INTELLIGENT PACKAGING

Definition:

- Intelligent packaging could be defined as a packaging system that is capable of carrying about intelligent functions (such as sensing, detecting, tracing, recording and communicating) to facilitate decision making to extend shelf life, improve quality, enhance safety, provide information, and warn about possible problems.
- Intelligent packaging is the one that monitored the conditions of packaged foods to give information about the quality of the food during storage and transport.
- Intelligent packaging could be defined as a packaging technique containing an external or internal indicator and sensors for the active product quality and history.

- Intelligent packaging systems have components that sense the environment and process the information and then allow action to protect the product by conducting communication functions.
- Examples of intelligent packaging are those that give the time-temperature history, indicate microbial growth**,** shock, leakage, spoilage, etc.
- The intelligent packaging monitors the condition of packaged foods and gives information about the quality of the packaged food during transport and storage.
- It is essentially an integrating method that deals with mechanical, chemical, electrical and/or electronically-driven functions that enhance the usability or effectiveness of the food products in a proven way.

Intelligent packaging systems

1. Indicator

- Time/temperature indicator
- Oxygen indicator
- Carbon dioxide indicator
- Color indicator
- Pathogen indicator

- Breakage indicator
- Freshness indicator (microbial spoilage)
- Leak indicator (tamper proof)

2. Sensors

- Bio-sensors
- Gas sensors

1. Indicator

Time-temperature indicator

- This indicator is giving information on temperature and it shows the variation and history in temperature.
- If perishable food products are stored above the suitable storage temperature, a rapid microbial growth take place.
- The product could be spoiled before the estimated use by date.
- Time-temperature indicator (TTI) attached to the package surface is designed for integrate the cumulative time-temperature history of the package throughout the whole distribution chain, and therefore, gives indirect information on the product quality.
- The time-temperature history is visualized as a color movement or color change.

Oxygen indicator

- This indicator is giving information on leakage.
- The usage area for this indictor is contolled and modified atmosphere food packaging.
- A typical oxygen indicator consists of a redox dye (such as methylene blue), an alkaline compound (such as sodium hydroxide) and a reducing compound (such as reducing sugars).

Carbon dioxide indicator

- This indicator gives information on concentration of carbon dioxide in modified atmosphere packaging.

- The usage area of this indicator is controlled or modified atmosphere packaging.

Color indicator/Microwave doneness indicator

- This indicator gives information on temperature in food packaging.
- Food for microwave preparation is the usage area of this indicator.
- This indicator would be able to detect the readiness of foods that are heated in microwave ovens and signal to consumers when foods are safe to eat.
- The biggest challenge in this field at the moment is the ability to evenly heat foods in the microwave to that there is a defined stage in which a food could be called safe to eat food.
- An ideal MDI would be located on the lid or dome of the microwave container so that the consumer could easily see the visual indicator for doneness.

Pathogen indicator

- This indicator gives information on microbiological status and it is used on meat, fish or poultry packaging.

Breakage indicator

- This indicator gives information on broken packaging and it is used on canned baby food packaging.

Freshness indicator

- Freshness indicator indicates the microbial quality of the product by reacting to the metabolites produced in the growth of microorganisms.
- The indicator may be based on
    - A color change of chromogenic substrates of enzymes produced by contaminating microbes.
    - The consumption of certain nutrients in the product, or
    - On the detection of microorganisms as such
- Milk bottles has a freshness indicator that turns from white to red as the level of lactic acid increased. When the milk has gone sour, the indicator turns to bright red.

Leak indicator

- A leak indicator gives information on the package integrity throughout the whole distribution chain which is attached into the package.
- Exclusion of oxygen and high concentration of carbon dioxide improves the stability of the product as the growth of aerobic microorganisms is prevented for many perishable products.
- The protecting atmosphere is deteriorated as a result of package leak.

2. Sensors

Bio-sensors

- A bio-sensor is an analytical device used to detect a substance, in this case a pathogen, and then transmit this information into some sort of signal that is quantifiable.
- An intelligent system in the works aims, attach antibodies to a plastic packaging surface to detect pathogens or toxins. If the antibodies come into contact with a target pathogen, the packaging material would display a visual clue to alert the consumer.
- This intelligent system would only be useful when foods were contaminated with very high concentration of pathogen or toxins.
- Also, this system would work only to detect pathogens or toxins on the surface of a food product.

Gas sensors

- As a result of the activity of the food product, the environmental conditions or the nature of the package, the gas composition in the package headspace often changes.
- Gas sensors are device that respond quantitatively and reversibly to the presence of a gaseous analyze by changing the physical parameters of the sensors and are monitored by an external device.

Advantages

- Extend shelf life

- Improve quality
- Enhance safety
- Provide information
- Warn about possible problems
- Improve value of a product
- To provide more convenience
- Provide tamper or the theft resistance
- Help the consumer in the decision making

Disadvantages

- The cost of intelligent packaging limits its commercial use.
- Less consumer acceptance
- Doubt relating consumer health in terms of toxicity caused by chemicals or other reagents used in indicators.