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Nanotechnology is the science of very small materials that has a big impact in food sector. It is newly emerging novel technique that can increase the shelf life of foods, minimizes the spoilage and ensures the food safety. Nanoparticles based food packages provide improved barrier, mechanical and antimicrobial properties that helps in preserving sensory qualities such as taste, colour, flavour, texture, appearance, consistency and also nutrients of food product. Edible nanolaminates could have applications in fresh fruits and vegetables, bakery products and confectionery, where they might protect the food from loss of moisture, lipids, gasses, off-flavours and odours. Food packages embedded with nanosensors can alert consumers when a product is no longer safe to eat. Intelligent food packaging, incorporating nanosensors, could even provide consumers with information on the state of the food inside.

Nanotechnology offers tremendous opportunities for innovative developments in food processing and packaging that can benefit both consumers and industry.

#### Definition:

Nanotechnology is defined as the study and use of structures between range of 1 nanometer (nm) and 100 nm in size, e.g. it would take eight hundred of 100 nanometer particles side by side to match the width of a human hair.

#### Do You Know?

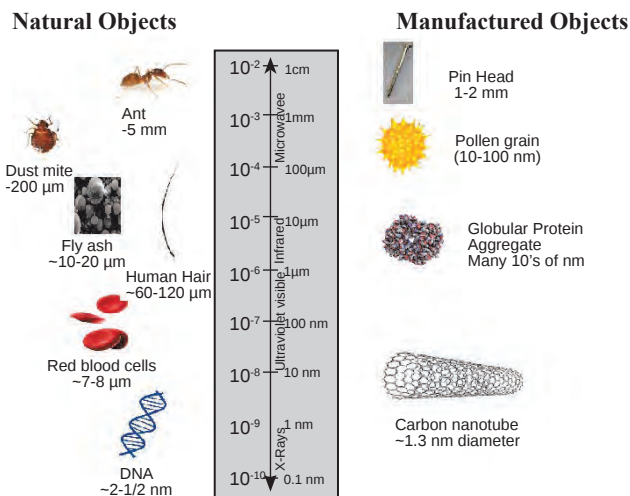
##### What is Nanotechnology?

**“Nanotechnology is the science, engineering and technology conducted at nanoscale which is about 1 to 100 nanometers”.**

- Understanding and control of matter at nanoscale
- Nano: Derived from greek word ‘nanos’-DWARF
- 1 Nano = billionth of a meter of  $10^{-9}$  of a meter

**Father of Nanotechnology: Richard Feynman**

Researchers have been studying and working with nanoparticles for centuries, but the effectiveness of their work has been hampered by their inability to see the structure of nanoparticles. The following illustration provides a comparison of various objects to help to understand the size of nonomaterials. The chart starts with objects that can be seen by the unaided eye, such as an ant, at the top of the chart, and progresses to objects about a nanometer or less in size, such as the ATP molecule used in humans to store energy from food.



**Fig. 15.1 : Visual display of natural and manufactured objects that fall in the “nano” (<100 nm) and “micro” (>100 nm) size ranges.**

The ability to see nano-sized materials has opened up a world of possibilities in a variety of industries and scientific endeavors. Because nanotechnology is basically a set of techniques that gives opportunity to alter the properties at a very small scale and it can have plenty of applications.

### 15.1 Applications of nanotechnology in the food industry

Scientists specified some areas of food processing which are as follows:

#### Food security:

Nanotechnology provides better food security by application to all component of food chain from farm to fork. These components include farm inputs, farm production system, post harvest management, processing, market and finally consumers.

#### Protection against spoilage:

Shelf life of food materials can be enhanced with the help of nanotechnology and helps to reduce wastage up to certain extent occurred due to microbial spoilage.

#### Development of innovative products:

Nanotechnology being applied in the formation of encapsulation, emulsions, biopolymer matrices, simple solutions, and association colloids offer efficient delivery systems with all the above-mentioned qualities. To improve taste, texture and consistency, numbers of nanostructured food ingredients are being developed.

#### Food processing:

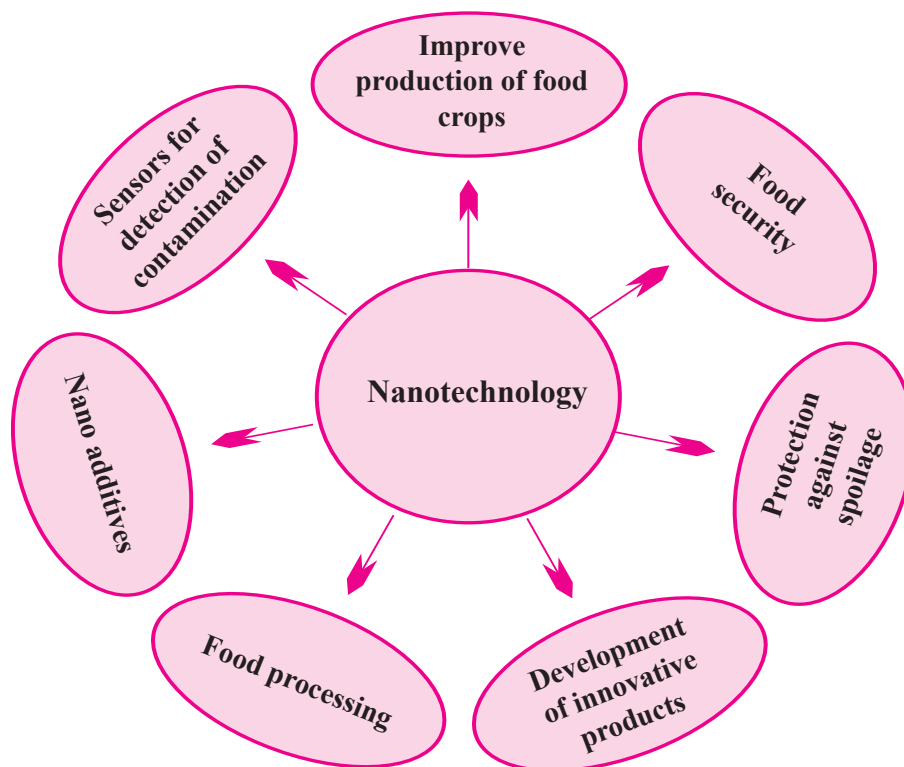
The importance of nanotechnology in food processing can be evaluated by considering its role in the improvement of food products in terms of (i) food texture, (ii) food appearance, (iii) food taste, (iv) nutritional value of the food, and (v) food shelf-life. Texture, taste, and appearance of food nanotechnology provides a range of options to improve the food quality and also helps in enhancing food taste.

#### Nano additives:

Nano particles are being used as food additives which makes the food to stay away from microbial contamination hence lengthening the lifespan. Nanoscale food additives may be used to influence product shelf life, texture, flavor, nutrient composition, or even detect food pathogens and provide functions as food quality indicators.

#### Sensors for detection of contamination:

Nanotechnology is used to make nanosensors which will enable rapid testing of raw and processed food products in factory and during transportation. Nanosensors can be used to prove the presence of contaminants, mycotoxins, and microorganisms in food. Electronic nose recently available is the best example of nanotechnology based sensor.



**Fig. 15.2 : Applications of nanotechnology**

### **Improve production of food crops:**

Nanotechnology provides new agrochemical agents and new delivery mechanism to improve crop productivity and it reduces the pesticides use.

### **15.2 Applications of Nanotechnology in food packaging**

Nano polymers are trying to replace conventional materials in food packaging. The ideal packaging material should have high barrier properties against gas and moisture along with strength and biodegradability (ecofriendly). A nano material helps to improves barrier properties along with improved mechanical strength. Nano-based “smart” and “active” food packagings confer several advantages than the conventional packaging from providing better packaging material with improved mechanical strength, barrier properties, antimicrobial properties to nanosensing for pathogen detection

and alerting consumers to the safety status of food. Application of nano-composites as an active material for packaging and material coating can also be used to improve food packaging. Food nano packaging classification and functions are indicated in Fig. 15.3.

### **Examples of nanotechnology in food packaging:**

- Antibodies attached to nanoparticles to detect chemicals or food borne pathogens.
- Biodegradable nanosensors for temperature, moisture and time monitoring.
- Nanoclays and nanofilms as barrier materials to prevent spoilage and prevent oxygen absorption.
- Electrochemical nanosensors to detect ethylene gas liberated during ripening.
- Antimicrobial and antifungal surface coating with nanoparticles.



**Fig. 15.3 Food nano-packaging classification and functions**

#### Do You Know?

- The ultra small has the potential to make enormous changes
- Nanotechnology is the technology of the future

#### Points to remember

- Nanotechnology has produced novel materials with interesting properties.
- Nanomaterial offer unique applications in food packaging & food safety.
- Nanotechnology offers tremendous opportunities for innovative developments in food processing and packaging
- Important application of nanoparticle in food industry such as food security, protection against spoilage, development of innovative products, food processing, nano additives, sensors for detection of contamination, improve production of food crops and advances food packaging

#### Activity

1. Collect the packaging materials having time temperature indicators and check its effect by changing environment of the wrapper.
2. Collect the color changing toys and record observation after change in temperature.

## Exercise

### Q.1 (a) Select the most appropriate option:

- i. Size of Nano particles ranges from \_\_\_\_\_  
(1-100 nm, 1-100 mm, 1-100 m)
- ii. Father of nanotechnology is \_\_\_\_\_  
(Nicolas Appert, Richard Feynman, Louis Pasteur)
- iii. \_\_\_\_\_ of the food material can be enhanced with the help of Nano Technology  
(Shelf life, spoliage, browning)
- iv. Nano technology is used to make nenosensors for rapid testing of \_\_\_\_\_ food.  
(Only raw, only processed, raw and processed)

### (b) Match the following:

| Component |                     | Functions |                 |
|-----------|---------------------|-----------|-----------------|
| i.        | Innovative Products | a.        | Food Additives  |
| ii.       | Nanoparticles       | b.        | Encapsulation   |
| iii.      | Nanosensors         | c.        | Packaging       |
| iv.       | Nano polymers       | d.        | Testing of food |
|           |                     | e.        | Food security   |

### (c) State whether the following statements are true or false:

- i. Nano technology is the science of very small materials that has a big impact in food sector.
- ii. The size of nano materials are 100 m.
- iii. Electric nose is the best example of nano technology based sensor.
- iv. A nano material helps to improve barrier properties.

### Q.2 Answer in brief

- i. Enlist the applications of nanotechnology in food science and technology.
- ii. Describe the nano additives.
- iii. Explain the role of nanotechnology in food packaging.
- iv. Enlist the nano food packaging.

### Q.3 Short answer question

- i. What is nano technology?
- ii. Enlist the examples of nano technology in food industry.

### Q.4 Long answer question

- i. Describe the nanotechnology in food industry.
- ii. Explain the applications of nano technology in food packging.

### ❖ Project:

Collect the information on role of nanotechnology in day to day life food products.

