Final Report of Training for 2nd Year Heart University Food Technology Bridge Program  
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Training Overview: Various food storage and food preservation techniques that can be used to maintain the quality of fruits and vegetables was covered in this training. This included thermal processing, drying, salting, juice making, fermenting, and vinegar production. Food samples were plated for enumeration of total bacteria, total coliforms, yeasts, and molds both before and after the preservation techniques were done to assess overall quality of the products. The importance of water quality, proper use of pesticides, good agricultural practices, and postharvest storage techniques to ensure the safest and highest quality fruits and vegetables are produced were also covered in the training. Various fruits and vegetables collected from the market were assessed for pesticide residue. In addition, water samples from crop irrigation sources (i.e. agricultural water) were tested for total coliforms, _E. coli_, nitrates, nitrites, pH, arsenic, phosphate, pesticide residues and lead. The students worked in groups to make a poster that is displayed at HUFA and that can also be displayed when working with both growers and consumers. This poster emphasized the importance of good agricultural practices, water quality, and postharvest storage to ensure the highest quality fruits and vegetables are produced. In addition, the students presented a research seminar to HUFA faculty and students to discuss their research on assessing drinking and agricultural water quality in Heart, Afghanistan.

Learning Objectives:
- To learn what causes food spoilage and how it can be prevented.
- To understand the importance of good agricultural practices, water quality, and the use of pesticides for the production of fruits and vegetables.
- To learn the concept of thermal processing, drying, salting, pickling, candying, and fermentation that can be used as a preservation technique for fruit and vegetables.
- Understanding the importance of postharvest storage and various conditions that can influence the overall quality of the stored products.

Week 1 Water Quality Testing:
The students tested agricultural water samples that were collected from various locations in Herat Province. The water samples were tested for total coliforms, *E. coli*, nitrates, nitrites, pH, arsenic, phosphate, pesticide residues and lead. Following collection of the data, the students prepared a poster that was printed and can be displayed at HUFA (Figure 1). The students also prepared a PowerPoint presentation and gave a research seminar to HUFA faculty and students that discussed the results of their research projects (Figure 2-6). The students learned how to prepare and present a PowerPoint presentation as well as how to make a poster to disseminate scientific data.
Figure 1: Poster Food Technology students prepared to discuss the research they performed to determine the agricultural and drinking water quality in Herat Province.
Figure 2: HUFA students preparing samples for testing.
Figure 3: HUFA students preparing samples for testing.
Figure 4: HUFA student presenting their research to faculty and students.
Figure 5: HUFA student presenting their research to faculty and students.
Week 2 Techniques in Food Preservation and Food Processing:

The following is an overview of topics that were covered in both lecture and lab for the training:

**Lecture Topic: Food spoilage: Causes and Prevention**
- What is food spoilage
- Defining microorganisms and the factors that affect their growth
  - Microorganism growth on different fruits and vegetables
  - The types of microorganisms that grow on specific products
  - How do the microorganisms impact the fruit and vegetables
  - Negative effects of microorganisms in food
- Importance of water for growing, cleaning, and washing fruits and vegetables
- Pesticide residue and the impact on human health

**Lab Topic:** Enumeration of microorganisms from fruit and vegetables (Figure 7).
- Fruit, vegetable, and grain samples were acquired from several local markets.
- The students enumerated total bacteria, coliforms, *E. coli*, yeasts, and molds using Petrifilm.
• These data provided insight into the microbial quality of fresh fruits and vegetables before a preservation technique was used to extend the shelf-life of the products.
• Testing of water quality for total coliforms, *E. coli*, nitrates, nitrites, pH, arsenic, phosphate, pesticide residues and lead. The testing was done throughout the training to ensure as many water samples as possible were processed.

Figure 7: HUFA students preparing food samples for enumeration of total bacteria, coliforms, yeasts, and molds.

**Lecture Topic: Thermal processing as a means of food preservation**
- Defining what thermal processing is and how it preserves the food
- Advantages and disadvantages to thermal processing
- Difference between pasteurization and sterilization
- Importance of packing volume
- The use of tin, glass, and plastic as a packing container
- Sterilization in a boiling water bath, pressure cooker, and autoclave
- Storage and consumption
- Examples spoiled products that are not thermally processed correctly

Lab Topic: Heat preserving fruits, vegetables, and juice (Figure 8-10)
The same type of fruits and vegetables used to determine initial microbial quality were used for heat preserving. These samples were prepared and canned using the boiling water bath method.

The students extracted juice from various fruits and learned how to can it using the boiling water bath method (Figure 11).

The following morning the students enumerated total bacteria, coliforms, *E. coli*, yeasts, and molds using Petrifilm from these samples to determine the log reduction in microorganisms present in the samples.

Figure 8: HUFA students preparing food samples for canning.
Figure 9: HUFA students preparing food samples for canning.
Figure 10: HUFA students preparing vegetables for canning.
Lecture Topic: Drying as preservation method for fruits and vegetables
- Overview of the principles of drying.
- Quality of fresh products used for drying
- Preparation of products for drying
  - Washing and cutting
  - Blanching
  - Osmotic drying
  - Use of preservatives
- Drying methods
  - Natural open air drying
  - Artificial drying
Examples of different drying methods
- Techniques to determine when a product is finished drying
- Consuming dried products
- Examples of dried products

Lab Topic: Drying fruits and vegetables (Figures 12-15)
- The same type of fruits and vegetables used to determine initial microbial quality were used for drying as a method of preservation. The students used both solar drying as well as drying using a heat source.
- The following morning the students enumerated total bacteria, coliforms, \textit{E. coli}, yeasts, and molds using Petrifilm from these samples to determine the log reduction in microorganisms present in the samples.

Figure 12: Solar dryer that was constructed by HUFA students.
Figure 13: Solar dryer containing fruit and vegetables that will be dried to increase the shelf-life of the product.
Figure 14: HUFA students sampling dried fruit and vegetables that were dried in the solar dryer.
Figure 15: HUFA students sampling dried fruit and vegetables that were dried in the solar dryer.

Lecture Topic: Preserving fruits and vegetables using salt, vinegar, and candying
- Overview of salt and/or vinegar as a preservation method
- Preserving with heavy salting and brines
- Preserving with small amounts of salt and brine
- Requirements for salting to ensure food safety
- Overview of preservation using vinegar
- Overview of candied fruit and jams

Lab Topic: Preserving fruits and vegetables using salt, vinegar, and candying (Figure 16-17)
- The same type of fruits and vegetables used to determine initial microbial quality were used for salting (both heavy and light salt and brines), pickling, and candying.
- The following morning the students enumerated total bacteria, coliforms, *E. coli*, yeasts, and molds using Petrifilm from these samples to determine the log reduction in microorganisms present in the samples.
Figure 16: Recipe HUFA students followed to candy orange peel.
Figure 17: Recipe HUFA student followed to preserve cucumbers by pickling.
Lecture topic: Fermented foods and postharvest storage methods

- Overview of the fermentation process
- Benefits of fermentation
- Example of products that are fermented
- Methods of postharvest storage
  - Importance of drying before storage
  - Benefits of hermetic storage
  - Production of mycotoxins
  - Best practices when storing preserved foods

Lab Topic: Making sauerkraut and testing nuts, dried fruits, pulses, and grains for mycotoxins (Figure 18)

- The students will learn about fermentation by making sauerkraut that they can take home to allow the fermentation process to be completed.
- Rapid aflatoxin test kits will be used to determine the presence of these toxins in nuts, dried fruits, pulses, and grains obtained from various markets. The students will be divided into groups and each group will test several samples.
Sauerkraut is naturally fermented cabbage. Natural fermentation is one of the oldest ways of preserving food. When salt is added to shredded cabbage, it causes juice to be extracted from the shredded cabbage. This juice contains fermentable sugars. Microorganisms naturally present on the cabbage leaves will, in the absence of oxygen, use these sugars to produce lactic acid. The acid will preserve the cabbage.

It is very important to use the correct amount of salt so that fermentation can take place. Sauerkraut is a salty food. People who must restrict their sodium intake need to take into account the high salt content of sauerkraut when planning their meals. Do not try to lower the sodium content of sauerkraut by adding less salt to the fermentation mixture. The cabbage will spoil rather than ferment. Instead, try rinsing the fermented kraut in cold water before eating it to remove some of the salt.

Although sauerkraut is traditionally made from regular green cabbage, you can make good kraut from red cabbage, too. The red cabbage may be a bluish-purple color at the beginning of the process, but the pigments will change to red/purple as the fermentation progresses and acid is formed.

If you want to make sauerkraut from Alaska's giant cabbages, you can, but it may take some extra work to get this cabbage shredded evenly. The leaves, especially the outer ones, may be tough on these very large cabbages. It is difficult to shred tough leaves to produce pieces that are of uniform size. Uneven size pieces could result in uneven fermentation. If the leaves are tough, try removing the veins and cutting the more tender, veinless leaf pieces with a knife. (If you cut them into small pieces, those tough veins can be used to make a good coleslaw.)

**Making Sauerkraut**

**Large Amount of Cabbage**

*(Yield: about 9 quart jars)*

- 25 pounds cabbage
- 7/4 cup canning salt

- Discard outer leaves. Rinse cabbage heads under cold water and drain. Cut heads in quarters and remove cores.

- Shred or slice to a thickness of a 25-cent coin or thinner. A meat slicer works well, if you have one. You may also use a food processor or food grinder. The shredded product will look a little different, but that will not affect its ability to ferment. (Not all food processors/grinders will give an even shred. You may have to shop around to find one that works well for cabbage.)

- Weigh cabbage. Put 5 pounds of shredded cabbage into a large mixing bowl or pan. Sprinkle 3 tablespoons canning salt (monodized) over the cabbage. Let salted cabbage stand 5 to 10 minutes to wilt slightly. This will help to draw the juices out. Then mix well with clean hands.

- Transfer the salted cabbage to a suitable fermentation container. Pound cabbage firmly with a wooden tamper or spoon (or press firmly with clean hands) until enough juices are drawn out to cover the cabbage.

Figure 18: Recipe HUFA used to ferment cabbage to make sauerkraut.