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RECENT TRENDS IN FOOD PACKAGING: A REVIEW

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ABSTRACT

The desire of convenience for handling, storage, transportation and maintaining the shelf life of perishable foods, a concept to packaging was developed. Historians believe that during the nomadic days, materials such as nuts or gourds, leaves and animal skins were used to store and transport items. With an ongoing day to day development in packaging features such as active and intelligent packaging, the raw material being used has also been improvised. Single use of plastics has become an integral part of our daily life which makes our life easier but has also been responsible for polluting the environment and creating imbalance to our ecosystem. There has been a continuous interest for developing and using biodegradable packing material to mitigate the damage and lead today's society in a sustainable way. In search of sustainable practices we have also come across through mycelium based packaging material designed by Evocative design, which can be grown quickly on the agricultural waste and are capable of replacing the polystyrene with their characteristics such as capability of moulding, biodegradability, insulation and shock absorbing properties.
Keywords **:** Packaging, Plastics, Biodegradable, Sustainable.

Introduction

The concept of packaging grew with the basic need to store and transport foods from one place to another in a convenient manner. Packaging is the foremost and complicated step in the voyage of the fresh and processed crops. The packaging materials are used to wrap product or item to make sure that product is safe during transportation and storage. The packing materials are developing a lot throughout the years from using glass and clay in 7000 B.C to using different types of plastics for storing varieties of products (Risch, 2009). Different types of plastic packaging are used such as crates, poly bags, flexible bags, and shrink wraps (Kale and Nath, 2020). In the recent years single use of plastics has become an integral part of our day to day life which makes our life easier but has also been responsible for polluting the environment and creating imbalance to our ecosystem. There has been a continuous interest for developing and using biodegradable packing material to mitigate the damage and lead today's society in a sustainable way.

HISTORY

Glass containers

This is one of the oldest packaging materials that are widely used due to their versatility and transparency. They act as an exceptional barrier between the product and external environment which increases the shelf life of the product. In 1500 B.C. the practice of packaging was started for the first time. Egyptians used glass mixed with melted limestone, soda, sand, silicate to shape the glass packaging. There has been a dramatic progress in the moulding techniques by 1200 B.C. where we were able to press the glass into moulds to make cups and bowls. The invention of the blowpipe led to rapid production of the round containers and the production of the glass packing material spread steadily across Europe (Welt, 2005).

Metal containers

During 1200A.D. in Bavaria we are able to find tin plating and iron cans coated with tin (Welt, 2005). In London during 1764 when the snuff was sold in the metal canisters it was found to be poisonous and people were not willing to use the metal canisters. In the early 1800, people of France realised how to store the foods in metal containers safely. A Persian chef named Nicholas Appert who is the father of canning found that we can preserve the food for a long time by sealing it hermetically in the tin containers and sterilizing it by boiling the cans. Metal cans are considered the path breakers of packaging that took the preservation of the food to a whole another level.

Paper containers

During the first or second century B.C., the foods were wrapped in the sheets which were treated with the mulberry bark. The technique has been refined and travelled a lot in the Middle East and Europe. After 200 years the first commercial cardboard box was invented by Chinese in England which made packing and transportation easy. In 1905, machinery was invented that automatically produced the in-line printed paper bags which was replaced by the glued paper sack because it is cheap and easy to manufacture. The cereal box was invented in the year 1908 by the Kellogg brothers who are known for their corn flake cereals. Cardboard is used for

marketing and distribution of their product which helped them in overcoming the competition and performs well at sales.

Plastic containers

The era of plastics started in the year 1838 and replaced every packing material because of its ease to manufacture, its durable nature and water proof ability. There is constant development and discovery of the new age plastics like styrene in 1831, vinyl chloride in 1835, and celluloid in the late 1860s. Styrene was earlier made from the balsam tree during 1831 but the first generation styrene was brittle and could get easily shattered. In 1933 Germany refined the process of making the styrene which led to the availability of the styrofoam worldwide. In industrialised countries they use thermoformed polystyrene trays for meat packaging. Here high density polypropylene, polyethylene are subjected to the heat and they are moulded into the desirable shape to pack different products.

Cellophane

With an aim to invent a cloth that does not absorb water, a Swiss chemist Jacques E. Branden Berger invented cellophane in that process. Cellophane is a thin film which is regenerated from the cellulose. Invention of this packaging material showed a major impact in the food packaging industry because of its transparency. The cellophane has different types of applications such as protection of the submarine telephone cables, radar cables, packing of the drug tablet.

Types of Packaging

Traditional Packaging

Traditionally we use leaves, plant fibres and wood for sales in local market and domestic storage.

(a) Leaves

Table 1 : Different kinds of leafs and their usage in packaging.

Different kinds of leafs	Usage in packaging
Banana leafs	Used for wrapping fruit confectionery such as cheese of guava and traditional cheese. Small banana leaves used for packing coffee beans.
Maize leaf	Used for wrapping corn paste and blocks of brown sugar.
Pan leaf	Used for wrapping spices.
Rattan fibres, Papyrus leaves, Bamboo and Green coconut palm	Used to make bags and baskets and carry vegetables and fruits.
Palmyra palm leaves	Used to make weave boxes and pack cooked foods.

(b) Fibres

Generally plant fibres are chosen because they are lightweight, flexible and resistant to tearing. These are rough and non-slippery so it is easy to stack them when compared to synthetic fibre sacks and these are biodegradable.

Table 2 : Different kinds of fibers and their usage in packaging

Different kinds of Fibres	Usage in packaging
Kenaf and sisal plant	Used to make net bags that help in transportation of hard fruits.
Jute sacks	Used in transportation of grains, flour, sugar, salt and hard fruits.
Calico	Used in packaging of legumes, coffee, grains, beans, sugar.
Muslin and cheesecloth	Used in processing and wrapping of cheese.

(c) Wood

In shipping of fruits and vegetables we use wooden boxes, crates, trays as they protect the food from compact injury and they also have good weight to strength ratio. Small wooden boxes are used to store spices and wooden wire bound crates are used in storing commodities and also helpful in hydro-cooling. Traditionally the wooden barrels are used to store cooking oils, wine and beer (Chandrashekhar, 2021).

Active packaging

It is a bleeding edge technology which interacts with the product physically, chemically and biologically in order to increase the shelf life of the product and store the product in its prime for an increased period of time. Sachets and Pads are very commonly used to absorb or emit gas in the package. In the late 1970s, sachets were developed in Japan. Oxygen scavenging sachets use a rusting process where iron powder gets oxidised to decrease the amount of oxygen present in the package or enzyme technology can be used where iron is replaced by the ascorbic acid. These kinds of sachets are commonly used in coffee, poultry products, meat and dried foods.

There are some other kinds of sachets with respect to their function such as:

- For storing the high moisture bakery products sachets which are capable of releasing ethanol are used to reduce the microbial activity.
- Some sachets are capable of absorbing both oxygen and carbon dioxide used in roasted coffee packages.
- Drip absorbent pads are used to absorb the water in the meat packages to avoid the mould growth (Yam *et al*., 2005).

Anti-microbial system in active packaging

It is an advanced technology where the antimicrobials are released on command so it is known as Bioswitch (De Jong *et al*., 2005). These commands basically change the pH, temperature and UV light which acts as the external stimuli for releasing the antimicrobials. The antimicrobial compounds such as organic acids, enzymes, bacteriocins, fungicides, natural extracts, ions, ethanol these are encapsulated in the polysaccharide particles. Most of the bacteria are able to digest the outer polysaccharide layer which releases the active agent inside which will inhibit the growth of the microbes. This technology reduces the amount

of chemicals in the food exceptionally for preservation (Ayoub, 2018).

Intelligent packaging

Intelligent packaging helps us to know certain aspects of the food and report the information to the consumer, to make the decision of purchase. Intelligent packaging system helps us to know about the following aspects of the food,

- The quality of the food.
- Warn if there are any toxins in the product.
- If the product is temperature abused.
- Acts as a freshness indicator.
- If the package is tampered or opened a transparent label present on the package will permanently change its colour indicating that the package is opened.
- Helps to know the gases composition of the package by changing the colour of the indicator through a chemical or enzymatic reaction (De Jong *et al*., 2005).
- Helps to know readiness of the foods which are heating in the microwave oven as it indicates to the consumer.
- RFID tags help to know temperature and cooking instructions data, nutritional information and relative humidity (Yam *et al*., 2005).

Types of intelligent indicators

- Gas indicators.
- Time-Temperature Indicators (TTIs).
- Thermochromic inks.
- Microwave doneness indicators.
- Biosensors for pathogen or toxin identification.
- Radio Frequency Identification (RFID).
- Freshness indicators.
- Enzyme-based time-temperature indicator.

Nature of packaging material

Biodegradable packaging:

Any form of packaging material that can be disintegrated naturally and decomposed is called biodegradable packaging. Based on the historic development of the biodegradable packaging material they are divided into three generations.

First generation

The initial generation has synthetic polymers like LDPE which contain auto-oxidative additives, pro-oxidizers and starch fillers. Later, this material disintegrates into smaller molecules which are not biodegradable and leaves a bad impression on the consumer towards first generation of the biodegradable packaging. Low density polyethylene are widely used for characteristics as being non-reactive at room temperature, resistant to alcohols, esters, acids, aldehydes, vegetable oils and ketones, transparency, flexibility, durability and have made their way into general and industrial purposes (Malpass, 2010).

Second generation

In this generation there is disintegration of the whole packaging material because the composition of the packaging material is different. It comprises LDPE and pre-gelatinized starch of 40-70% with inclusion of ethylene acrylic acid, vinyl acetate and polyvinyl alcohol. The starch will take about 40 days for complete degradation whereas the remaining contents will take 2-3 years for the degradation.

Third generation

The third generation consists of biodegradable materials that are divided into 3 categories based on methods of production and origin.

1. The polymers obtained naturally or by genetically modified organisms.
2. Polymers that are put together by bio-monomers and chemical synthesis.
3. Polymers those are isolated /extracted from the biomass (starch, chitin and chitosan, plant proteins, soybeans) (Chiellini, 2008).

Impact of Biodegradable packaging material

Table 3 : Advantages and Disadvantages of Biodegradable packaging material.

Advantages	Disadvantages
Reduce the emission of carbon dioxide	Compost ability
Less energy to produce	No awareness to people
easy to recycle	Large installation for the production
renewable	In the future there will no arable land
Eco-friendly	Short lived

Source: Ivankovic *et al.* (2017).

Non Degradable packaging material:

These packaging materials cannot be broken down into simpler compounds by microbes due to complex chemical composition.

Table 4 : Types of non degradable packaging materials and their properties

Polymer material	Abbreviation	Associated properties
Polystyrene	PS	Readily thermoformed and injection moulded, Low cost.
Polyvinyl chloride	PVC	Low cost, shrink properties.
Polyvinylidene chloride	HDPE	Low cost, reduced clarity, more gas impermeable than LDPE.
Ionomer	–	Produce films of unusual toughness and clarity, Heat seal ability.
Low density polyethylene	LDPE	Low cost, moisture barrier, formability.
Polyesters	PET	Heat and Mechanical resistance, moderate oxygen barrier.
Polyvinylidene chloride	PVDC	Good oxygen and fat barrier.
Polyethylene	PP	Dimensional stability, thermal resistance.
Polyamides	PP	Formability high mechanical strength and oxygen barrier.

Source: Walsh *et al*. (2017).

Impact of non degradable material

Table 5 : Advantages and Disadvantages of non degradable material.

Advantages	Disadvantages
Low cost of production.	Causes ecological imbalance.
Low cost for development.	Pollutes Air, Water and Soil.
Less time for development.	Causes severe health issues to humans.
Less weight.	Decreases the soil productivity by releasing the synthetic chemicals into the soil and also creates threat to beneficial soil micro organisms, aquatic and terrestrial life forms.
High durability.	Increases the COD, BOD, VSS, TSS of water and causes death of the life forms in it.
Can be moulded into desirable shapes.	The vast ranges of chemicals used to manufacture the plastic materials are entering the food chain and becoming a threat to living organisms.
Offers cost benefits.	Styrofoam, which is a type of foamed plastic, has become a big problem because it contains toxic chemicals like styrene and benzene which are carcinogenic in nature.

Source: UNEP (2018) and Pongrácz (2007)

Nanotechnology in food packaging

In the food packaging industry nanotechnology has become a newly emerging novel technique, which has the ability to repair the tears in packaging, minimise the spoilage of food, increase the shelf of food and ensure food safety. Nanotechnology has a multitude of nano sensors such as nano cantilevers, array biosensors, electronic noses, nano-test strips and nanoparticles in solution. These nano sensors are capable of detecting the different gases and Escherichia coli contamination in the package and silicate nanoparticles in the packaging material can cut down the flow of the oxygen into the package and hamper the moisture leak from the package which increases the shelf life of the product enormously (Wesley *et al.,* 2014). But we need to take on further migration and toxicology studies on the nanotechnology application in the food packaging industry (Pal, 2017).

Conclusion

Huge investments in the food processing, personal care, and pharmaceutical end user industries are creating scope for expansion of the packaging market. Fresh foods are highly perishable and have a short life span, which makes it very important to keep in mind the designing, nature and materials to be used for packaging. Packaging helps to maintain the benefits of food processing after the process is complete, enabling food to travel to long distances. Economics and environment have to be always considered while selecting a particular food-package. Food Safety and Standards Authority of India (FSSAI) has been continuously working with new packaging regulations to replace the former provisions. Recycled plastics and newspaper used for food packaging have also been banned in recent years. New labelling regulations are also revised as it is integral to packaging, rendering all the relevant information about the product. The increased number of manufacturing units, eco-friendly materials, and focused research and development has resulted in world class products being manufactured locally at low cost. Recent technological advances are on the anvil that will make the food packaging almost as intelligent as the consumer. Government initiatives such as 'Make in India' are expected to speed this process further.

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