

## Occurrence and Distribution of Migrants from Food Packaging Materials.

PEACE C. E., PROF. L.C. OSUJI, DR. C.I. OSU

*Institute of Natural Resources, Environment and Sustainable Development University of Port Harcourt*

**\*Corresponding Authors:** PEACE C. E, *Institute of Natural Resources, Environment and Sustainable Development University of Port Harcourt*

**Abstract:** Food packaging serves purposes of food product safety and easy handling and transport by preventing chemical contamination and enhancing shelf life, which provides convenience for consumers. Various types of materials, including plastics, glass, metals, and papers and their composites, have been used for food packaging. However, owing to consumers' increased health awareness, the significance of transferring harmful materials from packaging materials into foods is of greater concern. This review highlights the interactions of food with packaging materials and elaborates the mechanism, types, and contributing factors of migration of chemical substances from the packaging to foods. Also, various types of chemical migrants from different packaging materials with their possible impacts on food safety and human health are discussed. We conclude with a future outlook based on legislative considerations and ongoing technical contributions to optimization of food-package interactions.

**Keywords:** Heavy metals, Contaminated food

### 1. INTRODUCTION

Food packaging is used for diverse products, and food protection along the supply chain is largely based on the packaging (Brody et al., 2008). Without packaging, the handling of food products would be costly and inefficient (Robertson, 2006). Packaging also provides consumers initial product identity before deciding whether to purchase it. Also, consumer demand is changing and now includes such diverse packaging as active and intelligent packaging. These packaging systems interact and respond to the food-packaging environment, where they release some substances in or scavenge some from the packaging headspace and prolong the shelf life of food products (Robertson, 2006). Such innovative packaging is practiced in part to boost sales in a competitive environment. The packaging style and design may also enhance the product's image and acceptability. Thus, the selection of packaging material is a consideration for consumers at the end of supply chain.

The major objective of packaging is to protect and preserve foods from possible physical, chemical, microbiological, or other hazards that ultimately can impact their quality and safety (Lee, 2010). In the prediction of food shelf life, the design of food packaging is the main consideration. When selecting packaging materials, many factors should be considered, including cost, quality of products, and their ability to maintain product freshness. A few common materials used in food packaging are plastics, paper, glass, and metals. Among these, a wide variety of plastics are used in rigid or flexible food packaging. Packaging materials now include laminates, which were developed by systematically integrating materials with different inherent properties to improve the functionality of the final material. In general, various chemical substances are found in foods during different phases of the supply chain; these include micronutrients, flavorings, antimicrobials, antioxidants, pesticides, and mycotoxins. Also, additives such as plasticizers, monomers, and oligomers found in the packaging materials could transfer to the foods upon contact during process- Primary packaging is main package used to hold food being processed; secondary packaging combines primary packages inside one box; tertiary packaging combines multiple secondary packages into one pack.

## 2. MATERIALS AND METHODS

Food additives are divided into two categories: enrichment ingredients and technology additives. Enrichment compounds have been used to boost the nutritional value of food and to help prevent deficiency disorders. Iodine is added to salt to prevent goitre, and AD-vitamins are added to margarine to prevent health problems caused by a lack of these minerals. However, deficiency disorders are no longer a prominent concern in Europe, and hence the necessity for enrichment has diminished. The present review article will focus on the application and safety of technology food additives, which is a key subject today. Technological food additives are mostly employed to extend the shelf life of food (preservatives and antioxidants), improve the taste of food (sweeteners and flavoring agents), and change the consistency of food (texture modifiers) (emulsifiers and thickeners). Currently, there are over 300 approved technological food additives, which can be split into subgroups.

The majority of additives are found in nature as natural ingredients in foods such as fruits and vegetables. Some of them, however, are now manufactured synthetically. Other synthetically created additives are not found in nature. Natural chemicals that have been chemically changed are known as semi-synthetic additives. Nonetheless, with the exception of flavoring agents, all of these food additives are pure substances that have been assessed for safety and whose usage and intake are controlled, as will be detailed in this article. However, there are currently no regulatory rules for flavoring agents; however, following an ongoing safety study in the European Union, such rules will be implemented in the near future (see section "Flavouring agents"). In the following part, the main groups of food additives and their applications will be briefly discussed:

### Colouring Agents and Dyes

The use of coloring chemicals and colors in our main meals is prohibited. The reason for this is partially due to a widespread aversion to additives, and partly due to the large consumption of staple foods.

### Preservatives

These chemicals are used to preserve and protect food from microorganisms such as bacteria, fungus, and moulds that cause invasion and degradation. Natural poisons produced by bacteria can also be protected through preservation. People employed air-drying, smoke, salt, and fermentation as natural preservatives in the past. Some of these procedures are still utilized today, but others, such as heat treatment, deep freezing, and chemical preservation, are now available.

### Antioxidants

These are used to prevent the rancidification of fat and the discoloration of fruit-based foods. Antioxidants can also protect vitamins that are susceptible to deterioration (such as vitamins A, D, E, and B). Agents that act as emulsifiers, stabilizers, and thickeners, as well as anti-caking agents: This is a large group that includes a variety of substances that are used to change the consistency of foods. Consumers have expressed worry about some additives in this category, such as the anti-caking agent sodiumferrocyanid (E 535) in salt (see section "Flavouring agents").

### Sweeteners

Natural and synthetic (artificial) sweeteners are the two basic types of sweeteners. Natural sweeteners contain energy and can be further classified into two groups: ordinary sugars like glucose, sucrose, and fructose, and sugar alcohols like sorbitol and xylitol. Synthetic sweeteners containing no energy, such as aspartame, acesulphame K, saccharin, and cyclamate, belong to the second group. This set of artificial sweeteners has sparked a lot of debate about their safety, which will be covered in the "Alarm in the Media" section below.

### Flavouring Agents

This class of food additives is used to give foods a distinct flavor or scent. Flavouring agents can be synthesized or derived from natural sources. Some of these synthetic substances can be found in nature, while others are not. They can be used on their own or in combination with other flavorings. This is a huge group with around 2500 chemicals on the market, and their usage has not been controlled as rigorously as other food additives.

### Polycyclic aromatic hydrocarbon

In today's human environment, there are numerous and diverse sources of polycyclic aromatic hydrocarbon contamination of meals. Curing smokes, contaminated soils, polluted air and water, cooking methods, food additives, food processing, and endogenous sources have all been studied,

according to a review of the literature. However, many of the investigations were undertaken at random, and the source of the contaminants and the level of contamination have yet to be determined. Aside from smoke-cured foods, charcoal-broiled meats, and perhaps environmental pollution, Haenni (1968) claims that food additives of petroleum origin are the most common sources of polycyclics as potential food contaminants. As a result, analytical procedures have been implemented to rule out the presence of these chemicals in petroleum products that could be used as food additives. The complicated activities involved in food collecting, processing, and packing make determining the source of contamination extremely challenging.

Triantafyllou, et al. (2018) used Gas Chromatography–Tandem Mass Spectrometry to investigate Simultaneous Determination of 18 Polycyclic Aromatic Hydrocarbons in Daily Foods (Hanoi Metropolitan Area). PAHs, or polycyclic aromatic hydrocarbons, are a class of chemical molecules that are particularly harmful to human health. The QuEChERS sample treatment technology was used to collect and prepare 198 samples from six groups of everyday food products in the Hanoi metropolitan region for this study. Gas chromatography–tandem mass spectrometry (GC–MS/MS) was used to determine the presence and identity of PAHs. The results showed that when the solvent evaporation condition was improved using nitrogen gas at a low temperature, the recovery of PAH chemicals ranged between 71 and 110 percent (1 C). In terms of linearity, extraction condition, repeatability, recovery, limit of detection (LOD), and limit of quantification, the in-house method was validated (LOQ). Average PAH levels ranged from 9.3–9.6 g/kg in quick noodles, 0.22–2.48 g/kg in cakes, 0.91–4.83 g/kg in dry vegetables, 5.14–23.32 g/kg in teas, 4.82–24.35 g/kg in coffees, and 1.43–25.2 g/kg in instant noodles (grilled meats). The findings showed that overall quantities of residual PAHs and benzo(a)pyrene in instant noodles and grilled meat samples exceeded the European Commission's maximum tolerance levels (35 g/kg and 5 g/kg, respectively) in many of the samples tested.

Grob, K., 2002 conducted a comprehensive survey on the occurrence, isolation, and identification of polycyclic aromatic hydrocarbons in the human environment. These authors emphasized the significance of both the qualitative and quantitative aspects of their presence as residues in the overall environment. Because some of these compounds are carcinogenic. Thus. Strict monitoring of their presence in foodstuffs and other materials to which humans are exposed is required. Helmroth, et al., (2020) has provided an in-depth review of the development of analytical controls for potential polycyclic hydrocarbon contaminants in foods and food additives. As he suggests, it is very likely that only a small subset of the potential compounds in this class have been identified. Recognised. And toxicologically evaluated, owing to complex structures. Because of the small quantities present. And the fact that adequate specificity and sensitivity analytical methods have only recently been developed.

One of the most difficult challenges for the analyst has been the development of appropriate separative techniques for the identification and determination of individual polycyclic hydrocarbons. As Helmroth, et al., (2020), It is more of an exception than the rule to find only one or two of these compounds together. More often than not, they occur as a minute fraction of a complete hydrocarbon mixture. Physical and chemical properties are usually closely related. One of the most significant difficulties encountered in previous studies has been the resolution of the so-called "benzopyrene fraction," which contains the carcinogen benzo (a)pyrene. Its isomers include benzo(e) pyrene and benzo(k)fluoranthene. And also perylene. Such separations are critical for regulators because the analyst must be able to separate and unequivocally identify carcinogenic hydrocarbons from the many noncarcinogenic types that have been shown to be present in foodstuffs and related products of food additive significance.

Its previous studies on food additives were conducted by the Food and Drug Administration (FDA) several years ago. Initiated research in the Division of Food Chemistry and Technology on the development and application of analytical methods for polycyclic hydrocarbons. Food and Drug Administration, 2020 Washington, D.C. a variety of foodstuffs Two procedures applicable to smoked foods were described at the 1965 annual meeting of the Association of Official Analytical Chemists (AOAC): a general method for polycyclic aromatic hydrocarbons (Howard et al., 1966a) and a specific procedure for benzo(a)pyrene (Howard et al., 1966c). Both methods were shown to be sensitive to 2 ppb. In a nutshell, they consist of an initial hydrocarbon extraction followed by a partition step between dimethyl sulfoxide and an aliphatic solvent. Column chromatography on pretreated Florisil is then used to reduce interfering background material and isolate the polycyclic compound, followed by paper and thin-layer separation (s). Depending on the type of product being analyzed and the specific

hydrocarbons to be isolated, all of these techniques may be required to obtain satisfactory ultraviolet and spectrophotofluorometric spectra for characterization and estimation of the compounds present. If only benzo (a)pyrene is to be found. The procedure can be significantly shortened by using thin-layer chromatography on cellulose acetate directly instead of the time-consuming paper chromatographic technique. The cellulose acetate TLC procedure successfully separates the components of the aforementioned "benzopyrene fraction," whereas most other paper and thin-layer chromatographic techniques fail in this regard.

This project overlapped with the International Union of Pure and Applied Chemistry's (IUPAC) Subcommittee on Smoke Constituents, Trace Substances Commission, which also aimed to evaluate the procedures. Because of this shared interest, the AOAC and IUPAC decided to conduct a joint collaborative study. In the hope that it would garner enough broad support to justify TUPAC's adoption of the AOAC procedures, at least as referee methods. Members of the TUPAC Food Section agreed that the benzo (a)pyrene method should be investigated first. Because it was determined that the more time-consuming and complicated multicomponent procedure for specific hydrocarbons would be impractical for the program's initial phases, and also because benzo (a) pyrene is the most commonly occurring carcinogen of this type. The collaborative results obtained by 11 laboratories on nine samples (smoked fish and smoked ham) fortified with benzo(a)pyrene at levels of 4 and 10 p.p.b. were in good agreement, and the method was adopted as official, first action, at the 1967 AOAC meeting (Howard et al., 1968b). The Trace Substances Commission recommended that IUPAC adopt the method as a referee procedure. Since the publication of the aforementioned general method, it has been discovered that the procedure can be significantly shortened, and a collaborative study is expected to begin soon.

In addition to the studies on smoked foods and vegetable oils, the FDA has continued its method development program in other dietary applications (Duggan and Johnson, 1967; Mills, 1963). Furthermore, the nutrient content (Deutsch et al., 1963) of our food supplements Briefly, Verv. This type of surveillance is carried out using well-established methods for analyzing sample categories made up of combinations of similar food items. The wide range of food types and quantities. Their usage patterns, environmental factors, and permissible levels make it impractical to provide adequate control via product-by-product analysis (Haenni, 1968).

Multidetector procedures for determining polycyclic hydrocarbons in root vegetables, dairy products, oils, and fats have been developed. And meat, and shortenings. Fish. And there's poultry, and there's alcohol (Howard et al., 1968c). However, they have not been validated as a yet by a collaborative study. The following compounds were discovered in shortening composites at concentrations less than 0.5 p.p.b.: pyrene. Benzo(k)fluoranthene and benzo(b)fluoranthene benz(a) anthracene, perylene, pyrene, fluoranthene As well as phenanthrene. The only hydrocarbons found in the other composites were pyrene and fluoranthene.

### **Plants and fruits**

There is currently little information on the extent to which our food supply has been contaminated by air pollutants. Gunther et al. (1967) discovered approximately 25 ppm of anthracene and six unidentified polycyclics in the rinds of oranges grown in polluted environments. However, this does not apply to fruit harvested in uncontaminated areas. Based on these findings, they emphasized the importance of studying the polycyclic content of food plants. Particularly those grown in areas with high levels of air pollution. Industrialization and widespread petroleum oil exploitation According to Bolling (1964), wheat. Corn and oats Furthermore, barley grown in industrial settings had higher levels of contaminants than crops grown in more remote areas. Graf and Diehl (1966) isolated eight polycyclic hydrocarbons from plant leaves, including benzo(a)pyrene, at concentrations ranging from 8 to 40 ppb. Fruit and grains contained lower levels. These researchers came to the conclusion that the hydrocarbons were endogenous.

The migration of polycyclic hydrocarbons from contaminated soils into plants has also received some attention, but it is still unresolved. Benzo (a)pyrene (levels ranging from 40 to 1300 p.p.b.) and numerous other hydrocarbons have been discovered in soil (Blumer, 1961) and hypothesized to be derived from the pyrolysis of wood or alternatively as possible products of organisms that contribute organic matter to soils. The latter concept, which includes subsequent plant translocation. Mallet (1964) proposed it after discovering 10 to 14 p.p.b. of benzo (a)pyrene in tree leaves and 43 p.p.b. in decaying organic matter under the trees. Doerr reported additional evidence for the existence of this mechanism

(1965). Who demonstrated that benzo (a)pyrene was absorbed by barley roots in soil or water cultures, with subsequent transfer to shoots. Guddal (1959) also claims that plants grown in contaminated soils absorb various hydrocarbons.

### Seafoods

Polycyclic hydrocarbon uptake by marine life in polluted waters has been studied. Claudio (2012) isolated benzo(a)pyrene and other polycyclic compounds (total level about 200 p.p.b.) from oysters collected from a moderately contaminated area with petroleum oils. The authors assumed that the amount of hydrocarbons in oysters varies depending on their habitat. This assumption was based on previous findings of other researchers who found variations in the levels of compounds as well as the composition of the hydrocarbon mixture depending on the environment. Mallet (1964) and Mallet and Priou (1967) found benzo (a) pyrene in marine sediments that were 500 years old, as well as progressive mollusk contamination. Worms, algae, and other organisms were exposed to benzo (a)pyrene derivatives of unknown origin. Saccini-Cicatelli (1965, 1966) discovered that worms exposed to benzo (a)pyrene-contaminated water absorbed as much as 88.2 p.p.m. of the hydrocarbon but retained up to 350 p.p.b. when placed in pure water.

### Cooking of food

The mode of cooking as a potential source of food contamination is also worth mentioning here. Benzo (a)pyrene, for example, has been discovered in charred crusts of biscuits (Kuratsune, 1956) and in some samples of commercially roasted coffees (Kuratsune and Hueper, 1962). Because polysaccharides are present in most foods, Davies and Wilrnshurst (1960) investigated the pyrolytic behavior of starch in the absence of air and at atmospheric pressure. As a result, the following outcomes: At 370 to 390 C., benzo (a)pyrene was present in the distillation residue at a level of 0.7 p.p.b. ; at 650 C., 17 p.p.b.

Masuda et al. (1967) conducted some similar research on carbohydrates, amino acids, and fatty acids. At 300 C., no polycyclic compounds were discovered; however, at 500 C and 700 C., 19 hydrocarbons, including benzo (a)pyrene, were isolated from the above materials. Carbohydrates produced more polycyclics at 500 C., whereas fat acids produced more at 700 C. Many cooking processes use the temperature range of 370 to 390 C., whereas the surface temperatures of baking bread may approach 400 C. and boiling cooking fats, 400 to 600 C.

Seppilli and Scassellati-Sforzolini (2003) reported the formation of polycyclic hydrocarbons in meat as a result of grilling in 1963, and Lijinsky and Shubik (1965a) reported it in 1965. Benzo (a)pyrene was found at levels of 5 to 8 p.p.b. in charcoal-broiled steaks and 10.5 p.p.b. in barbecued ribs in the latter study. Several other polycyclic compounds were discovered. The authors concluded that the likely pyrolysis sources of the hydrocarbons were fat or other carbon-hydrogen-oxygen-containing compounds in the meat. Lijinsky and Ross (1967) investigated the effect of cooking methods on the content of benzo (a)pyrene and other polycyclic hydrocarbons in meat. The authors confirmed in this study that the production of polycyclic hydrocarbons in charcoal broiling is dependent on the fat content of the food. The proximity to the source of heat is also an important consideration. For example, levels of benzo (a)pyrene as high as 50 p.p.b. were found in thick T-bone steaks cooked close to the coals for extended periods of time, whereas concentrations were significantly lower in samples prepared (to the same end point) at a greater distance from the heat source. The authors concluded that in order to reduce the production of carcinogens such as benzo (a)pyrene in cooking, the method of preparation should avoid contact of the food with cooking flames, cook for a longer period of time at lower temperatures, and use meat with the least amount of fat.

## 3. CONCLUSION

Food safety and contamination attitudes in society are typically based on history and habit. Despite the fact that customers choose their diets based on social and financial considerations, the responsibility for food safety remains firmly in the hands of regulatory organizations. These organizations can keep an eye out for pollutants and enforce laws. Contamination of food has political ramifications as well. As previously stated, food safety rules are required, as are food and water contamination monitoring and steps to prevent and eliminate environmental pollution exposure. Following environmental pollution-related incidents, it is incumbent on a government to put in place public health, legal, and ethical frameworks as soon as possible. Society should be educated about safer crop production and livestock husbandry, as well as the importance of eating a balanced diet and using safer cooking methods.

Governments should work to decrease urban inequities in environmental exposures on a national scale. Although some contaminants have localized impacts, the majority are distributed worldwide. As a result, an international approach to food safety is required, with the goal of reducing environmental and food contamination while also ensuring global trade in safer food products.

### REFERENCES

- [1] Blumer, M. (1961). Benzpyrenes in soil. *Science*, 134(3477), 474-475.
- [2] Bolling, H. (1964). Carcinogenic substances in cereals dried by combustion gas. *Tech. Monit. Pinerolo*, 15, 137-142.
- [3] Brody, A.L., Bugusu, B., Han, J.H., Sand, C.K., McHugh, T.H., 2008. Innovative food packaging solutions. *J. Food Sci.* 73 (8), 107–116.
- [4] Claudio, L., 2012. Our food: Packaging & public health. *Environ. Health Perspect.* 120 (6), A232–7.
- [5] Deutsch, J. A., & Deutsch, D. (1963). Attention: Some theoretical considerations. *Psychological review*, 70(1), 80.
- [6] Duggan, R. E., & Weatherwax, J. R. (1967). Dietary Intake of Pesticide Chemicals: Calculated daily consumption of pesticides with foods are discussed and compared with currently accepted values. *Science*, 157(3792), 1006-1010.
- [7] Graf, W., & Diehl, H. (1966). Concerning the naturally caused normal level of carcinogenic polycyclic aromatics and its cause. *Arch. Hyg*, 150, 2499259.
- [8] Grob, K., 2002. Comprehensive analysis of migrates from foodpackaging materials:a challenge. *Food Addit. Contamin.* 19, 185e191.
- [9] Gunther, F. A., Buzzetti, F., & Westlake, W. E. (1967). Residue behavior of polynuclear hydrocarbons on and in oranges. *Residue Reviews/Rückstands-Berichte*, 81-104.
- [10] Haenni, E. O. (1968). Analytical control of polycyclic aromatic hydrocarbons in food and food additives. *Residue Reviews/Rückstands-Berichte*, 41-78.
- [11] Howard G. Johns, S.M., Jickells, S.M., Read, W.A., Castle, L., 1968b. Studies on functional barriersto migration. 3. Migration of benzophenone and model ink components from cartonboard to food during frozen storage and microwave heating. *Packag Technol. Sci.* 13 (3), 99–104.,
- [12] Howard, R., Bumba, V., & Smith, S. F. (1968). ATLAS OF SOLAR MAGNETIC FIELDS. MAPS OF PHOTOSPHERIC MAGNETIC FIELDS FOR AUGUST 1959-JUNE 1966. CARNEGIE INSTITUTION OF WASHINGTON DC.
- [13] Lee, K.M., 2010. Quality and safety aspects of meat production as affected by various physical manipulations of packaging materials. *Meat Sci.* 86, 138–150.
- [14] Mallet, J. (1964). De l'homosexualité psychotique. *Revue française de psychanalyse*, 28(5-6), 721-727.
- [15] Mallet, L., & Priou, M. (1967). Retention of BP-type PH by the marine sediments, fauna and flora of the Bay of Saint Malo, C. R. Acad. Sci.(Paris), 264, 969-971.
- [16] Mills, P. A., Onley, J. H., & Gaither, R. (1963). Rapid method for chlorinated pesticide residues in nonfatty foods. *Journal of the Association of Official Agricultural Chemists*, 46(2), 186-191.
- [17] Robertson, G.L., 2006. Safety and legislative aspects of packaging. *Food packaging principles and practice*, vol. 3. CRC Press, US, pp. 473–502.
- [18] Triantafyllou, V.I., Akrida-Demertzi, K., Demertzi, P.G., 2018. Determination of partition behaviour of organic surrogates between paperboard packaging materials and air. *J. Chromatogr. A.* 1077 (1), 74–79.

**Citation:** PEACE C. E., et.al., "Occurrence and Distribution of Migrants from Food Packaging Materials ", *International Journal of Research in Environmental Science (IJRES)*, vol. 8, no. 2, pp. 14-19, 2022. Available: DOI: <http://dx.doi.org/10.20431/2454-9444.0802002>

**Copyright:** © 2022 Authors. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.