HAZARD CHEMICALS IN SOME FOOD PACKAGING MATERIALS (A REVIEW)

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Abstract
Food is heterogeneous mixture of complex chemicals that react with one another or with any other chemical comes into direct contact with them. Fresh and processed foods are exposed to various storage and processing conditions that may trigger reactions between chemicals or may facilitate movement of active micro molecules from the package surfaces into the food. The primary aim for packaging food is to extent it shelf life by protecting it wholesomeness in such a way that safe food will reach consumer's table. This can be achieved by creating packaging atmosphere that will maintain the levels and quality of all the nutrients present, avoid changes in the chemical composition and prevent entrance of any foreign material. Interaction between food and packaging materials is highly undesirable and it draws more attention when the composition of the migrants is unknown or was not proved to be safe. Packaging materials are required to be absolutely inert so that they will not interact in any way with the food. Scientific evidences proved that food components can react with some packaging materials and produced chemicals that may be dangerous to consumers. Chemicals in some food contact surfaces do not really react with the food but they do release poisonous chemicals into the food when they come into direct contact. The extent of food contamination by package's chemicals in both flexible and rigid packaging materials depend on nature and composition of the food, nature and composition of the packaging material and properties of the storage or processing conditions.

Keywords: Food, Food packaging, Wholesomeness, hazardous, Contamination.

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1. INTRODUCTION

Food packaging is defined as external means of preservation of food during storage handling transportation and marketing (Bolaji, 2010). Food packaging is pervasive and essential (Gordon, 2010); it surrounds, enhances and protects foods during processing and manufacturing, through handling and storage, to the final consumer. Without packaging, materials handling would be a messy, inefficient and costly exercise and modem consumer marketing would be virtually impossible. (Bev et. al., 2003)

Food packaging performs a number of disparate tasks: it protects the food from contamination and spoilage; it makes it easier to transport and store foods; and it provides uniform measurement of contents. It also makes advertising meaningful and makes products more usable and convenient. Understanding deterioration reactions is the first step in developing food packaging that will minimize undesirable changes in quality and maximize the development and maintenance of desirable properties (Gordon, 2010). Maintaining quality parameters, safety improvement, and reducing postharvest losses and waste are key objectives of a sustainable food system. High incidence of postharvest losses and waste pose a major problem in the food industry and world at large. Inappropriate processing and packaging (or lack of these) can contribute to 25 to 50% food loss, especially in developing countries (Opara and Asanda, 2013). Packaging is one of the most important parts of marketing planning and it plays a key role on marketing products and services. A good packaging absorbs more customers and increases people's intention on purchasing products (Naser and Maryam, 2012).

Packaging provides protection from chemical, biological, and physical deteriorations. Chemical protection minimizes compositional changes triggered by environmental influences such as exposure to gases (typically oxygen), moisture (gain or loss), or light (visible, infrared, or ultraviolet). Biological protection provides a barrier to microorganisms (pathogens and spoiling agents), insects, rodents, and other animals, thereby preventing disease and spoilage. In addition, biological barriers maintain conditions to control senescence (ripening and aging). Physical protection shields food from mechanical damage and includes cushioning against the shock and vibration encountered during distribution. Typically developed from paperboard and corrugated materials, physical barriers resist impacts, abrasions, and crushing damage, so they are widely used as shipping containers and as packaging for delicate foods such as eggs and fresh fruits. (Kenneth and Betty, 2007).

2. CHEMICALS MIGRATION AND FOOD CONTACT SURFACES

It is recognized that chemicals from packaging and other food contact materials can migrate into the food and be ingested by the consumer (Castle, 2007). Mineral hydrocarbons, including liquid paraffin, white oil, petroleum jelly, hard paraffin and microcrystalline wax, may be used in certain polymers as processing aids (Helen and James, 2003). The monitoring of this migration has become an integral part of ensuring food safety. Packaging systems and other food-contact materials are also a source of chemicals in food products and beverages. Human exposure to chemicals from packaging and other materials in contact with food may occur as a result of migration from the packaging materials into foodstuffs. The intensity and danger of the chemical migrants depend on their quantity and characteristics (Maria and Timothy, 2010), length of contact time and temperature of exposure, with the highest levels observed where there was a direct contact between the film and food, and where the latter had a high fat content on the contact surface (Helen and James, 2003).
Food packaging has greatly improved human health both now and through the ages by helping to provide regular and reliable supplies of safe, wholesome and nutritious foods. But chemical migration is always undesirable and if not controlled it could be hazardous to the health of consumers. The exception is for ‘active packaging’ which may be intended to release substances into the food with beneficial effects, such as antioxidants or preservatives (Castle, 2007).
Food and beverages can be very aggressive products and may interact strongly with materials that they touch. Collectively, they are as good as many of the solvents used in a chemistry laboratory. For example, food acids can corrode metals, fats and oils can swell and leach plastics, and beverages can disintegrate unprotected paper and carton board. In fact, no food contact material is completely inert and so it is possible for their chemical constituents to ‘migrate’ into the packaged food. Metals, glass, ceramics, plastics, rubber and paper can all release minute amounts of their chemical constituents when they touch certain types of foods. This release of chemicals to the food is known technically as migration. Migration of chemicals from packaging materials into the food depend on Composition of the packaging material, nature and extent of contact, nature of the food, temperature of contact, duration of contact and Mobility of the chemicals in the packaging (Castle, 2007).

3. PLASTIC CONTAINERS

Plastic bags have been introduced in the 1970’s and gained an increasing popularity amongst consumers and retailers. They are available in huge numbers and varieties across the world (Abraha and Desta, 2012). Chemicals used in manufacturing plastics containers are highly toxic, mainly carcinogens. They are known to have effects on nervous system, blood, kidneys etc. There are many additives (eg plasticizers) added to plastics at the time of production to facilitate manufacture and use, these additives

are known to be harmful and they may interact with the food (Ningwei and Mahat, 2009 and Mark et. al., 2003).
The contents of the PET bottle and storage temperature both appear to influence the rate and magnitude of leaching of organic and inorganic compounds from PET bottle. Exposure of PET bottles at temperature range between 37^0C to 47^0C for 30 days shows significance increase in in the concentration of NO_3^-, SO_4, NH, Chemical oxygen demand (COD), Electrical conductivity (EC) and Total dissolved salt (TDS) with increase of sunlight exposure time. The concentrations of Cl^-, F^- and pH decrease with increase in sun light exposure time. Increase in EC and TDS concentration may be due to leaching of ions and metals from plastic to the water (Sulaiman et. al., 2011).
Mineral water (in PET bottle) concentrated with silica and store under darkness for 30 days revealed a mutagenic activity in salmonella strain TA 98. The mutagenic activity was twice as high for same samples expose to sunlight (40^0C, average) for 30 days (Bach et. al., 2012).
Reusing plastic materials with poor cleaning system result in leaching of chemical pollutants, such as bisphenol A, phthalates and antimony that are toxic to humans. It also serves as breeding grounds for pathogenic organisms, this spreads infectious diseases. This practice can cause serious health problems due to some carcinogenic agents and cross contamination by microorganisms (Abraha and Desta, 2012).

3.1 Bisphenol A (BPA) in PET bottle

Bisphenol A (BPA) is used to produce certain types of plastic that are used in thousands of formulations for myriad products. Containers made with these plastics may expose people to small amounts of BPA in food and water (Linda and Sarah, 2010).
Groff (2010) cited in Abraha and Desta (2012) reported that food and drinks stored in plastic containers can contain trace amount of bisphenol A (BPA), a synthetic chemical that interferes with the body's natural hormonal messaging system. The same studies found that repeated re-use of such bottles, which get dinged up through normal wear and tear and while being washed, increases the chance that chemicals will leak out of the tiny cracks and crevices that develop over time.
It is clear that BPA is capable of interfering with the action of estrogen, an important regulator of reproduction and development. (Interference with hormonal action is often referred to as endocrine disruption.). Bisphenol A exposure in the general population comes primarily from consumption of food and beverages (Linda and Sarah, 2010).

4. METAL CANS

Metal cans used in packaging foods must be able to preserve and protect it content, resist any chemical reactions, and withstand the handling and processing conditions. Mechanical damage to cans, such as denting caused by poor handling, can result in cracking of the internal lacquer. This will allow the product to gain access to the underlying metal, and may result in quite rapid localized corrosion, depending on the can and the product. Occasionally, internal corrosion may result from an unusually aggressive reaction between the can and its contents, causing the lacquer to peel away from the can surface (Bev et. al., 2003). Monomers such as bisphenol-A and bisphenol-F, and their diglycidyl ethers migrate from can lacquers into canned foods, these migrants considered to pose great health concern (Helen and James, 2003).
Ghada *et. al.* (2012) reported that aluminum leaching from the foil into the food solution is the same in liquid and vapor phases. Aluminum foil used in cooking provides an easy channel for the metal to enter the human body. The increase in cooking temperature causes more leaching. The leaching is also highly dependent on the pH value of the food solution, salt, and spices added to the food solutions. Aluminum foil is not suitable for cooking specially with acidic food. It is also possible that excessive consumption of food baked with aluminum foil may carry a serious health risk.

Investigations revealed that extremely toxic heavy metals (Pb; Cd and Al) were detected above the toxicity levels in locally packaged powdered milk marketed in Dakahlia, Egypt. The researchers related high concentration of these toxic metals to contamination during handling, storage, marketing, and leaching from containers (Salah et al., 2013).

5. INKED PAPERS

According to International Regulations and Guidelines on Printing Inks, the printed surfaces shall not come into direct contact with food, and under normal or foreseeable conditions of use they do not transfer their constituents to food in quantities that can endanger human health, bring about an unacceptable change in the composition of food, or bring about deterioration in the organoleptic characteristics thereof (Josef et. al., 2011).

Newspapers, question papers and answer scripts are used for food packaging in developing countries. For instant, in Nigeria, they are used in packaging of fresh and roasted meat (*Suya*), boiled and fried tubers, fried and smoked fish etc. Society of British Printing Ink Manufacturers (1993) reported that heavy metals such as titanium, chromate, molybdenum, and iron are used as pigments in printing ink production; cobalt and manganese are used as driers; titanium oxide is used for pearlescent pigments; and aluminum and brass are used in metallic inks. Food wrapped in any of these papers may likely to be defile by these heavy metals. Heat and presence of water or oil in the surface of the food will increase the rate of contamination. Dermal administration of black newsprint inks produces local toxicity at the site of application in mice (Joel, 1992).

In modern packaging, inks and lacquers are applied to the outside of packaging materials, but low molecular weight substances such as photoinitiators and plasticisers present in printing inks may permeate through the material and subsequently migrate into foods (Greenwo, 2011).

6. PORTLAND CEMENT PACKAGE

Cement paper also have wide applications in local packaging in Nigeria, particularly among rural dwellers. It is use in packaging of fresh and process animal flesh, use as casing in production of local sausage, it also use as wrapping material in processing of some traditional foods (eg kappa). Portal cement is a mixture of complex chemicals which include toxic alkalis such as MgO, Na_2O and K_2O, these chemicals when react with water in cement can increase pH value up to 13.5 (Cemex, 2006). It also contain Tricalcium Silicate (C_3S) and Dicalcium Silicate (C_3S) in large quantities which when react with water will produce calcium hydroxide {Ca(OH)2} (Mehta and Palulo, 2004). When food is package in cement paper trace of these toxic chemical may contaminate it and they may finally reach intestine through consumption.

7. TRADITIONAL PACKAGING

In the early days of agriculture, leaves and animal skin were used as packaging materials to carry food over short distances and to secure them for later use (Opara and Asanda, 2013). Research reveals that some traditional packaging materials may be hazardous or may have negative implications on the food quality.

7.1 Leaves

Leaves form a wide variety of tropical plants use for packaging either as direct wrapping or by firming them into containers and basket. Fresh leaves are not hygienic initially, they may be contaminated by spider webs, larvae or pupae (Bolaji, 2010), some leaves may contain natural occurring toxins (eg cassava leaves) in their compositions that may be dangerous to health. Therefore care must be taken while using leaves in food packaging, and must be clean thoroughly and properly dried before packaging the food (Bolaji, 2010).

Ajala (2011) reported that aluminium foil and nylon are far better than banana leaves in packaging of Egidi. Aluminium foil and nylon

were reported to be more affective in term of safety and quality protection.
Leaves cannot be used for long time storage because they have poor protection properties against environmental factors, microbes, odour and insects (Bolaji, 2010).

7.2 Basket and Jute Bags

Basket, jute bags and sacks of various capacities produced from plant stems, fronds and fiber are commonly used for transportation of wide range of legumes, tubers fruits and vegetables. Basket jute provides poor protection against insects, microorganisms and environmental factors (Bolaji, 2010). Foods package in basket and jute bags are susceptible to spoilage and contamination by both spoilage and pathogenic microorganisms because these packaging materials are difficult to sanitize hence cross contamination is highly possible.

7.3 Guard and calabash

These have wide application in storage and transportation of water, cereal gruel and dairy products. They are also used in traditional processing of milk (Bolaji, 2010). Unlike other traditional packaging materials, guard and calabash are easy to clean and they provide better protection than leaves, basket and jutes. They can be wash and dried under sun to remove microorganisms if presence and to remove smell of previous content (Bolaji, 2010).

7.4 Skin and Hide

Animal hides and skins have been use over years as containers for storing and transportation of wine and water. The disadvantage of using animal skin is the minimal protection offered and the contaminating odour that may arise from such packages (Bolaji, 2010).

8. CONCLUSIONS

Food processing and packaging aimed to extent the shelf life of agricultural produce so that varieties of food will be available year round, with the help of appropriate packaging different types of food will be available in different location at different season of the year. It is the responsibility of food processor to ensure safe delivery of food to ultimate consumer in a sound state. For this to be achieved, the use of packaging materials that are hazardous and use of processing or storage conditions which when combined with some packaging materials stimulate the formation of toxic chemicals must avoided.

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