Description of Module	
Subject Name	Food Technology
Paper Name	Unit Operations in Food Processing
Module Name/Title	Introduction to Unit Operations and Processes
Module Id	FT/UOFP/1
Pre-requisites	nil
Objectives	To know the role of food technologist, the definition of process and unit operations
Keywords	Food technologist, process, unit operation, flow chart

Introduction to Unit Operations and Processes

1.1 Introduction

Food technologists apply science to convert raw materials in to healthy, safe, palatable and convenient consumable food products. They apply engineering principles in research and development, production technology, quality control, packaging and processing to develop new food products for the society. The job of a food technologist is enormous. It starts from the quality control of raw materials in the supplier's factory through the manufacturing processes till consumption of finished products. Food technologists design the processes; modify the existing processes according to the need of the raw materials interactions to processing parameters and intended quality attributes desired in the food products. So, food technologist should have adequate knowledge on the processes and unit operations adopted in food processing so that they can manipulate the system as per the requirement of the product concerned. This module will help the students understand the terminologies like process, unit operation and get acquainted with the unit operations involved in development of food products in day to day life according to the need of the mankind.

1.2 Process

A process may be defined as a set of activities or operations which take place in manufacturing equipments; bring about a series of physico-chemical and biological changes in the raw food materials and as a result useful consumable products are derived. The products thus obtained are considered to be safe for consumption with greater market acceptability and enhanced storage stability, ease in handling and transportation. As for example, tomatoes are harvested from the field, the size and colour of each tomato varies from one another i.e. there is no uniformity in shape, size and colour. There may be chances of surface contamination by foreign matters like soil, leaves, pesticides etc. The tomatoes harvested from the field are not safe for use in cooking. So to make it

safe we adopt some processes like cleaning, sorting, blanching etc. The marketability of tomato can be increased by sorting and grading of tomatoes before sending them to supermarkets. If we want to preserve the perishable tomato for long time, we transform them physically and chemically to make products like pickles, puree/ketchup etc. The processes involved in transformation are peeling, deseeding, crushing, pulping, heat treatment etc.

Food processing is concerned with the processes involved in the development of food products. It requires a thorough understanding about the processes, principles of operations to transform raw materials physically, chemically and biochemically in to desirable products. Moreover, the processes are manipulated by changing the parameters like machine specifications and environmental conditions inside the machine (temperature, pressure, humidity etc.).

1.3 Process Flow Chart

The *flow charts*, also called as *flow diagrams* or *flow sheets* are the graphical representation of the processes. In short, a flow diagram shows the major operations of a process in sequence and the flow of raw materials along with the products and byproducts derived from the process. The processes are represented in schematic flow charts where each processes are written inside a 'rectangle' or 'box'. Therefore, the flow diagrams are also called as *block diagrams*. The series of processes that indicate the manufacturing steps are connected with arrow marks representing the direction of flow of feed materials. Additional information on processes like process conditions viz. temperature and pressure etc. and flow rate of feed material may also be given with the flow diagrams. Figure 1.1 shows a typical flow chart showing the food processes used during manufacture of tomato ketchup.

Another type of representation of a food process is, the equipments used for doing a particular operation are presented in pictorial view. This representation provides much detail information about a process. The standard symbolic pictures of important equipments are given in fig 1.2.

Other way of representing the process is by use of custom symbols that resembles like the original equipment. The drawing of this kind of *equipment flow chat* is difficult to some extent. Process piping is schematically added to the equipments kept in sequence, of course the layout of the equipments is not to the scale. An equipment flow chart of soy protein isolate manufacturing process is given in fig 1.3.

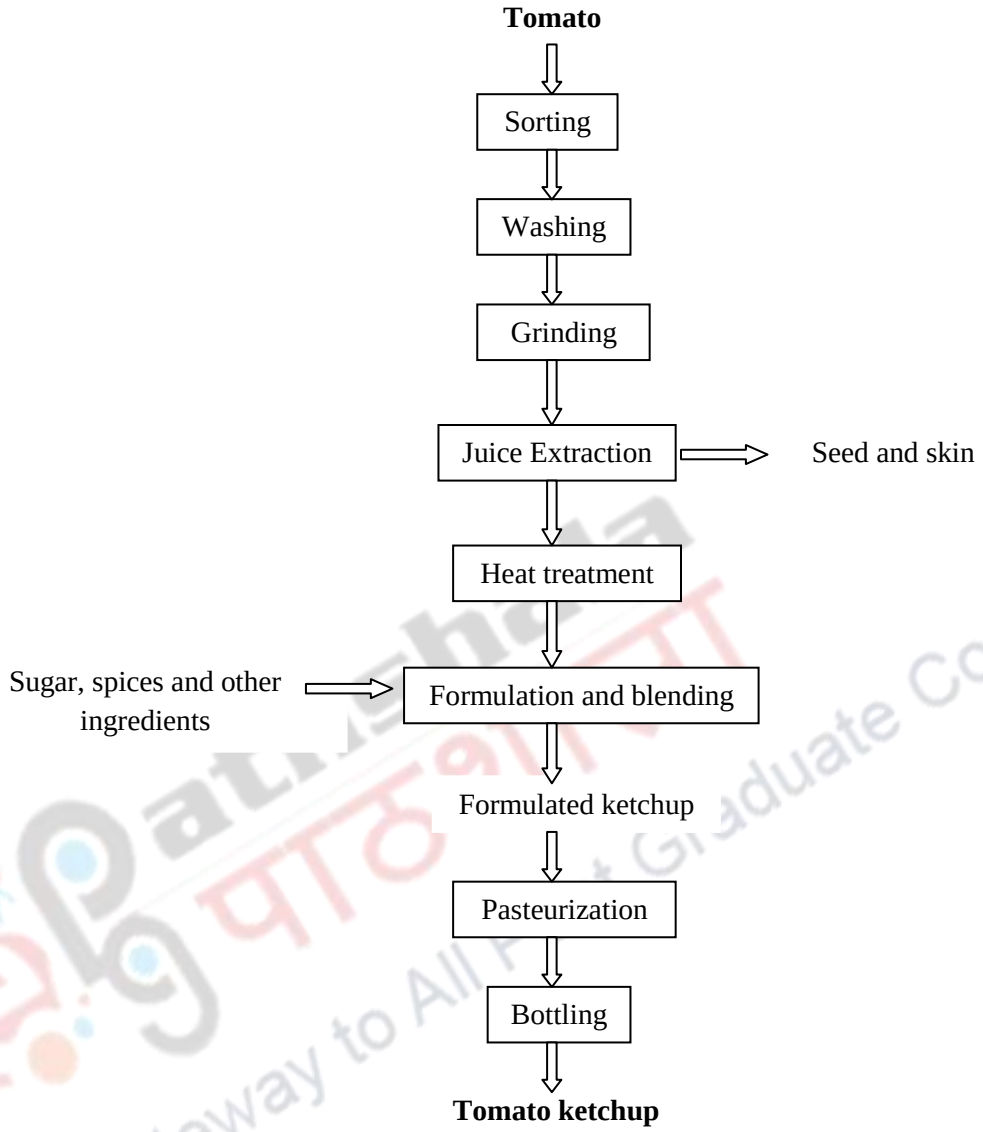

Figure 1.1 Process Flow Chart for preparation of Tomato Ketchup

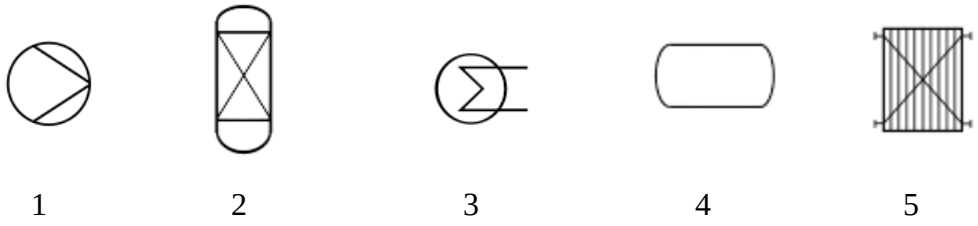

Figure 1.2 Some common symbols used in process flow charts: 1: Pump; 2: Packed column; 3: Heat exchanger; 4: Pressure vessel (Horizontal); 5: Plate and Frame heat exchanger

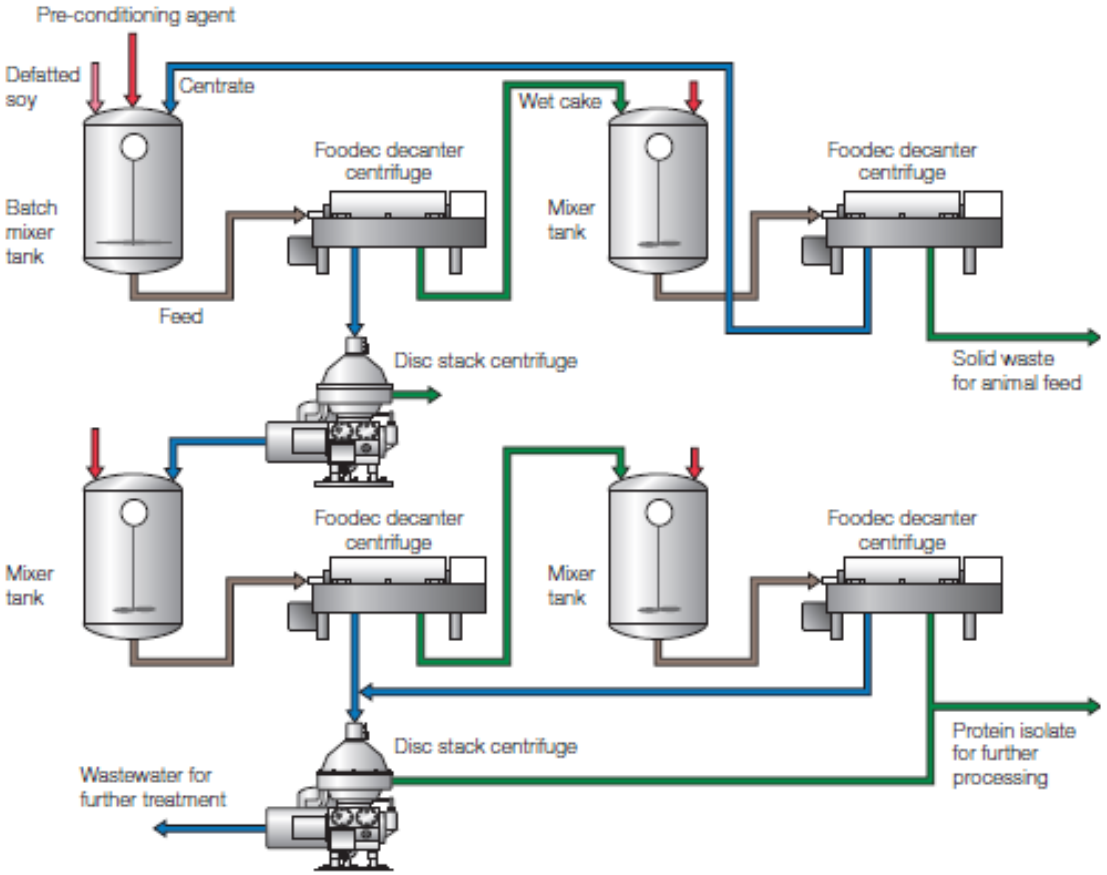

Fig. 1.3 An equipment flow chart of soy protein isolate manufacturing system (Courtesy of Alfa Laval)

1.4 Unit operations

A set of processes working with a common scientific principle are clumped together for ease in understanding in the study of food processing. The basic operations involved in these processes are called unit operations. Food processes are associated with diversed activities, but if we carefully analyse them, complicated and differing processed can be broken down to number of small unit operations. For example, heating for instances is used in food industries for numerous purposes required by the food material. Milk needs to be heated to pasteurization temperature to kill all the pathogenic microorganisms. Meat products are frozen to keep them protected from harmful external agents. Fruit products require a mild heat treatment called blanching before further processing to remove the foreign matters and microbial contamination at the surface level. In all the above three cases consideration is given to the extent of heating or cooling to accomplish a defined purpose at different conditions. Thus, this physical process qualifies to be called as a unit operation named 'heat transfer'. A unit operation is dependent on certain physical principles. So, a unit operation is

described with the help of a set of quantitative relationships in the form of mathematical equations. A process can be monitored, controlled or modified with the help of these equations.

1.4.1 Classification of Unit operations

Food products go through different transformation stages for different outcome. Milk is dried to form milk powder. The same milk is fermented to make curd/yoghurt. When acid is added to milk, it gives us cottage cheese. In first case, the change is physical where water is removed by heat treatment. In second case, milk undergoes some biochemical changes by the action of starter microorganisms. Conversion of milk to cheese is a chemical process. So, all the unit operations are broadly classified into three categories.

a. Physical: milling, grinding, sieving, mixing, fluidization, sedimentation, flotation, absorption, adsorption, extraction, rectification, evaporation, drying, extrusion etc.
b. Chemical: coagulation, refining etc.
c. Biochemical: fermentation, pasteurization, sterilization, enzymatic peeling etc.

Depending on the transferred properties, foods undergo transformation due to mass, energy or velocity differences. So, the unit operations are also grouped into following categories.

- Fluid flow processes: fluidization, filtration, sedimentation, liquid transportation etc.
- Heat transfer processes: evaporation, drying, concentration etc.
- Mass transfer processes: absorption, distillation, adsorption, extraction etc.
- Thermodynamic processes: gas liquefaction, refrigeration etc.
- Mechanical processes: crushing, pulverization, solid transportation, sieving etc.

In any kind of unit operation, the basic theory is the separation of different components or mixing of these components in homogenous or heterogeneous agricultural products or the transfer of one component to other based on some gradient. To achieve this objective different external agent act on the system that differs according to transferred properties.

Besides, some unit operations such as humidification etc. are complicated in nature wherein simultaneous heat and mass transfer take place. They cannot fall in any categories and are called as complementary unit operations.

The detail discussion on each unit operations will be done in subsequent modules.

1.5 Summary

The role of a food technologist is enormous. It starts from the harvesting of raw food materials, passes through various processing, thus giving a finished product of good sensory attributes, nutritious, healthy, palatable consumable food. Being a food technologist, one needs to have thorough knowledge on the processes used in food processing and the scientific principle lying behind each process. Unit operations which are a set of processes with common scientific principles help in the design of a process by using the mathematical equations of interactions of different parameters involved. These unit operations are classified as biological, chemical or physical operations. In terms of transport of components of a food system, one can categorize them as fluid flow, heat, mass, thermodynamic or mechanical processes.

References:

1. *Unit operations in food engineering*, Albert Ibarz and Gustavo V. Barbosa-Canovas, CRC Press,1st edn., 2003.
2. *Unit operations in food processing,* R.L. Earle and M.D. Earl, NZIFST (Inc.) Publ., 1983.