Course – M. Sc. Botany Part 1 Paper III

Topic – KOCH'S POSTULATES

&

HOT WATER TREATMENT

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ROBERT KOCH

- Robert Koch, a German scientist born in 1843-1910) is considered by many to be the founder of bacteriology.
- As the District Medical Officer, one of Koch's primary concerns was the prevalent occurrence of anthrax among farm animals in his area.
- He was the first to show, in 1876, that anthrax, a disease of sheep and other animals, including humans, was caused by a bacterium that he called Bacillus anthracis.
- subsequently discovered, in 1882, tuberculosis and in 1883, cholera, each caused by a different
  bacterium, which led to the general conclusion that each disease is caused a specific microbe.
- These experiments confirmed for the first time the germ theory of disease proposed earlier by Louis Pasteur.
- After converting his 4-room home into his own medical laboratory stocked only with a single microscope, Koch set to determining the cause of this virulent disease.
- Koch perfected his methods of diagnostics and expanded on the work of others.
- Koch invented the method of cultivating bacteria on nutrient mediums, using potatoes as his source of nutrients for bacteria, and created a medium that could be stored in dishes created by his colleague Petri.
- Koch's work on diseases and diagnostics culminated with the creation of what are now known as Koch's Postulates.
- Koch's Postulates are the 4 steps necessary to confirm if a suspected pathogen is indeed the cause of a disease.

ROBERT KOCH'S HYPOTHESIS

- Koch hypothesized that anthrax bacillus, a gram-positive bacterium, was the cause of the anthrax disease.
- Koch proved his hypothesis correct by infecting mice with the bacillus strains taken from the spleens of animals who died from the disease.
- When the infected mice showed identical symptoms, Koch proved his hypothesis correct.
- Koch then sought to prove that anthrax that had no prior contact with animals could cause the same disease when introduced to an animal host.
- Koch grew the bacilli in pure cultures over several generations; he then showed that they could still cause anthrax in later generations.

KOCH'SPOSTULATES

- Koch's postulates have been critically important in establishing the criteria whereby the scientific community agrees that a microorganism causes a disease.

- Robert Koch's postulates, published in 1890, are a set of criteria that establish whether a particular organism is the cause of a particular disease.
- The four postulates are:

1. The suspected causal organism (other microorganism or) bacterium must be found in abundance in all organisms suffering from the disease, but not in healthy organisms.
2. The microorganism must be isolated from a diseased organism and grown in pure culture
3. The cultured microorganism should cause disease when introduced into a healthy organism.

4. The microorganism must be re-isolated from the inoculated, diseased experimental host and identified as being identical to the original specific causative agent.

Koch's Postulates may be summarized as:

1. A microorganisms are isolated from dead animals.

2. Microorganisms are grown in pure culture.

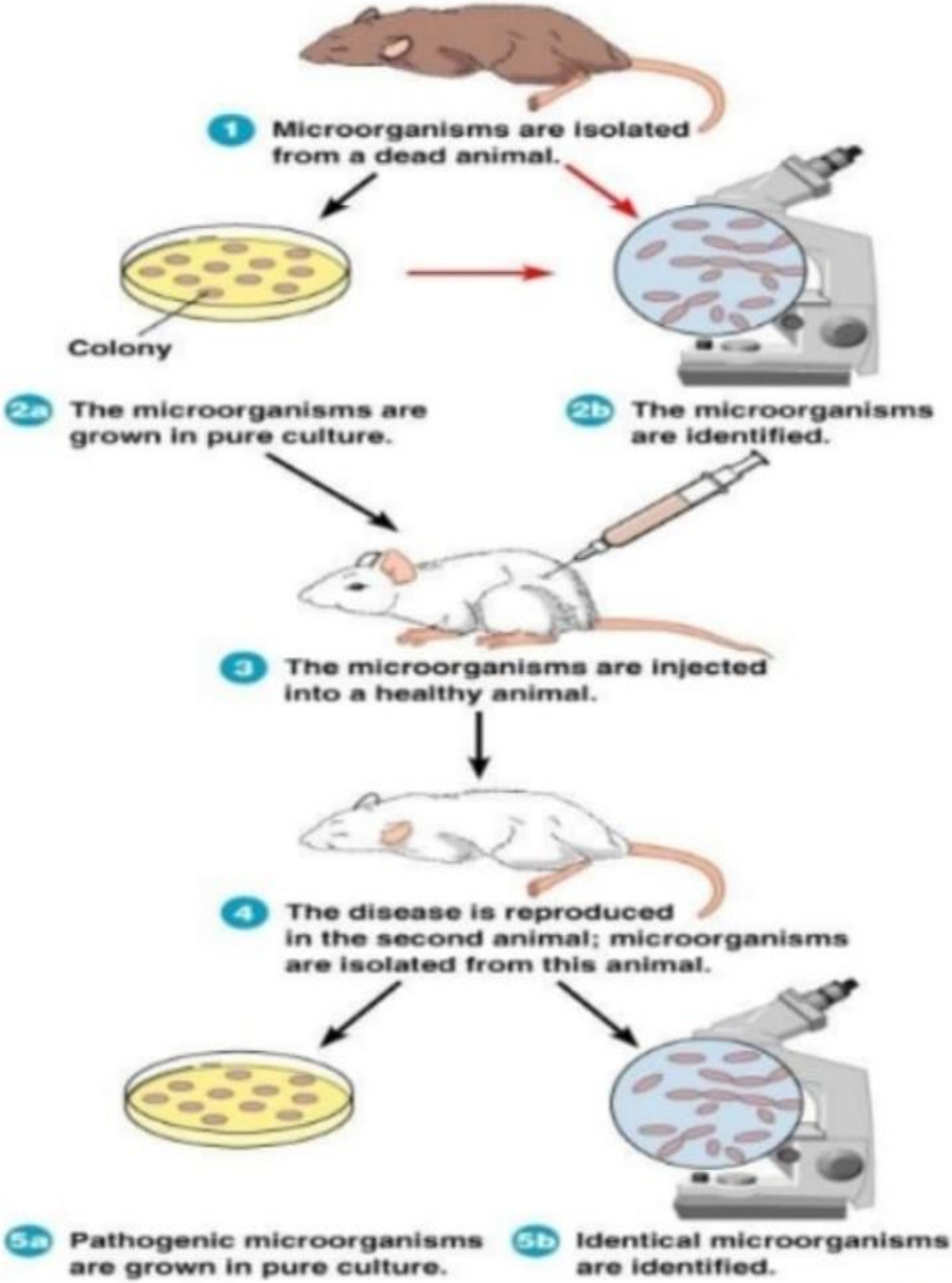
2b. Microorganisms are identified.

3. Microorganisms are injected into healthy animals.

4.Disease is reproduced in second animal.

5.Microorganisms are grown in pure culture.

5b. Identification of identical microorganism.


1 Microorganisms are isolated from a dead animal.
Colony
2a The microorganisms are grown in pure culture.
2b The microorganisms are identified.
3 The microorganisms are injected into a healthy animal.
4 The disease is reproduced in the second animal; microorganisms are isolated from this animal.
5a Pathogenic microorganisms are grown in pure culture.
5b Identical microorganisms are identified.

Limitations of Koch's Postulates:

- However, Koch's postulates have their limitations and so may not always be the last word. They may not hold if:
- The particular bacteria (such as the one that causes leprosy) cannot be "grown in pure culture" in the laboratory means, some microorganisms are unable to be cultured on artificial media (example: Treponema pallidum).
- There is no animal model of infection with that particular bacteria.
- A harmless bacterium may cause disease if:
  - It has acquired extra virulence factors making it pathogenic.
  - It gains access to deep tissues via trauma IQ, surgery, an IV line, etc.
  - It infects an immunocompromised patient
- Not all people infected by a bacterium may develop disease-subclinical infection is usually more common than clinically obvious infection.
- Some times 2 or more organism work in synergy to cause a disease.
- Symptoms and diseases can be causes by any one of several microbes.
- A single pathogen can cause several disease conditions.

Conclusion:

- Despite such limitations, Koch's postulates are still a useful benchmark in judging whether there is a cause-and effect relationship between a bacterium (or any other type of microorganism) and a clinical disease.
- He is established that specific disease are caused by specific germs (Germs theory of disease).
- He won noble prize for medicine in 1905 for his investigations and discoveries in relation to tuberculosis.

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Heat treatment may be applied for agricultural commodities by:

1.Immersion in hot water

2. Exposure to vapour heat

3. Exposure to hot dry air

4. Infra-red radiation treatment

5. Microwave radiation

Hot water treatment:

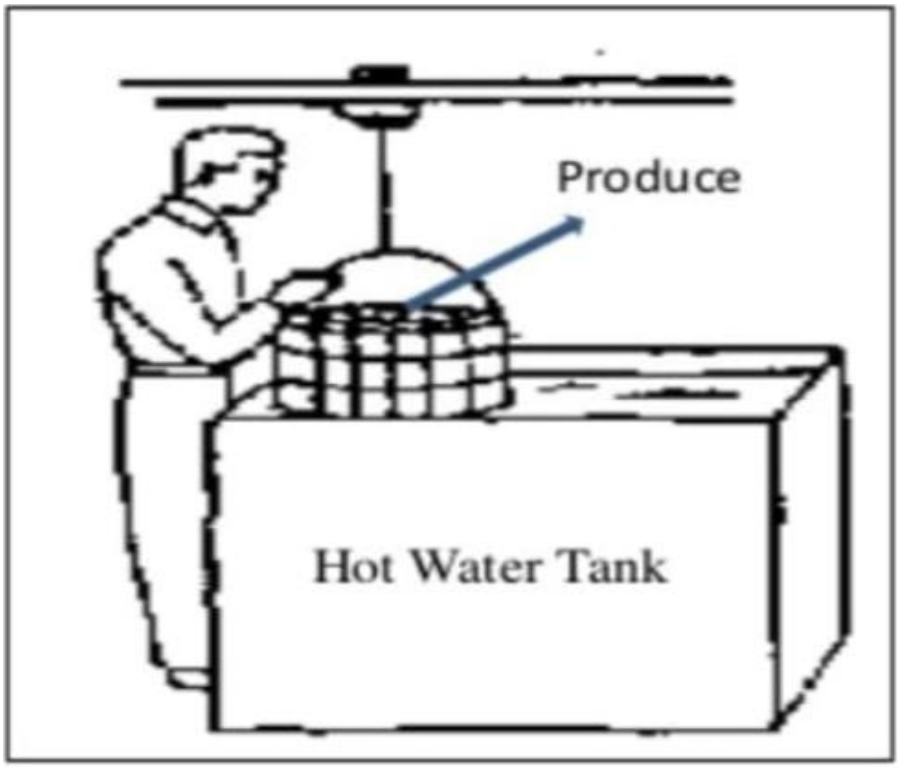
- In present day agriculture, use of chemicals for crop production is discouraged and other alternative method for disease control must be developed, hot water treatment is one of them.
- Temperature and duration of treatment differs from crop to crop.
- Hot water soaking is a very age-old practice and very efficiently destroy pathogens borne both outside the testa and inside the seed testa.
- By maintaining the temperature, the organisms or pathogens are killed and the seeds or the different plant materials are saved.
- Hot-water seed treatments are effective because hot water soaks into the seed for a brief time and kills disease-causing organisms, without killing the seed itself.
- This treatment is also successful for destroying viruses like mosaic virus that affect bell pepper.
- This treatment is used for treating pests or pathogens of following:
    - Seeds
    - Vegetables
    - Fruits
    - Bulbs
    - Nursery stock
- It is also used for diseases caused by various means or vectors:
    - Bacteria, (Bacterial spot, caused by Xanthomanas compestris)
    - Virus, (Mosaic virus)
    - Nematodes, (Ditylenchus dipsaci)
    - Fungi, (Loose smut)
    - Insects and Mites
- Hot water treatments were first reported in 1922 to control decay on citrus fruit (Fawcett, 1922)
- It can also be used in:
    - Pre storage
    - Post-harvest disease
    - Post-harvest decay

Methods of Hot Water Treatment:

1. Hot Water Immersion (HWI)
2. Hot Water Rinsing & Brushing (HERB)

Hot water immersion (HWI):

- ❖ Main components of a hot water immersion unit are;
    - Treatment tank
    - Heat exchanger unit
    - Water circulation system
    - Temperature controller

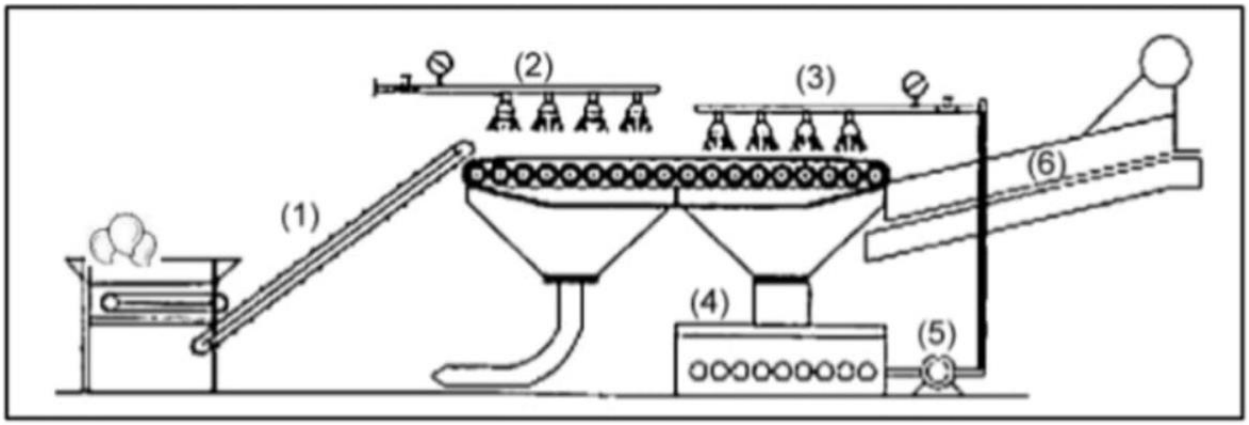


Hot water immersion (HWI)

Hot Water Rinsing & Brushing (HERB):

- ❖ To clean and disinfect fresh harvested produce.
- ❖ First introduced commercially in 1996
- ❖ Components are;
    1. Conveyor belt
    2. Tap water rinsing and brushing unit

3. Hot water rinsing and brushing unit (Water is recycled)
4. Hot water container
5. Water pump to pressurize and recycle the hot water
6. Forced-air dryer



Hot Water Rinsing & Brushing (HERB)

- First introduced commercially in 1996

Hot water brushing:

- An alternative method to SO2 fumigation for colour retention of litchi fruits.

Hot water treatment in Fruits:

- Hot water treatment is a common method to control postharvest diseases in fruits, but the temperature and treatment duration can have a marked effect on the color, appearance and eating quality of rambutans.
- Hot water treatment-fruits are immersed in hot water before storage or marketing

Hot water treatment in Vegetables:

- It can use to eradicate, or at least reduce commercial the level of pathogens (particularly bacterial pathogens), in vegetable seed.
- Some vegetable seed routinely use this method (as well as other more stringent decontamination methods) to eradicate pathogens.

Hot water treatment in Seeds:

- Hot-water seed treatment works best for small seed.

- ❖ It is not as effective for large or extremely fragile seed, pelleted seed, primed seed (i.e., seed treated to speed germination), fungicide-treated seed, old seed.
- ❖ Temperatures and durations will vary depending on the particular crop.
- ❖ Hot-water treatment of seeds is used against the following diseases:
    - Anthracnose; bacterial blight; bacterial leaf streak; bacterial spot; black rot; black leg; black scurf; black spot; common blight.
- ❖ Hot-water treatment of seeds can be used for the following crops:
    - Spinach; brussels sprouts; cabbage; pepper; tomato; eggplant; broccoli; cauliflower; carrot; collard; kale; kohlrabi; turnip; mustard; cress; radish; lettuce; celery; celeriac; banana; mango.
- ❖ Hot-water treatment can be used against the following pests:
    - Fruit flies (on mango fruits) / Banana weevil/ Mealybugs (cassava and pineapple) / Nematodes (banana suckers and pineapples)

Hot water treatment used in Quarantine:

- ❖ Hot water treatment or hot air treatment are also used in quarantine for eradication of insects, mites, nematodes, fungi, bacteria, and viruses.
- ❖ The basic principle involved is that treatment temperature should be sufficiently high to kill the associated pest/pathogen but not the host.
- ❖ However, in most cases, the margin of safety is very narrow and, therefore, the temperature should be very accurately controlled.
- ❖ Some recommended hot water treatments:

1. Against nematodes: Flower bulbs, 44°C for 240 min; chrysanthemum, 48°C for 25 min; potato tubers, 45°C for 5 min;
2. Against insects and mites: Narcissus bulbs, 44°C for 180 min; strawberry runners, 46°C for 10 min;
3. Against viruses: Grape vine, 45°C for 120–180 min; sugarcane sets, 50°C for 120 min.; potato tubers, 50°C for 17 min;
4. Against fungi: Celery seed, 50°C for 25 min; wheat seed 52-54°C for10 min.

Importance:

- ❖ Most appropriate treatment with respect to least damage, economy, efficiency and application.
- ❖ Useful for low volume high value seed.
- ❖ Effective for internally associated fungi and bacterial pathogens.
- ❖ It is a feasible practice, both financially and time wise
- ❖ Farmers, along with a little technical assistance, can easily adopt this treatment.
- ❖ This is classical thermophysical method of plant protection and are eco-friendlier and more effective.