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Immersion Method to Assess Safety Foodstuffs Plastic Packaging Materials in Gezira State

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ABSTRACT

This study was conducted to assess the safety of the commercial plastic packaging materials in Wad-Medani town which purchased from local market by the consumer for filling, packing and/or preserving foodstuffs. The samples of plastic packaging materials were randomly collected from the local market in Wad-Medani Town in Central Sudan. The immersion method technique was applied to determine overall migration (non-volatile) of plastic packaging materials. The main findings were that, 25% and 16.7% of the commercial plastic packaging materials not applicable and safe in aqueous food types if the pH value of the foodstuff > 4.5 and < 4.5, respectively, when compared with European commission regulations10/2011.

Keywords: Plastic Packaging; Overall Migration (OM); Food Stimulants; Food Contact Substance.

INTRODUCTION

The safety materials and additive substances in contact with food must be evaluated as molecules can migrate from the materials into food known as food contact substances (FCSs) [1,2]. So that, any potential transfer to foods that does not raise safety concerns, might change the composition of the food in an unacceptable way or have adverse effects on the taste and odour of foods [3–6]. The quality and descriptions of plastic packaging materials used for food packaging must be safe and compatible with international requirements in regulations at all stages of plastic supply chain beginning with the supply of resin (*i.e.* the base of plastic) and additive materials, manufacturing process in the factory, distribution of the plastic products in local market by retailers and proper use by the consumers at home[7]. In Sudan, the products of the commercial plastic packaging materials (*i.e.* wraps, pouches, sacks, bags) is supplied in the local markets from Khartoum plastic factories and most of plastic articles are imported for food services (*i.e.* cups, spoons, boxes and dishes, bowls) from Egypt, Saudi Arabia, China and United Arab Emirates.

The commercial plastic materials that are used for packaging foodstuffs in Sudan depend on the color. The plastic white color manufactured from Low-Density Polyethylene (LDPE) for frozen foodstuffs and from High-Density Polyethylene (HDPE) for hot foodstuffs, the black color for waste materials, and other colors for dry food and fresh foodstuffs in groceries [8]. This means the consumer and food retailer for marketing use many products of the commercial plastic packaging materials and articles for filling, preserving and packing foodstuffs with unknown safety standards for use.

MATERIALS AND METHODS

We randomly selected 72 samples from 144 specimens of plastic packaging materials from six plastic-sale points in Wad-Medani town local market which were manufactured in Sudan. The criteria of sample based on 300 mm length x 210 mm width and two kilograms pay load. The study focused on the commercial plastic packaging materials named as polyolefins (PO) due to lack of label information on plastic packaging. The polyolefins (PO) included: Low Density Polyethylene (LDPE), Very Low Density Polyethylene (VLDPE), High Density Polyethylene (HDPE) and Polypropylene (PP). This classification of polyolefins as referred to European Commission[9].

The preparation of aqueous food simulants and plastic samples of tests in the laboratory was laid under BS EN 1186-1: 2002 and BS EN 1186-3: 2002 framework and European Commission Directive EU 10/2011 to determine overall migration as:

⇨ Food simulant (A) 100 ml of 95% Ethanol (v/v) added to the 900 ml of distilled water to volume of 1 Liter. The food simulant (A) recommended for testing aqueous food pH > 4.5.
⇨ Food simulant (B) 30 g of acetic acid (w/v) added to the 970 ml distilled water to volume of 1 Liter. The food simulant (B) recommended for testing aqueous food type pH < 4.5.

The study applied standardized testing condition over migration number five (OM5) at 2 hours in 100 °C for determining overall migration (non-volatile) of plastic packaging materials polyolefins (PO) as recommended by European Commission Directive EU 10/2011[10–12].

The Statistical Package for Social Sciences (SPSS) Software Program Ver.20 was used to calculate the overall migration values average means and standard deviation (X ± SD) and compared with the overall migration as recommended by European Union (EU) regulations 10/2011[10].

RESULTS AND DISCUSSION

3.1. Overall migration (OM) value in aqueous food simulant (A)
As shown in Table 1 and Fig. 1, the overall migration mean values of the commercial plastic packaging materials ranged between 7.3-12 mg/dm² into aqueous food simulant (A). It has been found that, the overall migration mean±SD value of 25% (n=3/12) of the tested commercial plastic packaging materials samples was (9.5± 2.5 mg/dm²), and this value exceed the permissible limit (10 mg/dm²) and not applicable in aqueous food types if the pH value of the foodstuff exceeds 4.5 as stated by the European Commission Regulations 10/2011[10]. The permeability characteristics of polymer material with food simulants, which normally contain water, are an important key to fully understand its suitability as food packaging. The change in the permeability after the contact with food simulants is principally due to the swelling effect of the water molecules. Regarding Polyethylene (PE) and Propylene (PP), which are hydrophobic films, the gas permeability values (for N2, CO2, and O2) are strongly affected after the contact with the food simulants. The reason may be a consequence of a difference in crystallinity and morphology of films as well as the presence of additives, residual monomers, or oligomers as reported by [13]. If the packaging is not compatible with a given type of food then there can be a strong interaction leading to an accelerated release of chemical substances. However, undesirable interactions between food and packaging materials can give rise to potential health problems which effectively can be dealt with by careful design and construction of packages [14].

3.2. Overall migration (OM) value in aqueous food simulant (B).
As shown in Table. 2 and Fig. 2 the overall migration mean values ranged between 8-12 mg/dm² of the commercial plastic packaging materials into aqueous food simulant (B). The study found that 16.7% (n=2/12) of the overall migration mean±SD values 9.2±1.9 mg/dm² of the commercial plastic packaging materials exceed 10 mg/dm² of permissible limit and not applicable in aqueous food types if the pH value of the foodstuff exceed 4.5 as stated by the European Commission Regulations10/2011[10]. Any substance which migrates from packaging into the food is of concern because it could harm the consumer health. Even if the migration substance is not potentially harmful it could have an adverse effect on the flavor and acceptability of the food. Anyway, the effect of the different used food simulants is almost the same for all the studied polymers except for the Paper/Polyethylene, which showed a difference regarding the type of food simulant used, with the highest value in permeability changes when exposed to acetic acid solution, probably due to a minor stability of the monomer to acetic acid instead of ethanol solution as reported by [13].

Table 1. Overall migration (OM) value obtained by total immersion into food simulant (A) in 2 hours at 100 °C of experimental samples of the commercial plastic packaging materials

Experimental Samples	Overall Migration into Food Simulant (A) in (mg/dm²)			
	First Triplicate	**Mean± SD (g/dm²)**	**Second Triplicate**	**Mean± SD (mg/dm²)**
Sample 1	12.0 12.0 8.0	10.7±1.4	12.0 12.0 12.0	12.0±0.0
Sample 2	12.0 12.0 12.0	12.0±0.0	8.0 8.0 12.0	9.3±1.9
Sample 3	8.0 8.0 8.0	8.0±0.00	8.0 8.0 12.0	9.3±1.9
Sample 4	8.0 8.0 8.0	8.0±0.00	8.0 8.0 6.0	7.3±1.7
Sample 5	12.0 8.0 12.0	10.7±1.9	12.0 8.0 8.0	9.3±1.9
Sample 6	8.0 8.0 8.0	8.0±0.00	8.0 8.0 12.0	9.3±1.9
Overall Mean ± SD (mg/dm²)	**9.5±2.0**			

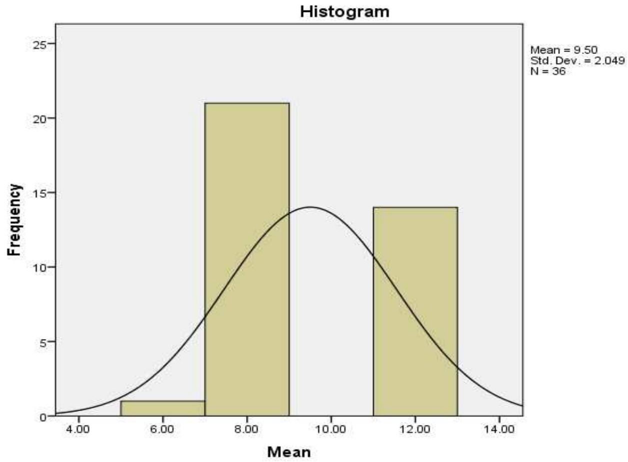

Figure 1. Overall migration (OM) mean value of experimental samples of the commercial plastic packaging materials in food simulant (A)

Table 2. Overall migration (OM) values obtained by total immersion into food simulant (B) in 2 hours at 100°C of experimental samples of the commercial plastic packaging materials

Experimental Samples	Overall Migration into Food Simulant (B) in (mg/dm²)			
	First Triplicate	**Mean± SD (mg/dm²)**	**Second Triplicate**	**Mean± SD (mg/dm²)**
Sample 1	8.0 12.0 12.0	10.7±1.4	8.0 8.0 12.0	9.3±1.9
Sample 2	8.0 8.0 8.0	8.0±0.0	8.0 12.0 8.0	9.3±1.9
Sample 3	8.0 8.0 8.0	8.0±0.0	8.0 12.0 8.0	9.3±1.9
Sample 4	8.0 8.0 8.0	8.0±0.0	8.0 8.0 12.0	9.3±1.9
Sample 5	8.0 12.0 12.0	10.3±1.9	8.0 8.0 8.0	8.0±0.0
Sample 6	8.0 12.0 12.0	10.7±1.4	12.0 8.0 8.0	9.3±1.9
Overall Mean± SD (mg/dm²)	**9.2±1.9**			

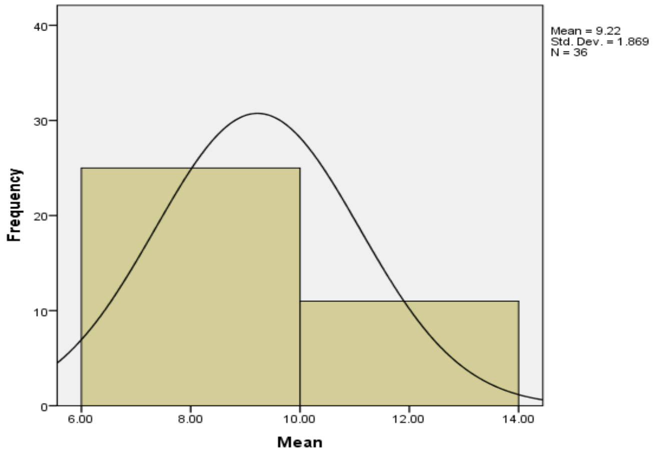

Figure 2. Overall migration (OM) mean value of experimental samples of the commercial plastic packaging materials in food simulant (B)

CONCLUSION

The study concluded that, traceability system of plastic packaging materials in Sudan not follow the chain and good manufacturing practice (GMP). The quality of plastic food packaging materials does not apply international symbol code number which provides a quick snapshot detailing the name of the resin (*i.e*. the base material of the plastic). The study highly recommends further surveillance research work studies on plastic packaging materials.

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