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The Influence Of Packaging And Technology On Shelf-Life Of Milk And Milk Products: An Overview

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Abstract

The dairy industry in India is gaining much attention as India is the largest producer of milk and various age groups prefer milk and milk products which are easily available in the market. Packaging is a technology that helps the dairy industry to perform functions such as convenience, aesthetic appearance, and protection against microbes and other external factors including light, moisture. The paper tries to explore the role of the packaging materials on shelf life of milk and milk products. The paper also highlights new trend in packaging technologies that are involved in the packaging of milk and milk products such as modified atmosphere packaging (MAP), active packaging (AP) and intelligent packaging (IP). Secondary data has been taken from various literature on milk and milk products through packaging perspective.

Keywords: Dairy industry; packaging; shelf life; milk and milk products; packaging technology.

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INTRODUCTION

The dairy sector contributes the biggest offer in the Indian food-based industry. Packaging is an imperative angle in the dairy industry since act as a barrier, provides protection from damage for example from microbes, air, moisture and so on. There are assortments of packaging materials accessible in the market that are being utilized in milk demands and drain items. The costs of different products depend upon packaging design either directly (purchasing cost and waste management) or indirectly (packing, handling, storage and transport) (Garcia and Prado, 2008).

In the dairy sector, packaging materials are required based on various food products (refer Table 1). Glass packing were very common in early days. Glass jars were so heavy so transportation was costly. Thus, innovation led to execution of flexible packaging material for its properties like light weight, less cost, high demand from the perspective of consumers. Further, aseptic packaging come into the market for increasing shelf life of the product and to keep it more hygienic and atmosphere control.

REVIEW OF LITERATURE

For this study we have studied papers to find out and analyze the role of packaging technology in milk and milk products.

Richmond (2012) analysed that packaging enhance shelf life of milk and milk products. Packaging provides information for consumers and thus act as a marketing tool. Packaging act as a physical barrier to protect milk and milk products from microbial contamination, change in aroma and moisture loss (Brody, 2006).

Various applications of packaging technology have developed to increase shelf life such as active packaging, intelligent packaging and modified atmosphere packaging which act as very important role to retain quality and safety of milk and milk products (Dobrucka and Cierpiszewski, 2014).

According to Soares et al. (2009), as consumers' demand increasing for advanced packaging information such as attractive labelling, nutritional information, lists of ingredients, novel techniques of packaging materials have replaced traditional approaches and give more attention to interactions between packaging and product. Milk and milk products are packaged with packaging materials in terms of different parameters such as storage conditions, processing

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conditions, handling requirements and end-use format. Packaging materials vary in properties like toxicity, strength, density cost (Walstra et al., 2006).

The most common types of materials used for milk packaging are low density polyethylene and laminated paper board carton (Alvarez and Pascall, 2011; Kontaminas, 2010; Karatapanis et al., 2006; Robertson, 2011).

Wong and Goddard (2014) found that innovative packaging trends such as active and intelligent packaging is also used for liquid milk products. Modified atmosphere packaging (MAP) is very useful in shelf life enhancement for cheese in terms of microbiological and sensorial aspects (Preeti et al., 2011). Active packaging is used as novel packaging technology that used additives into film or within containers due to which shelf life and safety of the product increased and quality is also maintained (Priyanka and Anita, 2014).

Arvanitoyannis and Oikonomou (2012) evaluated that intelligent packaging is an innovative packaging technology that indicate freshness of the product, storage conditions such as time-temperature indicators. Consumers are very aware towards convenient types of packaging for handling ice-cream (Lee, 2004). Antimicrobial films had resilient power and elongation properties and inhibit the fungal growth on the surface of the butter (Moraes et al., 2007).

The processing and concept of packaging due to long shelf life of dairy products distribution points that increase the shelf life of dairy products in cold chain distribution (Rysstad G. and Kolstad J., 2006).

OBJECTIVES OF THE STUDY

1. The main purpose of the research paper is to explore the influence of packaging materials on the shelf life of milk and milk products.
2. To find out the impact of innovative packaging technology in milk and milk products development.
3. To explore the differences among historical and current packaging scenario and type of packaging materials being used in the dairy sector.

RESEARCH METHODOLOGY

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The research is based on secondary data sources. Study based on secondary sources has been collected through various national and international reports. Others include government documents, books, articles published in journals which are indexed in web of science, Scopus, govt. reports and other publications.

PACKAGING AND ITS ROLE IN DAIRY INDUSTRY

Packaging is in infant stage yet considered as an effective barrier for milk and milk products. Milk and milk products include liquid milk, milk powder, ghee, curd, yoghurt, butter, cheese, ice-cream and chocolate. Milk and milk products need different packaging materials since these are perishable foods so demand protection from environmental factors such as air, moisture, microbes (Refer Table 2).

There are lots of differences in the packaging. In 1880s, glass bottles were used but it was very hard to transport milk from supplier to end-consumers. Consumers need convenient way of handling food products even though they are more concerned towards package design, price, light weight, label. Current packaging involves multilayered film that protects milk products from external barriers. To overcome problems of plastics and its impact on health and environment, packaging firms are focusing on sustainable packaging concerning environmental problems and compliances with rules, standards and regulations under Food Safety and Standard Authority of India (FSSAI). In early days there was low speed in milk packaging i.e. 25-30 pouches in a minute and now using various technology in packaging it has been increased i.e. 50-80 pouches per minute (Refer Figure 1).

INFLUENCE OF PACKAGING MATERIALS ON SHELF-LIFE AND STORAGE TEMPERATURE OF DAIRY PRODUCTS

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In dairy industry, the storage temperature has to be in controlled condition for each packaging materials according to the need of products so that the shelf-life is increased.

Packaging material play role in increasing shelf-life of the milk and milk products by maintaining optimum temperature (Refer Table 3).

NEW TRENDS AND INNOVATION IN PACKAGING TECHNOLOGY

Main factors that are to be considered in the food processing and packaging industry are quality, cost and productivity (Hung & Sung, 2011). There are different patterns of advanced packaging technology that are associated with the packaging of liquid milk and value-added products of milk, for example, modified atmosphere packaging (MAP), active packaging (AP), intelligent packaging (IP), nanotechnology-based packaging, and biodegradable packaging (BDP) (Brody, 2001; Lopez 2004).

A. Modified Atmosphere Packaging (MAP)

Modified atmosphere packaging is changing or modifying composition of gas in the packaging (Fronseca, 2000). It also enhances the shelf life of perishable food during storage and distribution as it controls temperature and composition of gas according to the food, the shelf life and the need of processor and consumer (Church 1994; Phillips, 1996). The main gases that should be present during MAP is nitrogen, oxygen and carbon dioxide combined with different proportions.

B. Active packaging (AP)

Antimicrobial packaging is considered as one of the most applicable functions of active packaging (Floros and Han, 1997). The processes of active packaging system are adding active

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ingredients to the packaging system or by using functional polymers that are very active (Han and Rooney, 2002). Antimicrobial activity in the packaging system prevents the growth of microorganisms by decreasing their live count (Han et al. 2002).

C. Intelligent Packaging (IP)

IP is also an innovative concept of smart packaging like active packaging. It monitors the packaged food condition and the environmental atmosphere of food at the time of storage and transport. It also provides sufficient correct and reliable information on the part of food conditions, the environment and the packaging integrity (European Commission, 2011).

D. Nanotechnology in Packaging

From various reports it is found that nanotechnology has various applications in the field of packaging and is less developed but the R&D process is still going on. Main application of nanomaterial is to detect the freshness and to monitor any changes occurred internally o externally in the product. Reynolds (2007) estimated that about 500 products using nano-based packaging are in commercial use and it is expected that manufacturing of 25 per cent of all food packaging using nanotechnology in next era.

E. Biodegradable Packaging (BDP)

Biodegradable packaging is helpful in exchange of gas and/or controlling transfer of moisture in order to provide safe and preserve the nutritional and sensory quality (Siracusa et al. 2008). Biodegradable or eco-friendly packaging is for sustainable development. Examples of biodegradable plastics are cellophane, polylactic acid (PLA), Polyhydroxyalkanoates (PHA).

CONCLUSION

From the above passage it is clear that packaging has a significant role in the progress of milk and milk products by protecting it from external barrier. Packaging is very functional and

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important aspects for milk and milk products. Packaging materials are used to enhance the shelf-life of milk and milk products. Glass was very common in early days for milk packing but the weight and transportation cost of glass was high, so it got disappeared and more use of flexible and rigid packaging materials had been accepted by consumers. Modern packaging practices have reduced the time of packaging and are more efficient and convenient. Recently different packaging techniques have come up to tackle issues of perishable food products especially milk and milk products.

Innovation led to the advancement in packaging technology such as MAP, AP, IP, NP and BDP. Packaging is a technology that adds aesthetic value to a product and also defines the primary functions as barrier and protects milk and milk products from moisture, air, microbes. Packing directly influence the cost of the products as it has brought revolution in modern packaging techniques. Packaging depends on type of food. The products require packaging material accordingly.

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Table 1.Timeline of Innovation and Development in Packaging Industry

Timeline	**Packaging materials**
1200 B.C.	Glass jars
Middle Ages	Wooden barrels
1764	Metal tins
1817	Paperboard box
1884	First glass milk bottle patented
1895	Commercial pasteurization of milk
1899	Milk homogenizer is patented
Early 1900's	Wooden crates and boxes
1908	Cellophane
1914	First milk tanker trucks are introduced
1950-60s	Glass bottles are replaced by carton, Tetra pak, aluminium cans
1961	Aseptic cartons
Mid 1980s and the early 1990s	Plastics, Polyethylene, PET
2011	Intelligent packaging

(Source: Author's compilation from different sources, 2019)

Table 2. Milk and milk products and types of packaging material used

S. No.	**Milk and milk Products**	**Packaging Materials**
1.	Liquid milk	Glass bottles, 3-layer LDPE film with LLDPE based films,

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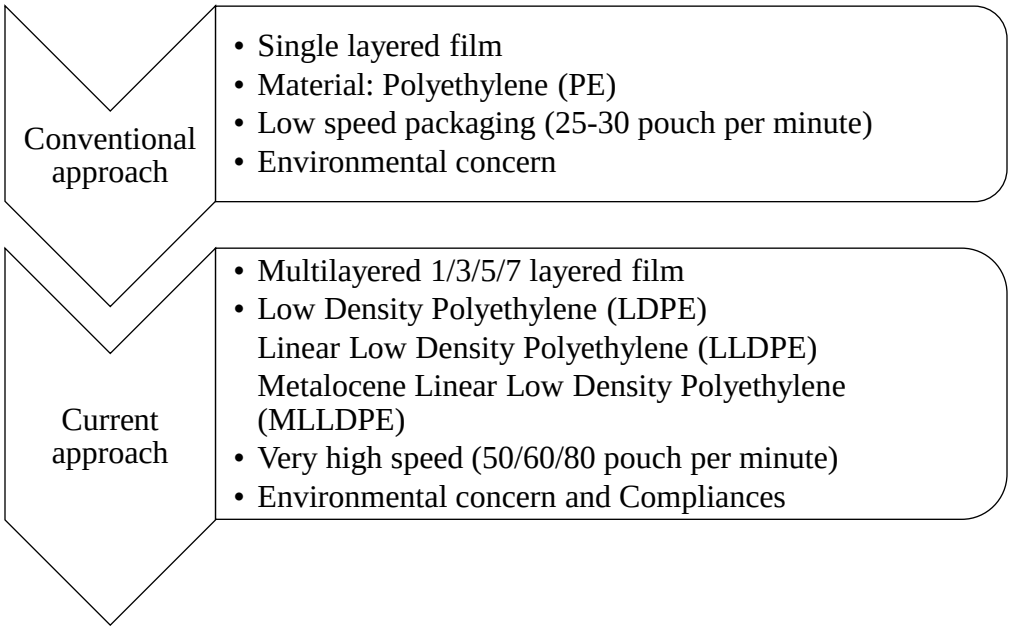
		PET bottles, Paper laminates for tetra packs
2	Butter milk	Plastic pouches, PVC lined HDPE, Tetra pak
3.	Lassi	Polystyrene cups with aluminium foil lid, glass jars, PS/PP cups, PVC lined HDPE, Tetra pak/Brick
4.	Milk Powder	Tin plate containers, Metallized Al. foils, Duplex board carton with inner unprinted pouch
5.	Ghee	Tin plate container, HDPE film pouches, glass bottles
6.	Curd/Yoghurt	Thermoformed polypropylene cups
7.	Butter	Inner parchment paper for duplex board, Tin plate container, Aluminium foil
8.	Cheese/ Cheese spread	CRYOVAC, PVDC (Polyvinyl Dichloride), Tinplate container lacquered from inside, Packed in Al foil and then in a Duplex carton board
9.	Ice-cream	Container which is Thermoformed/ Injection moulded, Duplex board carton, laminates of BOPP or PET
10.	Chocolate	Polyester/ Metalized BOPP

(Source: Adapted from Patil, 2003)

Figure 1. Explains the differences in the packaging materials of milk



(Source: Author's own elaboration, 2019)

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Table 3. Effect of Packaging Materials on Shelf-life and Storage Conditions of Milk and Milk Products

S. No.	Type of Products		Packaging material (Flexible/ Rigid)	Storage Temperature	Shelf-life
1.	Milk	Pouch Milk	Single-use Plastic (Polyethylene)	Below 8^0C under refrigeration	2 days
		PET bottled Milk	Multiple-use Plastic (PVC, HDPE or PET)	Below 8^0C under refrigeration	4 days
		UHT Milk	Pouch	Cool and dry place	2 days after opening and 90 days if packed
			Tetra Pak i.e. Aseptic packaging (70% Paper, 24% Polyethylene plastic and 6% Al.)	Ambient	180 days
2.	Flavoured Milk		PET bottles, Glass bottles, Tetra Pak, Can	Ambient	180 days
3.	Buttermilk		Pouch	Below 8^0C	2 days
			Tetra Pak	Ambient	180 days
4.	Cheese		Tin plate containers	At or below 4^0C	270 days
			Plastic pouches, Al. foils in duplex board carton	At or below 4^0C	180 days
5.	Ghee		PET jar	Cool and dry place	180 days
			Pouch, Refill	Cool and dry place	270 days
			Plastic, Tin	Cool and dry place	365 days
6.	Curd		Poly pack pouches	Below 8^0C	7 days

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			Polypropylene cup	Below 8^0C	15 days
7.	Lassi		Tetra Pak	Ambient	180 days
			Plastic bottle	Below 8^0C	7 days
8.	Ice-cream		Cone, cups, plastic container, paper	Below 18^0C	270 days
9.	Cream		Tetra Pak	Cool and dry place	120 days
10.	Milk-powder		Pouch, Tin, Refill	Ambient	365 days
11.	Malt-based food (Amul-pro)		Glass cube jar, Refill	Ambient	365 days
12.	Paneer		Tin	Ambient	180 days
			Carton, plastic pouch	Below -4^0C	180 days
			Polyethylene Vacuum pouch	At 4^0C	45 days
13.	Sweets	Gulab Jamun/ Rasogolla	Lacquered Tin cans, Paper cartons or polyester boxes	Cool and dry place	180 days
		Burfi/Peda	Paper cartons or duplex board, Polypropylene or HDPE boxes	30^0C	16 days
14.	Butter	Salted Butter	Al. foil, Blister pack	At or Below 4^0C	365 days
			Sleeve carton, Tub with single serve pack	Below 10^0C	270 days
		Unsalted Butter	Sleeve carton	At or below 0^0C	180 days

(Source: Author compilation from various sources, 2019)