surrounding environment.

2-5-2. BOD incubators (Low-Temperature Incubators)

These types of incubators are often called low-temperature incubators used for the growth of fungi i.e. yeast and mold as they require a low temperature to grow. These types of incubators are called BOD (Biological oxygen demand) incubators because in biological oxygen demand testing there is a need for a low temperature around 20-25˚C. So, don't confuse the term because the purpose of BOD incubators is also the same as bacteriological incubators.

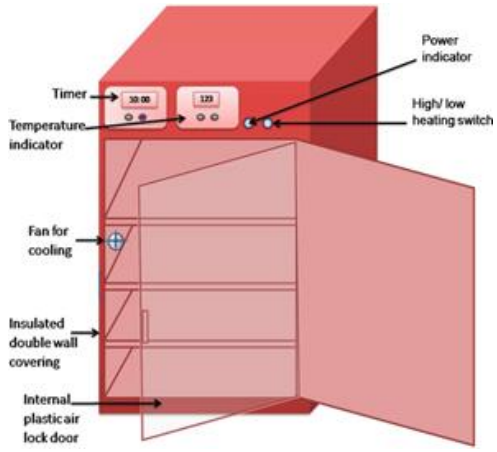


Figure (2-3) Bod incubator

2-5-3. CO2 Incubators

Inside incubators, also known as a gassed incubator, an atmosphere is created that is as natural as possible to develop cell and tissue cultures. This way of cultivating living organisms is called in vitro and is the main application for CO2 incubators. The following parameters are crucial for cell cultivation:

- ✓ CO2 level
- ✓ Temperature
- ✓ Humidity

2-5-4. Shaking Incubator

A combined form of motor/shaker and incubator is termed a shaking incubator. The incubator provides controlled temperature, humidity, oxygen level, etc. It also offers constant shaking for a homogenous mixture of the samples like a centrifuge. It is mainly used in molecular biology and genetics. Benchtop/standard incubators are the incubator present in the most common laboratory.

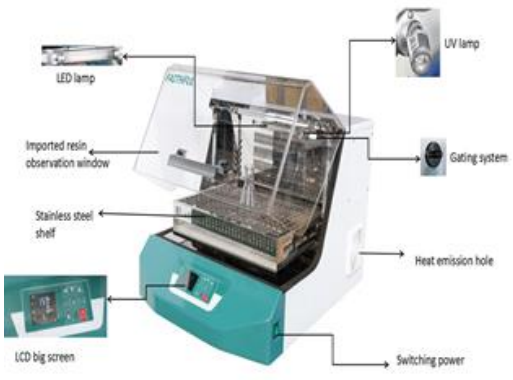


Figure (2-4) Shaking incubator

The temperature ranges from ambient to up to 100℃. Most of these incubators have a glass door, alarms, and a display screen that displays the temperature and time.

2-5-5. Humidity Incubator

A humidity incubator is a special type of incubator with control settings for humidity. It is important because the growth of certain organisms requires some moisture. Temperature and humidity are controlled simultaneously. Indirect heating helps in maintaining the special atmosphere inside the cabinet.

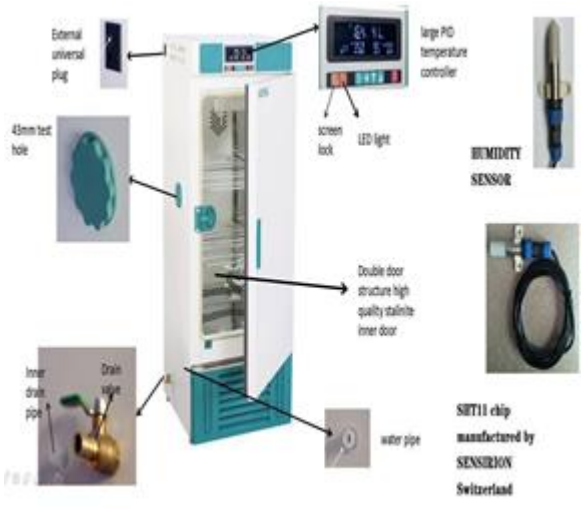


Figure (2-5) Humidity incubator

Some microorganisms cannot grow in oxygen reach environment.CO2 incubator provides this environment.

2-6 Components/Parts of Incubator

2-6-1 Closet

- The cabinet is the main body of the incubator and consists of a double-walled cubic container with a capacity of 20 to 800 liters.
- The outer wall is made of stainless-steel sheets while the inner wall is made of aluminum.
- The space between the two walls is filled with glass wool to provide insulation for the incubator.
- The insulation prevents heat loss and reduces electricity consumption, thus ensuring the smooth operation of the device.
- The inner wall of the incubator is provided with internal projections that support the shelves located inside the incubator.

2-6-2 Door

- ✓ There is a door in all nurseries to close the insulated cabinet.
- ✓ The door also has its own insulator. It is also provided with a glass that allows visualization of the interior of the incubator during incubation without disturbing the internal environment.
- ✓ There is a handle on the outside of the door to help maneuver the door.

2-6-3 control Board

- On the outer wall of the incubator there is a control panel with all the switches and indicators that allow controlling the parameters of the incubator.
- The control panel also has a witch to control the device's thermostat.

2-6-4 thermostat

- The thermostat is used to set the desired temperature for the incubator.
- After the desired temperature is reached, the thermostat automatically keeps the incubator at that temperature until the temperature is changed again.

2-6-5 perforated shelves

- Binding to the inner wall are some perforated shelves on which plates with culture media are placed.
- Perforations on the racks allow hot air to circulate throughout the interior of the incubator.
- In some incubators, the shelves are removable, which allows the shelves to be cleaned properly.

2-6-6 Asbestos door gasket

- Asbestos door gasket provides an almost airtight seal between the door and the cabinet.
- This seal prevents outside air from entering the cabinet and thus, creates an insulated heated environment inside the cabinet without interruption from the outside environment.

2-6-7 HEPA filters

- Some advanced incubators are also fitted with HEPA filters to reduce potential airflow contamination.
- The air pump with filters creates a closed loop system so that the air flowing into the incubator generates less pollution.
- Humidity and gas control
- Carbon dioxide incubators are fitted with a tank under the chamber containing water.
- The water is evaporated to maintain the relative humidity inside the room.
- Similarly, these incubators are also equipped with gas chambers to give the required concentration of carbon dioxide inside the incubator.

2-7 Uses of Incubator

Incubators have a wide range of applications in various areas including cell culture, pharmaceutical studies, hematological studies, and biochemical studies.

Some of the uses of incubators are given below:

- ✓ Incubators are used to grow microbial culture or cell cultures.
- ✓ Incubators can also be used to maintain the culture of organisms to be used later.
- ✓ Some incubators are used to increase the growth rate of organisms, having a prolonged growth rate in the natural environment.
- ✓ Specific incubators are used for the reproduction of microbial colonies and subsequent determination of biochemical oxygen demand.
- ✓ These are also used for breeding of insects and hatching of eggs in zoology.
- ✓ Incubators also provide a controlled condition for sample storage before they can be processed in the laboratories.

2-8 Precautions

The following precautions are to be followed while running an incubator:

- As microorganisms are susceptible to temperature change, the fluctuations in temperature of the cabinet by repeatedly opening the door should be avoided.

- The required parameters growth of the organism should be met before the culture plates are placed inside the cabinet.
- The plates should be placed upside down with the lid at the bottom to prevent the condensation of water on to the media.
- The inside of the incubators should be cleaned regularly to prevent the organisms from settling on the shelves or the corners of the incubator.
- While running the incubator for an extended period of time, sterile water should be placed underneath the shelves to prevent the culture media from drying out.

Chapter 3

Practical Implementation

3-1 Introduction

In this chapter, we explain the practical side of the project, the nature of its basic components, how to develop the laboratory incubator and the tools used.

3-2 The components of the incubator

Table (3-2-1): Incubator component material.

No.	Parts of incubator	Material made of
1	Door	Made of glass window
2	Cabinet	Modified from oven
3	UV lamp	Using a water purifier candle
4	Heater	Metal alloy in a form of W letter
5	Fan	Made of metal perforated shelves
6	perforated shelves	Made of Aluminum

3-3 Method

A laboratory incubator that contains shelves for placing colonies and laboratory samples.

We turn on the incubator first and control the temperature of the incubator and it is close to the human body temperature of 37℃.The thermostat maintains a constant temperature and can be read from the outside of the control panel. During the heating cycle, we operate the fan to distribute the heat.

3-3-1 Add UV Light

we modified the incubator by placing an ultraviolet light before and after the culture process for sterilization, and we set a timer that could be controlled by specifying a short period of time.

Sterilization is the comprehensive annihilation of germs and the disposal of their remains, and the process of removing or killing life manifestations of microorganisms; Surface bacteria and viruses include the surface of human skin or the surfaces of surgical instruments

To understand the basis of the sterilization process, it is necessary to know the kinetics of death of microorganisms, which can be expressed in the irreversible loss of the ability to reproduce, and this characteristic can be relied upon in evaluating the sterilization process, since only living cells can form colonies.

Therefore, we relied on the use of ultraviolet radiation technology because it is of particular importance in sterilization due to its deadly effect on microorganisms. Although the sun radiates large amounts of ultraviolet radiation with its different wavelengths, most of these short-wavelength rays, which have the strongest effect in sterilization, are absorbed in the layers of the atmosphere, or the longer-wavelength rays, which have the least effect in sterilization, and most of them reach the earth. And the microorganisms that reach the upper layers of the atmosphere in

one way or another are quickly reduced by these rays, as well as the microorganisms on the surfaces of rocks exposed to the sun.

We also worked to close the sides of the hole that we made with silicone to ensure that there is no heat leakage inside the incubator.

And install it inside the incubator using clamps. We also established an external electrical point that can be controlled manually to turn off and turn on the ultraviolet candle inside the incubator.

We used this particular technique for the purpose of sterilizing the room from unwanted biological contaminants or the remnants of the previous culture process that affect the bacterial growth of the next test. The sterilization period with this technique ranges from 10-15 minutes.

What distinguishes ultraviolet sterilization from other technologies is the following:

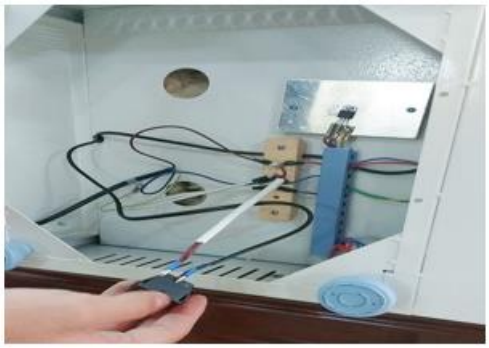
- ✓ Ease of use
- ✓ High efficiency in sterilization
- ✓ It requires a short time
- ✓ Do not cause damage to the electronic parts inside the incubator

So, we have added an ultraviolet candle, where we worked on the incubator hole in proportion to the size and measurement of the ultraviolet candle.

As in the following photographs:

3.1. The picture shows the opening of the base of the incubator

3.2. The picture shows the opening of the base of the incubator



3.3. picture shows button has been linked to the electrical circuit

3.4. The picture shows shape of the uv lite power button

3.5. A picture shows a hole was made in the back of the incubator in order to insert a UV candle

3.6. A picture showing the work of a UV candle

3-3-2 Add small incubator chamber

Figure 3-7. picture showing the small chamber

Instead of buying and using two incubators for samples, we can put different samples in one incubator, thus saving time and money. The dimensions of the box made of resistant glass were taken and placed inside the incubator, and a heater and its own control panel were added to it. to ensure the isolation of samples and the provision of different conditions for each sample. Inside the incubator itself, we drilled a hole in the incubator, connected the box and the heater from the back, connected it to the electrical circuit of the mother incubator, and then connected it to a digital control panel that ensures the temperature changes according to the sample, knowing that the chamber glass is permeable to UV light, Glass 8mm thick, Height 13cm, length 17cm, Width 15cm. The presence of a shelf inside to ensure the placement of more than one sample and the exploitation of the place.

Figure 3-8. The picture shows making holes in the small incubator /chamber

We have identified a place to place the small incubator and made three holes, two of which are to insert the poles of the heater, which operates at a capacity of 200 Watts, and another hole to insert the thermo sensor to control the amount of heat required to be provided inside the incubator, and connect both the sensor and the heater to the thermo couple device, which in turn is connected to the power source remotely by connecting it together to the electrical circuit inside the incubator, by opening the base of the incubator and making a connection between it and the mother incubator circuit.

Thus, we obtained two incubators, a small incubator inside the mother incubator, which provides appropriate heat, insulation, and a window to ultraviolet rays. We made an external modification, where we made a hole for the incubator from the outside, for the control panel of the small incubator. The pictures below shows the method of connection.

Figure 3-9 Image showing the location of the control panel

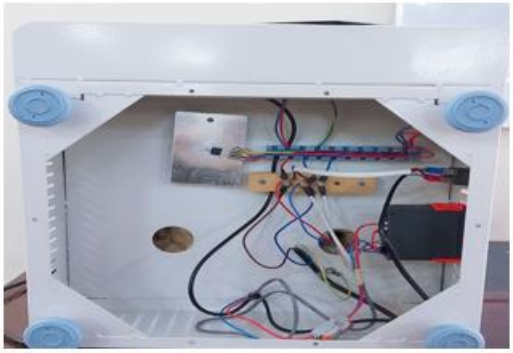


Figure 3-10 Image showing connecting wires in an electrical circuit

Chapter 4

Results

4-1 UV light efficacy test

4-1 A picture showing the incubator operating at a temperature of 37 degrees, with samples inside

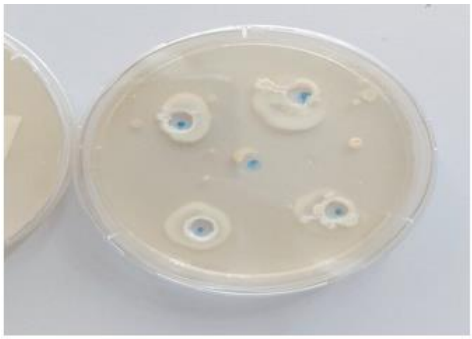
In the beginning, we cultivated the fruit fungi in discs and placed them inside the incubator, The type of culture is “mat”, then we inserted the five samples, each sample has a specific time. The first sample is 5 minutes, the second sample is 10 minutes, the third sample is 15 minutes, the fourth sample is 20 minutes, the fifth sample is 25 minutes.

Table (4-1-1): The number of germinated colonies on the surface after the incubation period:

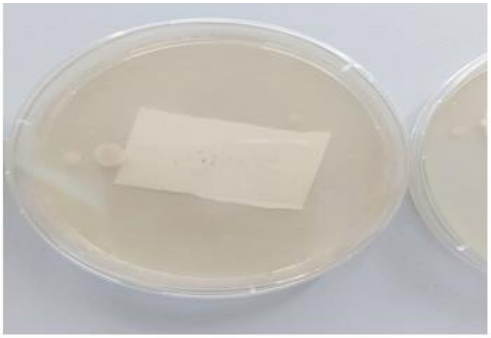
No.	Exposure time	number of colonies	percentage of inhibition
1	Without exposure	13	0.0
2	5 min	3	%76.6
3	10 min	2	%84.6
4	15 min	0.0	%100
5	20 min	0.0	%100
6	25 min	0.0	%100

Thus, we make sure that the UV light are effective for sterilization.

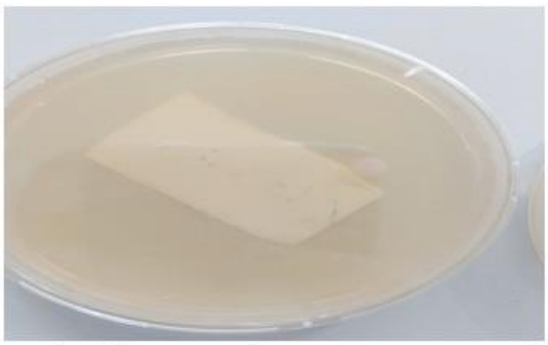
4-2 A picture showing the arrangement of samples inside the incubator for examination.



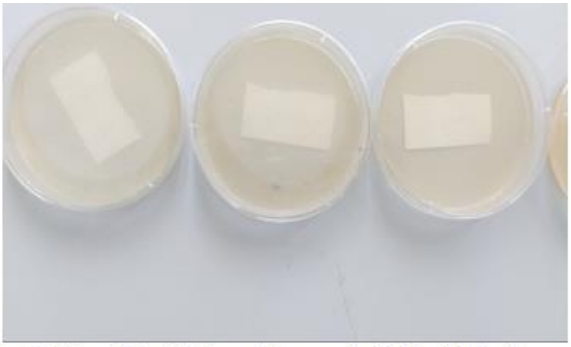
4-3 The sample was unexposed



4-4 The first sample was 3 colonies



4-5 The second sample was one colony



4-6 The third, fourth, and fifth killed

We used two ready-made samples of bacteria that were previously cultivated in the laboratory, a type klebsiella and pseudomonas They are treated with care and caution because they are harmful, and we put them in a small incubator, then they were exposed to ultraviolet rays, and the result showed that they were killed, and thus we used in our project types of bacteria in addition to parasites. Pictures show:

4-7 Pictures showing bacterial samples inside the small-incubator

Chapter 5

Conclusion and Recommendations

5-1 Conclusion

This chapter includes our findings and discussion.

We've got a multi-use incubator, And we put in place an effective sterilization system before and after the incubation process to ensure the prevention of contamination and the transmission of diseases and infections..which guarantees the safety of all workers in the field of laboratory incubators

Experiments have also shown that the sterilization time needs from 15 minutes or more for sterilization, and the less time is less than 15 minutes, the colonies will increase.. Also, ultraviolet rays can act as a sterilization system for tools or the incubator itself.. to ensure that samples are placed in a suitable and sterile environment. We also added a small room represented by a small incubator inside the mother incubator to ensure placing more than one sample and separating them without affecting one over the other, thus saving time and money.

It is possible to add a sample of bacteria in a small incubator and blood samples in a large incubator under suitable conditions for both.

Experiments have shown that the glass is permeable to ultraviolet rays and that it works efficiently without problems at a temperature of 37 °C, which is the temperature of the human body.

Ease of temperature control, as the incubator is designed to provide an environment similar to that of the human body, and the average temperature ranges from 36.1 to 37.2

5-2 Recommendations

- ✓ Use a timer clock for the UV system.
- ✓ Developing types of sensors to read the temperature and taste.
- ✓ Reduce risks and get better results.

- ✓ Incubator capacity and size in terms of the number of samples that accommodate.
- ✓ Provide filters to reduce pollution and keep pace with scientific progress.
- ✓ Provide a camera inside the incubator to monitor the work.
- ✓ Remote control of the incubator.
- ✓ Add an external source to increase energy in case of emergency.

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