MIGRATION STUDY OF FOOD PACKAGING MATERIAL

Abstract

Consumers expect safety and quality from packing materials in addition to contamination protection and prevention. The extensive use of additives in the synthesis of food packaging materials increases the likelihood of migration into food ingredients. These migrants include monomers and oligomers, antioxidants, pollutants, pigments, and solvents, among others. The migration rate is influenced by factors such as packaging material contact time with food products, food composition, and storage temperature. The scientific community has taken notice of the health difficulties caused by the migration phenomena. As a result, its identification, quantification, and negative impacts on the human body must be addressed.

Keywords: Food safety, Food packaging, Legislation, Migration

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I. INTRODUCTION

The functions of food packaging include protecting food from outside contamination and damage, keeping food enclosed, and providing consumers with ingredient and nutritional information. Polyethylene, polyvinyl chloride, polyvinylidene chloride, polystyrene, polyethylene terephthalate, and polyamide are the most often used plastic polymers. The food packaging section is always evolving to meet specific requirements of the consumer. Nowdays, consumers are not only expecting safety and quality from food packaging materials but also, they are concerned about the migration issues occurred from the packaging materials. One of the most important processes that occur as a result of food packaging is migration, which is defined as the mass transference of components from the packaging material to the foodstuff. The diffusion process has a significant impact on the qualities of the packing material. The migration itself is not a health issue, but rather a legal issue in most nations with legislation on permitted materials, substance limits, and prohibitions for certain purposes. Because consumers are becoming more health-conscious; the importance of compounds migrating from packaged materials to foods has intrigued the research and regulatory communities. The term migration usually refers to a diffusion process that is influenced significantly by the interaction of food components with the packaging material. In this chapter the migration mechanism, potential migrants, the migration evaluation and the regulatory controls are discussed.

II. MIGRATION MECHANISM

The diffusion, adsorption, desorption, and evaporation are the basic mechanisms by which additives from packages enter food. Different factors affect the rate of migration. When direct contact with food is used, the migration extent is considerably increased. The ingredients from packaging move into food, which is undesirable. However, because most food stuffs are packed before being purchased by the consumer, some transfer is unavoidable. Contamination occurs when food dissolves and reacts with the migrating stabilizers on the polymer surface. During this procedure, a packaging material comes into contact with food, and even if its mechanical and diffusion properties remain constant, it may impair the organoleptic characteristics of the packaged food. During the processing of packaging, a variety of additives gets develop. Plasticizers, antioxidants, slip additives, and thermal stabilizers are the common additives in most plastics. Adipic acid, toluene, butanone-2, ethyl acetate, and hexane are among the solvents that migrate with molybdate orange pigments[1].Certain factors influence migration parameters, the most important of these elements are: The type of contact- level of migration is determined by whether food packaging material and packaged food come into direct or indirect contact. The nature of the food-foods with a high-fat content have significantly higher rates of migration [2].The amount of a migrating substance is inversely proportional to the contact time squared [3]**.** The temperature at the place of contact appears to have a direct effect on both the quantity and frequency of migration. Temperature increase cause faster migration and the establishment of equilibrium [2]**.** The thickness of the package has a sizable effect on migration rates; higher migration rates are associated with thinner packages [4],whereas there is no connection between migration and the amount of recycled ingredients[5]**.** Highly volatile compounds migrate at a rapid and accelerated rate as demonstrated by [6]**.** Furthermore, when compared to low molecular weight materials, high molecular weight components (>1,200 Daltons) exhibit reduced levels of migration.

III. CHEMICALS THAT MIGRATE FROM PACKAGING MATERIALS

1. **Plasticisers:** It is a chemical that, when added to a plastic can increase its flexibility and ease processing of the material. Plasticizers are crucial additives in many polymers and thus elements of a wide range of goods like food packaging, bottled water containers, toys, and cosmetics. The most common polar and nonpolar plasticizer chemical structures are phthalates, phosphates, carboxylic acid esters, epoxidized fatty acid esters, polymeric polyesters, and modified polymers. Plasticizers are released into the surroundings during the manufacturing and processing of plastic items, as well as during consumer use [3].

2. **Solvents:** Inks are employed as solvent-based dissolutions or dispersions during the printing of plastic packages, which can then be removed by penetration, distillation, and contact, in specific types of oven [3]**.** Organic compounds with low molecular weight that include ketones, esters, alcohols, and hydrocarbons are the most widely used solvents, and they can migrate into food by directly contacting it.

3. **Monomers and Oligomers:** Polystyrene monomer styrene is commonly utilized monomers in polymers that come into proximity to food. Polystyrene is commonly found in yoghurt, fruit juice containers, as well as meat trays, biscuit trays, egg carton [7]. According to [8], It is possible to convert styrene monomer to styrene oxide, which has a high mutagenicity and can be further metabolised to produce hippuric acid. The most prevalent harmful effects of styrene exposure include skin, eye, respiratory tract irritation, and central nervous system depression. According to [9], styrene monomer levels in food packaging typically vary from 100 to 3,000 ppm. Polyethylene Terephthalate (PET) oligomer includes traces levels of low molecular weight oligomers that range from dimers to pentamers. Acetaldehyde is the most important volatile molecule in PET because of its impact on smell quality, particularly in cola-type beverages.

4. **Contaminants:** Other chemicals that could contaminate food include those produced by the breakdown of additives or monomers [10].Benzene and other volatile benzene and alkyl-benzene could be produced during high temperature applications from a variety of food contact plastics. Benzene can diffuse into food from contaminated PET, poly styrene packaging. Due to its low molecular weight; benzene can pass through the packing material and into the food. Because benzene is a potentially carcinogenic component, it must be measured in plastic food packaging [11,12].

IV. MIGRATION TESTING

The migrating chemicals from packing materials to foods can be quantified by exposing the packaging material to food for certain time and temperature periods [11].These migrants are quantified in terms ofspecific migration limit (SML)and overall migration limit (OML).The term overall migration limit (OML) refers to the most permissible quantity of non-volatile chemicals that released from a product into food-simulants (FS).The following compounds must not be released in levels that exceed the specified migration limitations listed in Table 1.

Table 1: Specific migration limit requirements for plastic materials in contact with food

S.No.	Contaminant	Maximum migration limit (mg/kg)
1	Barium	1.0
2	Cobalt	0.05
3	Copper	5.0
4	Iron	48.0
5	Lithium	0.6
6	Manganese	0.6
7	Zinc	25.0

(Source: Food Safety and Standards (Packaging) Regulations, 2017)

V. FOOD SIMULANTS

The FS is a chemical that simulates the properties of many food categories. The migration in stimulants determination must be carried out using the simulants listed in Table2

Table 2: List of migration testing stimulants

Simulant A	Distilled water for aqueous foods with a pH higher than 4.5
Simulant B	3%aceticacidused for acidic aqueous foods (pH below 4.5) such as vinegar
Simulant C	15%ethanolfor the production of alcoholic products
Simulant D	Rectified olive oil, sunflower oil for the production of fatty foods

(Source: IS9845:1988)

VI. QUANTIFICATION OF OVERALL MIGRATION LIMIT(OML)

Fill a 1000 ml cylindrical jar partly with preheated simulant at the desired temperature. Later immerse the test film (10cm×10cm) completely in the simulant. Submerge the cylindrical jar, which is covered with a glass plate, in a simulant at the desired temperature and time. Upon completion of the test period remove, the sample using a glass rod and wash with a small amount of fresh simulant before being combined with the extract ants. By evaporating within a hot plate over low heat, the extracted simulant concentrated to 50-60 ml. The concentrate is then transferred to a clean-tared stainless-steel dish and wash three times with a small amount offers stimulant before being dried in an oven at 100± 5°C. After cooling in a desiccators for 30 minutes, the concentrate 0.1 mgclosest to the weight until a constant weight of residue get into cylindrical jar. The extractive is calculated in mg/dm^2. Blank shall also perform in the absence of a sample. The determination of overall migration shall done by **IS9845:1998** method as given in equation (1)

Amount of extract (Ex) $\frac{mg}{dm^2} = \frac{M}{A} \times 100$………………. (1)

Where
M = residue amounting mg,
A = total exposed surface areaincm^2 for each replicate

VII. LEGISLATION

According to IS 9845 and CEC (Commission of the European Communities) all packaging materials made of plastic must pass with no detectable color migration at the recommended overall migration level of 60 mg/kg or 10 mg/dm^2.

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