The Annals of the University *Dunarea de Jos* of Galati
Fascicle VI – Food Technology, 34(2)

ORIGINAL ARTICLE

USE AND SAFETY OF PET, PACKAGE MATERIAL IN CONTACT WITH BEVERAGES*

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Polyethylene terephthalate (PET) is a long-chain polymer belonging to the generic family of polyesters. PET has found increasing applications within the food packaging field. The aim of the study was to survey the behavior of materials intended to come in contact with non-alcoholic or alcoholic beverages of an alcoholic concentration greater than 5% vol., like fruit juices, sparkling water, beer and others. The conclusion was that PET is a stable material, the value of global migration of components in selected simulants being in compliance with the legislation's requirements (10 mg/dm^2 or 60 mg/kg of food).

Keywords: PET, food package, migration, beverages, food safety

1. Introduction

Nowadays almost all foods available on market are packed. In order to avoid health hazards, all package materials have to be tested from the point of view of the interaction with the foodstuffs.

Polyethylene terephthalate (PET) becomes the package of choice for many products, particularly beverages and mineral waters. PET is a long-chain polymer belonging to the generic family of polyesters and is formed by co-polimerisation of terephthalic acid (TPA) and etilenglycol (EG) (Wiley Encyclopedia, 1997).

PET bottles are manufactured by the process of *Injection Stretch Blow Molding*. Impact resistance, transparency, stiffness, gas barrier properties and creep are all optimised during this part of operation. The desired properties for packaging applications are attained from the properties of PET as shown in the previous sentence. Therefore, additives such as antioxidants, plasticizers or UV stabilizers are not required (ILSI, 2000).

Substances which migrate readily are usually low molecular weight and volatile. These substances for PET can be represented by acetaldehyde, terephthalic acid, isophtalic acid, isophtalic acid, dimethyl ester, ethylene glycol, diethylene glycol.

Even though small interactions can be detected by means of sophisticated analytical procedures, the monitoring of migration can be relatively simple. The surplus of the global migration of components, going beyond the limits imposed by legislation, is due to the transfer of unwanted substances from the package, to the food and represents a hazard to human health.

In the present study, there have been supervised and controlled PET packages in direct contact with low-alcoholic and non-alcoholic beverages (fruit juices, soft drinks, mineral water, beer, wine, and so on).

2. Materials and methods

The present study was carried out between 2006 and 2008, in 15 counties of Romania: Alba, Bihor, Brasov, Botosani, Călăraşi, Cluj, Constanta, Covasna, Dambovita, Galati, Mures, Neamt, Prahova, Sibiu and Vrancea. The supervising and control of the materials in contact with food (in the present study, with PET) consisted in: identifying the conditions of contact between food and package, identifying the extraction conditions and verifying the global migration of components.

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* Paper presented at the International Symposium *Euro - aliment 2009*, 9th – 10th of October 2009, Galati – ROMANIA

The global migration of components, *M*, representing the mass of substance migrating from the tested material, into the simulant (Government Decision no. 1.197/2002), was evaluated by gravimetry, followed by a correction made using the formula:

$$M = \frac{m \cdot a_2}{a_1 \cdot q} \cdot 1000$$

where:
M – is the migration in mg/kg;
M – is the weight of the substances eliminated by the sample which was determined by the test of migration, in mg;
a_1 – is the specific surface of the sample in contact with food or the simulant during the test for migration, in dm^2;
a_2 – is the specific surface of the material or object in the real conditions of use, in dm^2;
q – is the amount of food that comes in contact with the material or objects in the real conditions of use (in grams).

The global migration of components in an extraction liquid, respectively in a simulant, is evaluated in severe conditions, simulating the worst situations in which a plastic (PET) material can be used in practical packaging (Council Directive 82/711/EEC). The testing conditions consist in a certain temperature, duration of contact time and in a selected simulant. In order to select a specific simulant for testing, it is necessary to know which type of food the material set under analysis will be in contact with.

The food simulants were introduced because it is not always possible to use foods for testing the contact materials. They are classified by convention, depending on how they show the characteristics of one or more types of food products. The types of food and the food simulants used are mentioned in Table 1. (Commission Directive 93/8/EEC)

Table 1. Types of food and food simulants

Type of food Abbreviation	Conventional classification	Food simulants
Simulant A Food with water content that has the pH > 4.5	Food for which only the test with simulant A is envisaged	Distilled water or water of equivalent quality
Simulant B Food with acid content (food with water content that has the pH ≤ 4.5)	Food for which only the test with simulant B is envisaged	3% acetic acid (m/v)
Simulant C Food with alcohol content	Food for which only the test with simulant C is envisaged	10% ethanol (v/v) This concentration can be adapted to the real alcoholic concentration of the food if it exceeds 10% (v/v)
Simulant D Food with fat content	Food for which only the test with simulant D is envisaged	Refined olive oil or other simulants with fat content
Dehydrated foods	None	None

The testing of PET samples was carried out using distilled water and acetic acid 3% as simulants (Commission Directive 97/48/EC**)**, the temperature being successively the room temperature, 5°C and 40°C and 10 days contact duration. The beverages have different pH values and an alcoholic concentration smaller than 10%, except 2 samples of PET which came in contact with wine.

Distilled water (conductivity – 4.33 mS/cm at 23^0C, Mettler Toledo MC-226 conductometer) was used as stimulant A. Acetic acid glacial (Merck AG) and distilled water were used to prepare a solution of simulant B.

3. Results and discussion

In the present study, 174 samples of PET bottles were tested, which came in contact with non-alcoholic or alcoholic beverages with an alcoholic concentration greater than 5% vol. The percentage of PET bottles use in contact with beverages is given in Figure 1.

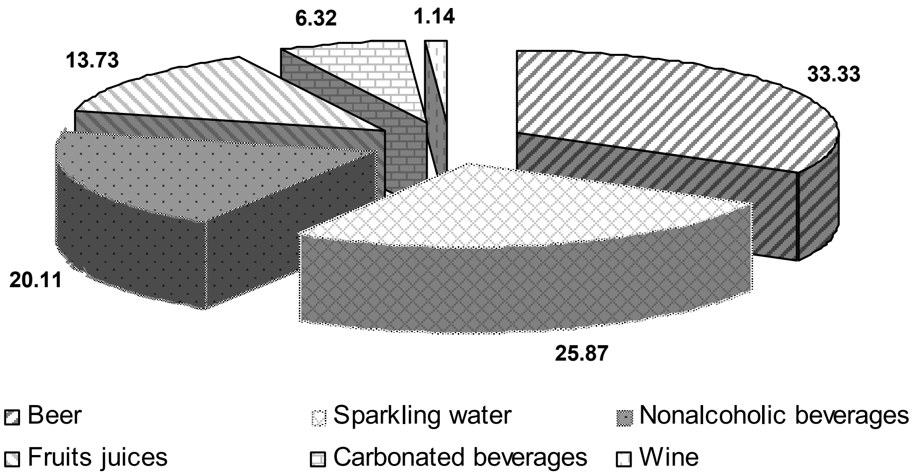

Figure 1. Percent of PET use in contact with different beverages (%)

The average values of the components of global migration from polyethylene terephthalate in contact with sparkling water, fruit juices, carbonated beverages, soft drinks, wine and beer are given in Table 2. Due to the different producer or retailer for each PET, samples are not the same, data have only a guiding value.

Table 2. The values of global components migration

No. samples	Foodstuffs	The value of global components migration (mg/dm^2) – 10 days contact time –					
		Simulant: distilled water			Simulant: acetic acid 3%		
		Room temperature	5°C	40°C	Room temperature	5°C	40°C
58	Beer	0.47	2.26	0.0034	3.5	4.93	-
44	Sparkling water	1.21	0.69	0.61	2.38	0.14	0.75
35	Nonalcoholic beverages	0.55	-	-	4.747	-	-
24	Fruits juices	8.05	8.05	-	4.12	0.44	5.68
11	Carbonated beverages	-	-	0.66	-	-	0.39
2	Wine	-	-	-	2.11	1.84	-

Legislation in force stipulates that materials in contact with food are not allowed to transfer their constituents into food over the values of 10 mg/dm^2 or 60 mg/kg food, for different test conditions, in this study, various temperature and two types of food simulants.

As it can be seen, for all types of beverages, the increase of temperature, from 5^0C to room temperature, at the same type of stimulant, produces an increasing of the migration value, except PET in contact with beer. However, these values were five times smaller than the legal limit.

The global migration was far greater for the natural fruit juice concentrate, than for the sparkling water: 8.05 than 1.21 respectively 0.69, in the same conditions of testing: - distilled water, room temperature and 5°C, and a contact period of 10 days. When PET bottles were tested with acetic acid solution 3% as simulant, in the same testing conditions, the values of global migration were double for the natural fruit juices, than for the sparkling water, 4.74 compared to 2.38.

4. Conclusions

In this study, polyethylene terephtalate was the material that has been in target. Due to the special choice of the territorial laboratories, PET was tested when being in contact with different products mostly with beer, even if, in practice, PET bottles are more used as packaging material for other beverages like: plate water, sparkling water, fruit juices, carbonated beverages and soft drinks.

The migration values of PET components are sensitively affected by temperature. Comparing the migration values of PET components when using different food simulants, there where no differences between acetic acid 3% solution and distilled water.

The global migration values of the components in selected simulants are counted in accordance with legislation requirements (10 mg/dm^2 or 60 mg/kg food). PET, coming in direct contact with non alcoholic and low alcoholic concentration beverages, is generally stable.

Practically, the tested material is chemically stable, so the polyethylene terephtalate used in contact with different beverages can be safe.

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