

COURSE OBJECTIVES

- **To learn the physical and thermophysical properties of food and agricultural materials.**
- **Understand the science and engineering concepts for characterizing the physical and thermophysical behaviours of food and agricultural materials.**
- **To learn the requirement of engineering properties of materials for analysis and design of agricultural, food and biological systems.**

LEARNING OUTCOMES

At the end of the course, students should be able to

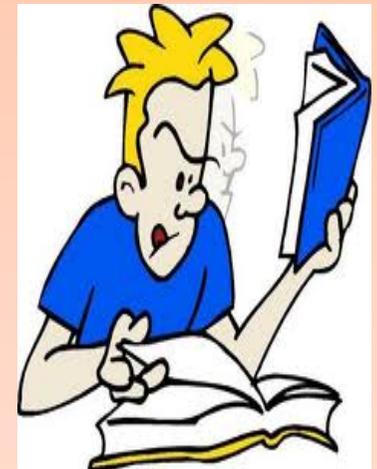
- 1) identify engineering properties of food and agricultural materials**
- 2) explain related measurement methods**
- 3) relate engineering properties of food and agricultural materials to process design and quality control**

TOPICS

1. **Physical properties**
2. **Chemical properties**
3. **Mechanical properties**
4. **Rheological properties**
5. **Frictional properties**
6. **Aerodynamic and Hydrodynamic properties**
7. **Thermal properties**
8. **Electromagnetic properties**

Why are you taking this course?

- Raw food materials are biological and have certain unique characteristics.
- Food and feed undergo various unit operations from pre-harvest to post harvest processing, formulation, preservation, packaging, storage distribution, domestic storage and finally consumption.
- During all those processes, the properties of biological (food and agricultural) material will be changed.
- An understanding of the engineering properties of biological material are important in order to solve problems while designing and selecting the modes of preservation, packaging, processing, storage, marketing and consumption.



Engineering Properties

Introduction

Any attribute affecting the processing or handling of a biological material can be defined as an engineering property

- They are divided into the following categories:

Physical properties (Structural and Geometric Properties)

Chemical properties

Mechanical properties (Strength properties)

Rheological properties

Frictional properties

Aerodynamic and hydrodynamic properties

Thermal properties

Electromagnetic properties

-Various food processing methods can potential alter those properties and cause desirable or sometimes not so desirable changes in nutrient profiles, texture, color, taste, aroma and other quality attributes.

1. Physical properties

- Shape, size, volume, surface area, density and porosity
- Knowledge on some of physical properties is necessary for the design of various separating, handling, storing and drying systems.

2. Chemical properties

- Focus on chemical compositions and moisture content
- Knowledge on the composition of biomaterials is useful for estimating densities and thermal properties.

3. Mechanical properties

- Focus on strength properties and testing such as compressive strength and deformation

4. Rheological properties

- Focus on food texture and rheological characterization
- Knowledge of rheological properties of various food systems is important in the design of flow processes for quality control, in predicting storage, and in understanding and designing texture.

5. Frictional properties

- Coefficient of friction, angle of internal friction and angle of repose
- Angle of repose and coefficient of friction are important in designing equipment for solid flow and storage structures.
- Angle of internal friction between seed and wall in the prediction of seed pressure on walls.
- Coefficient of friction is also important in designing storage bins, hoppers, chutes, screw conveyors, forage harvesters, and threshers.

6. Thermal properties

- These properties are involved in almost every food processing operation.
- Such as specific heat, thermal conductivity and thermal diffusivity
- Knowledge of these properties helps in designing thermal process and calculating thermal load for canning, sterilization, pasteurization, cooking and many other processes.

7. Aerodynamic and Hydrodynamic properties

- Terminal velocity and drag coefficient of agricultural products are important in designing of air/hydro conveying systems and separation equipment.
- Air is often used as a carrier for transport or for separating the desirable products, therefore terminal velocity and drag coefficient are needed for air conveying and pneumatic separation of materials.

8. Electromagnetic properties

- Dielectric constant, dielectric loss factor and penetration depth
- Dielectric properties is important in determining the interaction between the food material being processed and the electromagnetic energy.
- Useful in designing and controlling thermal processing and moisture content determination.

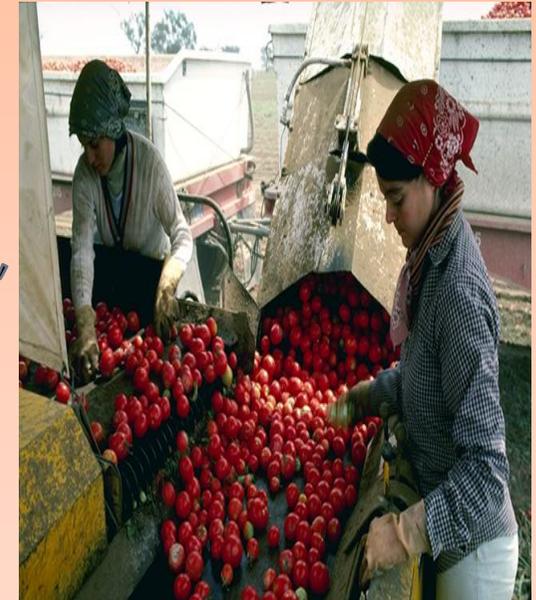
Applications

- Understand the way biological food materials respond to physical + chemical treatment to allow for optimum design of food equipment + processes to ensure food quality + safety
- Knowledge of an engineering properties of biological/food material is necessary:
 - 1) Defining quantifying a description of the biological / food materials.
 - 2) Providing basic data for food processing + unit operation
 - 3) Predicting behaviour of new food material.

The relation of engineering properties of biological material to food processing

Example : post harvest

- 1) Handling and transportation
 - Materials harvest different size, shape, density
 - Sorting + grading operations can aid by removing oversize, undersize, and over quality.
 - * How to distinguish it?
 - * Why required to sort it?



- During handling – can kernel damage could happen? How to control ?
Proper equipment design
- How to maintain the quality of food during transportaion?
- Storage + market value of the material?
Need to know moisture content + protein

How to measure it?

- Seed planting – one kind of seed or many kinds of seed
- Need to know the size + shape for plate design



Transformations to food product

- a) Wheat to flour
Need to know the kernel hardness
for grinding
How to measure it?
- b) Baking
The process – deformation of
characteristics of dough and
finished loaf



Proofer



Baking

c) Food processing into juice
Juice yield as compression time.

d) Fruit juice/ puree

- juice is Newtonian
- puree is non-Newtonian

Info need to
determine
flowrate through
pumping
equipment

