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Intelligent Packaging Technology: Innovative Way to Increase the Shelf Life of Food

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SUMMARY

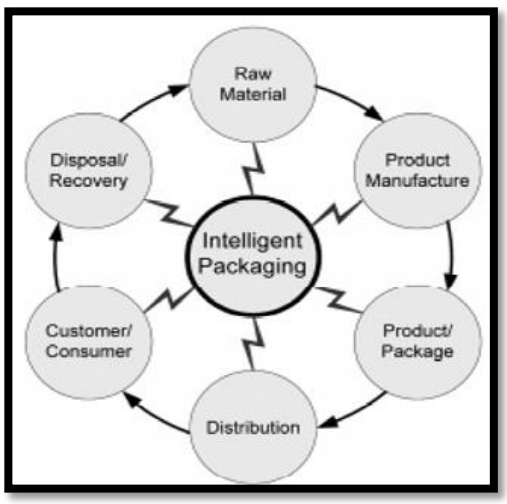
Shelf life of food is defined as the period up to which food is able to consume as safe food. Shelf life of food depends on various factors consisting of environmental (oxygen, carbon dioxide, relative humidity, moisture content etc.), physical (Volume, density, shape), chemical (free fatty acids, enzymes, proteins etc.), biological (insects, yeast, microorganisms) and packaging (permeability, thickness, orientation etc). Interaction of food components with these factors responsible for the decrease or increase the shelf life of food. For convenience handling of food, packaging play as an important role. The developed packaging types must be ensuring that, it should provide sufficient safety to food in terms of their quality and quantitavely loss reduction. From the last decades many of researches has been developed various types of novel packaging materials such as LDP, HPD, antimicrobial, active, passive, modified, smart and intelligent.

INTRODUCTION

In old-style packaging; the package is used to interconnect with the customer as a marketing device, protect the product in contradiction of the deteriorative effects of the outside environment, contain products of various sizes and shapes and deliver the consumer with greater ease of use and time-saving accessibility. The traditional packaging is no longer sufficient because the society has become increasingly complex today (Mohebi and Marquez, 2015). Although it has contributed to the early development of the food delivery arrangements. The aim of food packaging is to protect the food from chemical and microbial adulteration, water vapours, oxygen and light. This usage of package has an important role in decisive the shelf life of a food. Generally, this role is a rather passive and inert one, but in recent years, the idea of active and intelligent packaging has received more courtesy and many commercial products have been introduced and used in the food area (Shao *et al.*,2021). Intelligent packaging is in an early stage of progress technology that uses the communication function of the package to facilitate decision making to achieve the benefits of enhanced food safety and quality. Intelligent packaging could be defined; as a packaging system that is capable of carrying out 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. A package can be intelligent if it has the aptitude to track the product, sense the atmosphere inside or outside the package, and communicate with human (Kalpana *et al*., 2019) For example, an intelligent package can monitor the safety and quality condition of a food product and provide early warning to the consumer or food manufacturer.

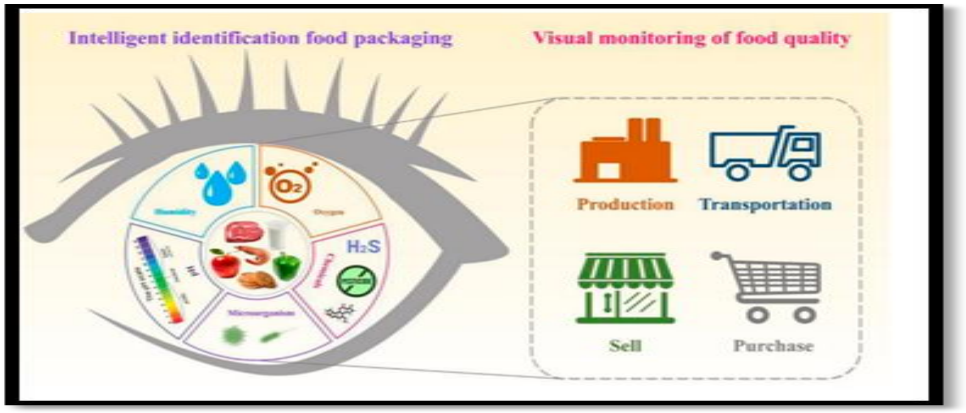
Conceptual framework of intelligent packaging

Intelligent packaging can play an important role in facilitating the flow of both resources and evidence in the food supply chain cycle. In Figure 1 & 2. The outer circles represent the supply chain cycle from raw



material through manufacturing, packaging, distribution, product use, and disposal (Dutra and Ana,2019). The package, in one form or another (such as pouch, container, drum, pallet), is conventionally used to smooth the flow of materials from one place to another, by accomplishment the basic functions of containment and protection of the product. Furthermore, the package can also facilitate the flow of information, though this message function has been largely overlooked. The package can indeed be a highly effective interconnect. The system consists of 4 components: smart package devices, data layers, data processing, and information highway. The smart package devices are largely responsible for giving birth to the concept of IP because they impart the package with a new ability to acquire, store, and transfer data. The data layers, data processing, and information thoroughfare are together mentioned here as the decision support system. From the quality and safety viewpoint, the external environment can be further divided into the ambient, physical, and human environments (Fang *et al*.,2017), which are factors important for determining shelf life. However, the commercial atmosphere is also an important factor; in fact, the development of smart package devices and the information highway is largely motivated by the desire to increase profit and operation efficiency.

Fig 1. Concept framework of Intelligent Packaging

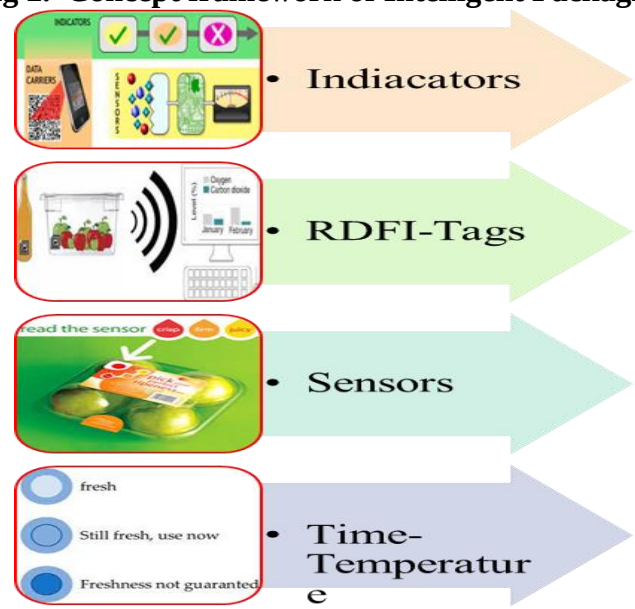


Intelligent packgaing sysytem

Time-temperature indicator

This indicator is giving information on temperature and it shows the difference and past in temperature. It is used as addition to labelling in transport or storage. If perishable food products are stored above the appropriate storage temperature, a rapid microbial growth takes place. The product could be spoiled before the estimated use by date. Time-temperature indicators (TTI) involved to the package surface is designed for integrate the increasing time-temperature history of the package through the whole distribution chain, and therefore, gives indirect information on the product quality. The time-temperature history is imagined as a colour movement or colour change. Time temperature indicators which are commercially presented are based on various reaction mechanisms (diffusion, polymerization or enzyme reaction). The temperature needy reaction kinetics of the indicator and activation of the indicator at the moment of packaging is a common feature for all concepts.

Fig 2. Concept framework of Intelligent Packaging



Oxygen indicator

This indicator is giving information on leakage. The usage area for this indicator is controlled or 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). Oxygen indicators have been recently described which based on oxidative enzymes. In addition to these main components, such as a solvent (water or an alcohol) and bulking agent (such as silica gel, polymers, cellulose materials, zeolite) compounds are added to the indicator. The indicator can be formulated as a label, a printed layer, a tablet, or it may also be laminated in a polymer film (Mohebi and Marquez, 2015).

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 film.

Colour indicator

This indicator gives information on temperature in food packaging. Food for microwave preparation is the usage area of this indicator.

Freshness indicators

Freshness indicators designate the microbial excellence of the product by responding to the metabolites produced in the growth of microorganisms. A specific pointer material has been developed for the detection of *E. coli O157 enterotoxin* and the possibility for applying the technology for the detection of other toxins is currently being explored. The indicator may be based on a colour change of chromogenic substrates of enzymes produced by polluting microbes, the depletion of certain nutrients in the product, or on the discovery of microorganisms, as such (Dutra and Ana,2019).

Radio Frequency Identification Tags (RFID)

Wireless data collection technology, uses electronic tags for storing data and identification of animals, objects or people. Tags attached to assets (pallets, cattle, packs, meat bins) to transmit information to a reader. Tags are could be classified into two groups; first one is passive tag which is cheap, simple, short-range, powered by energy from reader and the second one is active tag which is battery powered, longer range, more information (nutritional information, temperature, cooking instructions etc.

Intelligent sensors

Devices used to locate, detect or count matter or energy, giving a signal for the discovery of a chemical or physical property to which the device responds. Most of devices contain two useful units: first one is receptor which is transformed chemical or physical information into a form of energy; second one is transducer which is a device that converts this dynamism into a useful analytical signal (Vu and Won 2014). The marker concept is; used to determine a primary measurable or a secondary physical, chemical or biological variable. Exacting industry specifications, high development costs and safety considerations have limited commercial realization although significant steps have been made.

Bio-Sensors

Compact analytical devices that detect, transmit and record information pertaining to biological reactions. Specific to a target analytic (such as; microbes, hormones, enzymes, antigens) is baroreceptor. To convert biological signals to an electrical response (such as electrochemical, optical) is transducer

CONCLUSIONS

Intelligent food packaging is an advanced equipment which is developing in recent years. The reason of development intelligent packaging is rational the outdoor of package. On the other hand, to extend shelf life, improve quality, enhance safety, provide information, and warn about possible problems, this wrapping technology is industrialized and also these parameters are the benefits of the system.

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