Phthalate concentrations in primary packaging for meat products in the Czech Republic

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Abstract

Packaging materials of meat products distributed on the market in the Czech Republic were analyzed for di-n-butyl phthalate and di-2-ethylhexyl phthalate. The upper part of the package, printed and unprinted parts, and the bottom sheet which serves as a base were analyzed. Thermally shapeable film containers for meat products contain dangerous phthalates, but the measured concentrations constitute no serious health risk.

Di-n-butyl phthalate, di-2-ethylhexyl phthalate, food film

Introduction

Many studies have recently been undertaken to monitor plasticizer migration from packaging into foods as the result of direct contact between those two. The most frequently used plasticizers are phthalic acid esters (phthalates, PAE). PAEs of lower molecular weight are more readily released from materials, while a higher molecular weight guarantees better stability of these additives and their migration rate is limited (Otto et al. 2008). The process of migration can be affected by many factors, the most important being the storage temperature, the length of contact with the food, the lipid content of the food, and the amount of plasticizer used. High-fat foods have a greater potential to absorb plasticizers because plasticizers are considerably lipophilic.

Phthalate toxicity has been ascertained by many authors (Dirven et al. 1993; Doull et al. 1999; David et al. 2000). Recent studies have demonstrated that di-2-ethylhexyl phthalate (DEHP) can disrupt the endocrine system of the human body, and can have adverse effects on the development and reproduction and the nervous and immune systems of both man and many species of animal (Latini et al. 2004). According to Latini (2005), an analysis of biochemical effects associated with exposure to DEHP at the steroid and gonadotropin hormone levels should be part of a comprehensive risk evaluation in the human population. Swan et al. (2010) suggested that exposure to DEHP and DBP during pregnancy can affect brain development and block the effects of the male sex hormone testosterone. Grob et al. (2007) pointed out that in the case of small packages with a high contact area (surface area/volume) ratio, the European legislation tolerates extremely high migration in terms of food concentrations, because limits are set as migration on the surface. The Overall Migration Limit (OML) may be in excess of 1 000 $mg \cdot kg^{-1}$, which is an order of magnitude greater than the limit allowed for any other type of food contaminant.

The European Union has no limit values for phthalate in foods. The tolerable daily intake (TDI) values of di-n-butyl phthalate (DBP) and di-2-ethylhexyl phthalate (DEHP) set forth by the EEC Scientific Committee for Food are 0.050 and 0.025 mg per kg live weight, respectively (Velíšek 2002).

The basic legal regulation relating to food packaging is Decree of the Ministry of Health No. 38/2001 of 19 January 2001 as amended by Decree No. 127/2009 on hygienic requirements for products intended for contact with foods and viands. This decree stipulates

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that ingredients contained in plastic materials and items made from plastic must not migrate into foodstuffs in amounts exceeding 60 mg of released constituents per kg of foodstuff or food simulant. An overall migration limit of 10 mg per square decimetre of material or article can be used (in the case of containers or articles which are comparable to containers and which can be filled, with a capacity of less than 500 ml or more than 10 l; plates, films or other articles which can be filled but whose ratio between the surface area of the article and the amount of foodstuff that is in contact with it cannot be estimated). The aim of the present study was to determine the contents of the most frequently used phthalates (DBP and DEHP) in some wrappings used for the packaging of meat products that are placed on the market in the Czech Republic, and to assess the hazards they may pose.

Materials and Methods

Five wrappings of meat products were used in the analysis. According to their Product Certificate, these are thermally shapeable films suitable for the packaging of foodstuffs. Samples 1−4 were intended for the packaging of sliced products, and sample 5 for the packaging of whole sticks of dry salami using a deep-drawing machine. The packaging consisted of at least two plastic materials, and in some cases a part of it was printed. The bottom sheet of sample 5 was metalized. Each part was analyzed individually and in duplicate.

The samples were analysed by methods verified for the determination of DBP (di-n-butyl phthalate) and DEHP (di-2-ethylhexyl phthalate). PAEs were extracted from the samples three times using a 1:1 mix of hexane and dichloromethane. Pooled filtered extracts were thickened in a rotary vacuum evaporator. After the samples were nitrogen dried, their volume was adjusted to 1 ml by the addition of acetonitrile. PAEs were determined by HPLC using UV detection at 224 nm. We used a 5 µm Zorbax Eclipse C8 column, 4.6 mm × 150 mm in size. Acetonitrile was employed as the mobile phase. Resulting concentrations were computed from the calibration curve using Agilent Chemstation software for LC and LC/MS systems (Jarošová et al. 1999).

Results and Discussion

Table 1 shows DBP and DEHP concentrations and their sums in individual types of meat product wrappings. PAE concentrations are given in µg per kg of original material and also recalculated to surface area, i.e. to µg per dm^2 (in accordance with the directive which requires that overall migration be expressed per one kilogram of food or per square decimetre of surface).

Table 1. Mean concentrations of DBP and DEHP and their sums in individual types of meat product packaging expressed in $\mu g \cdot kg^{-1}$ and $\mu g \cdot dm^{-2}$

Packaging	Packaging part	DBP	DEHP	Σ DBP + DEHP	DBP	DEHP	Σ DBP + DEH
			$\mu g \cdot kg^{-1}$			$\mu g \cdot dm^{-2}$	
1	upper film unprinted	24.59	17.97	42.56	13.33	9.74	23.07
	upper film printed	31.20	24.87	56.08	16.91	13.48	30.39
	bottom sheet	nd	3.96	3.96	nd	14.46	14.46
2	upper film unprinted	35.06	25.51	60.57	19.00	13.83	32.83
	upper film printed	nd	40.37	40.37	nd	23.09	23.09
	bottom sheet	nd	5.21	5.21	nd	15.34	15.34
3	upper film unprinted	29.07	19.27	48.34	15.81	10.48	26.30
	upper film printed	nd	19.40	19.40	nd	10.59	10.59
	bottom sheet	nd	3.56	3.56	nd	12.95	12.95
4	upper film unprinted	29.62	13.91	43.53	15.76	7.40	23.16
	upper film printed	nd	19.96	19.96	nd	11.54	11.54
	bottom sheet	nd	3.72	3.72	nd	10.91	10.91
5	upper film	5.04	5.12	10.16	5.56	5.56	11.21
	bottom sheet	nd	9.19	9.19	nd	6.56	6.56

nd – not detected

The principal objective of the present study was to determine the quantities of phthalates (DBP and DEHP) in the packaging of certain meat products that are placed on the market in the Czech Republic, and to assess the hazards they may pose for the consumer. PAE concentrations were in a range from 3.56 to 60.57 $\mu g.kg^{-1}$, or 6.56 to 32.83 $\mu g.dm^{-2}$. DBP concentrations were in a range from 5.04 to 35.06 $\mu g.kg^{-1}$, or 5.56 to 19.00 $\mu g.dm^{-2}$. DEHP concentrations were in a range from 3.56 to 40.37 $\mu g.kg^{-1}$, or 5.65 to 23.09 $\mu g.dm^{-2}$.

Neither EU nor Czech law sets any limits on PAE quantities in packaging, but it does set limits to their migration from packaging. In the case of these types of packaging, it is appropriate to consider migration from the packaging surface to the food. The overall migration limit is 10 $mg.dm^{-2}$ of packaging surface area. The overall migration limit, however, also includes other phthalates and many other substances able to migrate from packaging into food. We can state that the PAE concentrations that we ascertained in the packaging of meat products do not pose a serious health hazard to consumers.

Another objective of our study was to confirm the presence of phthalates in printing inks in which they have an adhesive function, i.e. we assumed higher phthalate concentrations in the printed parts of the packaging. This assumption was confirmed for both phthalates in one case, where the phthalate concentration in the printed part was 56.08 $\mu g.kg^{-1}$ and in the unprinted part 42.56 $\mu g.kg^{-1}$. No DBP was detected in any other cases. The fact that it was not detected does not mean that it was not present in the samples. The inks used seem to affect phthalate detection. DEHP was detected in every sample and its concentrations confirm our assumption that PAEs are added to printing inks, because DEHP concentrations in the printed parts of the packaging were higher than in unprinted parts.

The bottom sheet of the packaging was more hardened, and we therefore expected lower phthalate concentrations in this part of the packaging. PAE concentrations in the bottom sheet were in the 3.56–5.21 $\mu g.kg^{-1}$ range. In the printed and the unprinted parts of the upper film, PAE concentrations were in the 19.40–56.08 $\mu g.kg^{-1}$ range and 42.56–60.57 $\mu g.kg^{-1}$ range, respectively. It follows from these values that the bottom sheet contains less phthalates than the upper film, which corresponds to the characteristics of these materials.

The characteristics of the material used in sample 5 (packaging with a metalized bottom sheet for whole sticks of salami) were different from that used in samples 1–4 (packaging intended for sliced products). PAE concentrations in the upper film and the bottom sheet of sample 5 were 10.16 $\mu g.kg^{-1}$ and 9.19 $\mu g.kg^{-1}$, respectively.

Conclusions

Different materials used in meat product packaging (upper film, printed and unprinted parts, bottom sheet) placed on the market in the Czech Republic were analyzed. Concentrations of the printed and unprinted parts were in the 19.40–56.08 $\mu g.kg^{-1}$ and 42.56–60.57 $\mu g.kg^{-1}$ range, respectively, and those of the bottom sheet in the 3.56–5.21 $\mu g.kg^{-1}$ range. PAE concentrations in the upper film and in the metalized bottom sheet of sample 5 were 10.16 $\mu g.kg^{-1}$ and 9.19 $\mu g.kg^{-1}$, respectively. It follows from these values that the bottom sheet contains less phthalates than the upper film, and the printed part more PAE than the unprinted part. The measured values lead us to conclude that although the meat product packaging that we analyzed contains dangerous phthalates, their concentrations are low and do not pose a threat to consumers.

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