International Journal of Home Science 2020; 6(2): 85-89

International Journal of Home Science

ISSN: 2395-7476
IJHS 2020; 6(2): 85-89

www.homesciencejournal.com
Received: 25-03-2020
Accepted: 30-04-2020

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Basics of food science and technology: Today tomorrow and yesterday

Dr. Shuchi Mittal

Abstract
Food science is a study of understanding of the changes that occur in food components during food preparation whether natural or induced by handling procedures. Food science can be defined as the application of the basic science and engineering to study the fundamental physical, chemical and biochemical nature of foods and the principles of food processing. Food technology is the use of the information generated by food science in the selection, preservation, processing, packaging and distribution as it affects the consumption of safe, nutritious and wholesome food. It is a broad discipline which contains within it many specializations such as food microbiology, food analysis, food engineering, food chemistry and food processing technology. 1. Nutrients required for energy include carbohydrates, protein and fats. 2. The nutrients for control of body processes include proteins, minerals, vitamins and water. 3. The nutrients required for the growth of tissues and their maintenance include proteins, Mineral and water.

Keywords: Food science, technology, engineering

Introduction
Food science covers all aspects of food material production, handling, processing, distribution, marketing and finally consumption. Still some would limit food science to the properties of food materials and their relation to processing and wholesomeness. Food processing shall mitigate the problem by appropriate value addition to the food to enhance the shelf life and to reduce post harvest losses. The major thrust areas could be self sufficiency in the area of food engineering and packaging in addition to food additives and processing aids. Design and development of process machinery shall be stressed upon to a great extent to keep up the long term interests. There is also need for improvements in commodity quality making it suitable for agroprocessing by breeding appropriate raw material varieties to withstand competitiveness in a profitable manner. Food science is one of the ancient sciences and the genisis originates to the very beginning of human civilization. The advent of food science was associated with practice and observation by humans before the establishment of scientific concepts. The ancient man know that roasting or smoking of meat improves the edibility and digestibility. Many of the modern preservation concepts had their origin in pre-historic period itself as humans could use techniques such as dehydration, fermentation and pickling to their advantage to improve the sensory attributes of the products and also enhance their shelf life. Humans during pre-neolithic period used fire for cooking meat. During the paleolithic period humans not only roasted food but also developed grinding, pounding and drying. During the Mesolithic era, humans practiced domestication of animal and animal husbandry became a reality.

The Neolithic period made qualitative changes in the food habits of humans and they changed from a food gathering and hunting society to one of food production. The advent of copper, bronze and iron age made human civilizations more comprehensive and complete with regards to basic necessities of life. Advanced processes techniques like baking of leavened bread also took place. Lactic acid fermentation could make entry and pickles were extensively developed for a number of commodities inclusive of vegetarian and non-vegetarian commodities. The metal age saw the development of oils by expeller methods and frying practices could gain a foodhold in the culinary preparation.

Addition of fat and spices to meat could result in development of sausages. Different civilizations like the Egyptian, Greek, Roman, Chinese and Indian contributed to the growth of food processing and preservation. Romans were responsible for manufacture of large scale milling devices, large ovens, mechanical kneeding and fining of wines.

Simultaneously Chinese contributed significantly to the growth of food technology as practice. Steaming of food was first carried out by Chinese to improve the edibilily and nutritional nature of rice. Indians also contributed significantly right from the Aryan period and some of their contributions include development of ghee (clarified butter fat) and mixed spices for curry preparations. Industrial revolution made food technology take a quantum jump by incorporation of heavy duty machinery for commercial scale food processing operations.

The freezing and refrigeration industry gave a greater boost to marine products such as ice was used in Great Britain in 1786 for transportation of fish. The modern scientific and engineering developments led to a host of food processing technology and machinery such as centrifugal cream. The Babcock butter fat test provided sound basis for payment of the producer of milk and helped to standardize the fat content of milk. Commercial dehydration of fruits, vegetables got a great boost during World War II period and potato dehydration and preparation of potato starch gained considerable importance. The advent of freeze drying techniques improved the quality of freeze dehydrated meat and related products significantly. The development of appears canning process facilitated revolutionary growth in food industry. As such the industrial revolution and world war were responsible for qualitative and quantitative changes in food industry.

Some of the recent trends in food science and technology are briefly discussed. Sterilization of milk by ultrahigh temperature (UHT) started in 1908 in Denmark and 1982 in India. The advantages of UHT sterilization over pasteurization include channelization of sterilized milk into the lean season in lieu of milk products such as powder milk, butter and ghee.

Sea foods, meat and poultry

Frozen marine products such as prawns made rapid progress for the last 30 years and the prospective buyers include Japan, USA, UK. India exports significant quantity of shrimps, tiger, prawns, pamphlet, ribbon, fish and crabs. Poultry products are ruling the roost in Indian market and India ranks fifth in chicken meat production.

Milling of wheat and rice

Milling of cereals is one of the milestones in the advent of modern processed foods. Advent of roller flour mills gave great boost to bakery and confection products. Improvements in the milling of rice made rice bran a commercially potential product for the extraction of oil and rice husk as such is being harnessed for the production of biofuel and electrical energy. The country is making rapid strides in the production of flaked or beaten rice using indigenously developed flaking machines.

Extruded and fermented foods

Modern food science has its base in food engineering. Different types of vernicelle, macaroni and pasta products are in great demand in the country and bulk processing of these products still continues to depend on imported machinery. Brewing industry in India transformed to a great extent. Some of Indian fermented products such as idli, dosa etc., could be improved by incorporation of lyophilized or micro-encapsulated starter cultures. The ready mixes concerning these products need to be incorporated with hydrocolloids to retain maximum gases generated by chemical leavening.

Canning/retorting/aseptically processed foods

Canning or retorting of Indian ethnic foods such as upma, halwa, parathas, curries, dhals etc is one of the major developments. The design of semiautomatic horizontal, retort unit for batch processing of RTE food made drastic inputs for the growth of retort industry in India. Aseptic processing had made rapid advances in the processing and marketing of liquid foods such as fruit and vegetable juices, nectars, milk, beverages health functional drinks etc., Bulk processing of fruit juices and concentrates in higher capacity plastic containers may make the products more cost effective.

Ready-to-use/ready-to-eat convenience foods

Convenience foods are user specific meeting the ethnic requirements of different consumer groups- Additive treated dehydrated vegetables, flaked commodities such as dhals and legumes and freeze dehydrated juices were formulated to obtain quick cooking reconstitution to instant products which found commercial success. Several health promoting formulations such as drumstick soup mix and several low calorie antidiabetic herbal preparation are available in the market.

Protein supplements

With growing population, there is an absolute requirement of adequate protein nourishment for deprived section of the society and non-conventional sources of protein like SCP and soybean are being used. India is yet to realize the full potential of soybean which is widely grown across the country. The price of conventional dhals is sky rocketing and day as a pulse could be promoted as the growth potential of soy is very high compared with other emerged leguminous crops.

Functional foods

The functional food section has emerged strongly as the modern consumer wants to stay healthy realizing the fact that food plays a major role in promoting health and prevention of diseases and the same is better than seeking remedial measures. The growing menace of cancer, juvenile obesity could be overcome by having strict control over diet profile. Food processing has a major role to play in commercializing these formulations in suitable ready-to-use or ready-to-eat modes. Food science embraces many disciplines chemical and biochemical methods are used to determine food composition. Knowledge of food composition help us to use food intelligently to fulfil our nutritional needs. Retention of food quality and preservation of foods are based on food microbiology.

The changes that occur in foods during preparations, such as volume and texture are physical ones. Study of food acceptability is based on the understanding of socio-cultural background. The principles of economics help us to manage food budget efficiently. The basic sciences such of physics, chemistry and biology are all involved and also biochemistry, yet food science is more than the sum of these disciplines, because it is a subject with its own characters. Food biotechnology is fast emerging field of food science which

involves development of genetically modified foods and food products have become common, inspire of controversy on the use of GMO. It is necessary that the controversies be resolved satisfactorily to ensure consumer safety. The dividing line between food science and food technology is often blurred because food technology is well illustrated in solving the fore most problem of feeding the world's rapidly increasing human population.

Aims of food science and technology

Food requirements for increasing global population and consumer safety have necessitated defining the objectives of food science and technology.

They are as follows:

1. Make available wholesome nutritious and appetizing at economical rates.
2. Improve nutritive value and minimum loss of essential nutrients during processing and preservation.
3. Ensure long term storage stability even at elevated temperatures.
4. Market the processed foods of high calorie density in compact and easily reconstitutable form in light weight and easily operable containers.
5. Prevent food poisoning, contamination or adulteration.
6. Cater to the special dietary requirements of astronauts, patients, sports persons and children.
7. Improving mechanical processing operations such as harvesting to replace or minimizing labour.
8. Develop new varieties of instant or convenience foods.
9. Understand the changes during food preparation and control them in order to obtain food which has desirable characteristics.

The Importance and Source of Food

The raw products of present day foods generally originate from two major sources: the plant and animal kingdoms. We still rely on the agricultural lands, lakes, rivers, and the seas for their origin in forests and wildlife, and in many parts of the world they still constitute important sources of food. The plant and animal products that compose our foods and food products may be classified in the following way:

Plant Products

A. Grains (cereals) wheat, corn (maize), sorghum (kaoliang, jowar), barley, oats, rye, millets (including ragi), rice, adlay, buckwheat

B. Pulses beans (red kidney), lima beans, navy beans, peas, lentils, broad beans, cowpea

C. (chickpea), vetch (fitches)

D. Fruits

1. Tropical fruits banana, plantain, pineapple, papaya, guava, mango, passion fruit, breadfruit, avocado, zapote, cherimoya, naranjilla, surina (Brazil) cherry.
2. Subtropical fruits
   a. Citrus fruits orange, lemon, tangerine, grapefruit, pomelo, citron, lime, kumquat.
   b. Other figs, pomegranate, olives, persimmon tunas (cactus figs), peijabe.
3. Deciduous fruits Pome (seed) fruits, Apple, Grapes, Pear, Quince.
4. Stone fruits peach, cherry, plum, apricot.
5. Berries strawberries, raspberries, black raspberries, blackberries, loganberries, boysenberries, cloudberries, blueberries, cranberries, lingo berries (whortleberries), elderberries, black currants, red currants, gooseberries, rose hips.

E. Melons and squashes: Cantaloupe, honeydew, watermelon, squashes.

F. Vegetables

1. Leaf(y) vegetables cabbage, Brussels sprouts, spinach, celery, artichoke, leeks,
2. Lettuce, endive, bamboo shoots, heart of palms, herbs.
3. Root vegetables carrot, radish, parsnip, turnip, rutabaga, salsify.
4. Seeds green peas, green beans, lima beans, okr.
5. Others cauliflower and broccoli, cucumbers, onions, garlic, tomatoes.

G. Tuber products: (Irish or white) potatoes, sweet potatoes (yams), taro, cassava (maniok), Jerusalem artichoke (topinambur), true yams (Dioscorea spp.), earth almonds.

H. Nuts: Almond, beech, Brazil nut, breadnut, butternut, cashew chestnut, filbert, peanut (groundnut), pecan, pinole, pistachio, walnut.

I. Fungi: (1) Fat type bakers' yeast, brewers' yeast, food yeast (2) Protein type champignon, truffles, morels, antharels miscellaneous, I. Honey (nectar)

J. Manna: Ash tree, oak, tamarisk, alhagi

K. Sugars: Sugar cane, sugar beet, maple syrup palm sugar (date).

L. Oilseeds soybean: olive, cottonseed, peanut (groundnut), sunflower, palm kernels, coconut (copra), rapeseed, sesame.

M. Seaweeds: Laver, nori (Porphyra spp.), kombu (Laminaria spp.), wakame (Undaroainnatifida)

N. Beverage ingredients: Coffee, tea, cocoa, yerba mate, miscellaneous (mint, fenugreek, tilia, etc.) The above given items are major items of plant and animal origin that compose the multitude of food articles available at present-day markets. They also constitute the raw material for a number of major industries & manufactured products. The major manufactured food products are listed below:

1. Sugars: cane, beet, maple, corn.
2. Starches: corn, potato, cassava (manioc), arrowroot, sago, wheat.
3. Flour, bread, and cereals.
4. Sweet baked goods.
5. Confectionery products.
6. Canned foods.
7. Frozen foods.
8. Dried (dehydrated) foods.
9. Pickled and marinated foods.
10. Salted and cured foods.
11. Dairy products: market milk (homogenized0, cheese, butter, cultured milks, ice cream, dry nonfat solids, milk concentrates.
12. Meat products: sausages, hams, luncheon meats, meat extract, pastes.
13. Seafood products: fillets, fish sticks, breaded shrimp, sausages, pastes.
14. Oleomargarine and other food fats and oils: soybean, corn, sunflower, cotton seed, olive.
15. Jams and jellies
16. Fermented foods: pickles, sauerkraut, fish sauces.
17. Fermented beverages: wine, beer.
18. Soft drinks: carbonated and still drinks.
19. Mixes: baking, soup.

20. Soybean products.
21. Corn products.
22. Yeast: food yeast, bakers' yeast, brewers' yeast.
23. Fish flour.
24. Protein hydrolyzates.
25. Imitation foods (spun proteins, fruit drinks, synthetic cream, etc.)

Raw material selection Definition of Quality

Degree of excellence and include such things as taste, appearance, and nutritional content. The composite of characteristics that have significance and make for acceptability

- Quality Factors in Foods
- Appearance Factors
- Textural Factors
- Flavor Factors
- Additional Quality Factors

Appearance Factors

Include such things as;

- Size
- Shape
- Wholeness
- Different forms of damage
- Glass
- Transparency
- Color
- Consistency
- Size and shape
- Easily measured
- Important factors in federal and state grade

- **Size:** Approximated by weight after rough grading Ex. Determining the weight of dozen eggs
- **Shape:** Have more than visual importance The grades of certain types of pickles include the degree of curvature
- **Color and Gloss:** Color is commonly an index of ripeness and spoilage: Potatoes darken in color as they are fried Blenching of dried tomato powder on storage
- **Consistency:** May be considered a textural quality attribute Measured by viscosity of food:
  a. Higher viscosity – higher consistency
  b. Lower viscosity products – lower consistency
- **Texture Factors:** Texture Refers to those qualities of food that we can feel either with the fingers, the tongue, the palate or the teeth. A departure from an expected texture is a "quality defect".
- **Expected texture**
  a. Chewing gum to be chewy
  b. Crackers and potato chips to be crisp
  c. Steak to be compressible and shearable between the teeth

Flavor factors

Flavor a combination of both taste and smell Largely subjective Hard to measure ecause of difference of opinion: People differ in

a. Their sensitivity to detect different tastes and odors
b. Their preference
c. Their cultures

Additional Quality Factors

- Nutritional Quality
- Sanitary Quality May not always is apparent by sensory observation.
- Keeping Quality

Nutritional Quality: Can be assessed by chemical or instrumental analyses for specific nutrients, Animal feeding tests or equivalent biological tests must be used in many cases Particularly common in evaluating the quality of

a. Protein sources
b. Interacting variables of
   - Protein level
   - Amino acid composition
   - Digestibility
   - Absorption of amino acid
   - Sanitary Quality usually measured by counts of bacteria, yeast, mold, and insect, fragments sediment levels

Keeping Quality or storage stability

Measured under storage and handling conditions stimulated conditions:

a. extremes of temperature
b. extremes of humidity
c. other variables

Principles of Quality Control

a. Raw Material Control
b. The use of good and sound raw material is of primary importance for the achievement of the required end product of consistent quality.
c. Process Control
d. Finished Product Inspection

The Importance of Raw Material Selection

a. A poor raw material cannot be converted into a good finished product.
b. In food processing; General rule:- the effective methods must be carefully applied to conserve the original
c. qualities of the raw materials cannot improve the raw material

Definition of Food Technology: Food Technology is the application of food science to the selection, preservation, processing, packaging, distribution, and use of safe, nutritious, and wholesome food.

Scope of Food Technology

- Food Technology developed as a discipline to systematically organize and link the various kinds of knowledge which are necessary to inform human activity in food handling, processing, distribution and marketing.
- Food Technology applies
  1. The principles and concepts of engineering to problems of food handling and processing, and
  2. Studies the interrelationships between the properties of materials and the changing methods of handling and manufacturing them.

Food Business

- The food business may be characterized as:
- Vulnerable to spoilage,
- High volume,
- •Low margin,
- Multiple products,

- Transportation intensive; and
- End user marketing intensive.
- Since WWII the value added part of the food industry has increased steadily, and in 1980 surpassed agriculture's contribution.
- There is great emphasis on speed and efficiency in production, and on optimization of the food system from production through consumption.
- It has even been predicted that "nutrient delivery packages", customized for particular situations, will be developed to take the place of traditional "meals".

Components of Food Technology

- Food analysis and chemistry
- Food Quality Factors and their Measurement
- Nutritive aspects of food constituents and effect of processing and handling
- Food microbiology, mycology, and toxicology
- Food processing and engineering

Emerging trends in Food Technology

Increased concern about the nutritional content of technologically derived, refined foods is expressed by both consumers and nutritionists.

- Dietary guidelines and nutrition education focus on partially replacing refined foods with whole grains, legumes, and other foods which retain their biochemical unity.
- Concern about food safety issues is very strong. Food scientists are responding to these nutritional and safety concerns in a variety of ways,
- Increased attention to food interactions and bioavailability of nutrients,
- Improved analytical and detection methods, and research and education in food safety.
- New product development, particularly in the area of reduced-fat and reduced-calorie products is predicted. New processing technologies such as high energy electric pulse processing, freeze concentration, and hydrostatic pressure processing (which are often not yet available in the U.S.) show promise.
- Biotechnology is a growing area.

Impact of developments in other Technologies on Food Technology

For the sake of completeness it should also be mentioned that development of food technology draws heavily on developments in other technologies, such as those in steel, tinplate, glass, aluminum, plastics, engineering, instrumentation, electronics, chemicals, and agriculture.

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