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# INVESTIGATION INTO THE MIGRATION POTENTIAL OF COATING MATERIALS FROM COOKWARE PRODUCTS

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**INVESTIGATION INTO THE MIGRATION POTENTIAL OF COATING MATERIALS FROM COOKWARE PRODUCTS**

Journal:	<i>Food Additives and Contaminants</i>
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Complete List of Authors:	Bradley, Emma; Central Science Laboratory, FSG
Methods/Techniques:	Chromatographic analysis
Additives/Contaminants:	Migration, Packaging cookware
Food Types:	

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Table 1. Products purchased and the coating type and weight identified

Product code	Product description	Polymer coating type identified by FT-IR <sup>a</sup>	Coating weight (mg/dm <sup>2</sup> ) <sup>b</sup>
NS 1	Mince pie and bun sheet	PES	150
NS 2	Milk Pan	PTFE	390
NS 3	8" Sandwich tin	PES	170
NS 4	1 lb Loaf tin	PES	375
NS 5	Dish	BPA-EPI	150
NS 6	Turkey tin	BPA-EPI	125
NS 7	Pie Pan	PES	240
NS 8	Sandwich tin	PES	370
NS 9	Frying Pan	PTFE	805
NS 10	18 cm French skillet	PTFE	240
NS 11	20 cm frying pan	PTFE	485
NS 12	7" Sandwich pan	PES	190
NS 13	Omelette Pan 20 cm	PTFE	850
NS 14	Wok	PTFE	420
NS 15	Bun sheet	PES	285
NS 16	Small roasting pan	PES	190
NS 17	Oven tray	PES	260
NS 18	Yorkshire pudding tray	PES	330
NS 19	King size roaster	PES	165
NS 20	14 cm Aluminium milk pan	PTFE	660
NS 21	14 cm Saucepan	PTFE	245
NS 22	Omelette Pan	PTFE	710
NS 23	14 cm Milk pan	PTFE	840
NS 24	14 cm Pan	PTFE	705
NS 25	Milk pan	mixture <sup>T</sup>	295
NS 26	Deep multi-use tray	PES	160

3 a) PES = polyethersulphone; PTFE = polytetrafluoroethylene; BPA-EPI = bisphenol

A/epichlorohydrin. T = no good library match, possibly a mixture

b) Average of 4 to 7 specimens. rsd on coating weight, average of 11%, range 5 to 30%.

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- 6 Table 2. Overall migration into simulants and chloroform extractables from NS 4 and NS 8 (n=3 specimens tested)

	mg/dm <sup>2</sup>	
	NS4	NS8
3% Acetic acid * 1 hour at 100°C	125	34
Iso-octane 4 hours at 60°C	2.9	2.5
95% Ethanol 6 hours at 60°C	4.6	1.6
MPPO 2 hours at 175°C	8.9	1.7
Chloroform 24 hours at 23°C, then 1 hour at 175°C (empty), lastly 24 hours at 23°C	34	27

- 9 \* the coating was disrupted and the base metal attacked. Not a suitable simulant.

Table 3. Substances found in the solvent extracts of the non-stick coatings

Substance	Incidence	Range ( $\mu\text{g}/\text{dm}^2$ )	Average ( $\mu\text{g}/\text{dm}^2$ )
di(2-ethylhexyl) phthalate	23/26	0.5 to 11	2.8
dibutyl phthalate	13/26	0.6 to 3	1.3
diisobutyl phthalate	12/26	0.6 to 9	2.4
hexadecanoic acid	10/26	0.7 to 1.7	1.0
1-octadecanol	9/26	0.5 to 7	2.3
benzophenone	9/26	0.6 to 27	9.1
bis(3-t-butyl-5-ethyl-2-hydroxyphenyl)methane	9/26	1 to 85	16.9
2-phenoxyethanol	8/26	0.9 to 9	2.5
diisopropyl naphthalene isomers	8/26	2.3 to 9.4	5.7
1-hexadecanol	7/26	1 to 11	2.9
isopropyl dodecanoate	7/26	0.5 to 1.9	1.3
bisphenol A	7/26	0.5 to 18	3.2
9-octadecenoic acid, methyl ester	5/26	0.7 to 8.5	2.8
2,2,4-trimethyl-pentan-1,3-dioldiisobutyrate	4/26	0.5 to 1.8	1.3
diisodecyl phthalate	4/26	1.2 to 2.7	1.9
lauric acid, octyl ester	4/26	0.9 to 2.9	1.8
benzaldehyde	3/26	0.7 to 0.9	0.8
benzenemethanol	3/26	0.6 to 0.8	0.7
benzophenone related compounds	3/26	2 to 5	4.3
octadecanoic acid	3/26	0.5 to 0.7	0.6
undecylbenzene	3/26	0.6 to 1.0	0.8
1-methyldodecylbenzene	3/26	1 to 5	2.6
diethyl phthalate	2/26	0.8-0.8	0.8
hexadecanoic acid, methyl ester	2/26	0.6 to 2.3	1.5
methyl-4-(6'-methylheptan-4'-on-2'-yl)-cyclohex-1-enecarboxylate	2/26	0.7 to 0.8	0.7
phenol	2/26	0.6 to 0.7	0.7
tetradecanoic acid, 1-methylethyl ester	2/26	0.8 to 1.0	0.9
unknowns (69 occurrences in total)	69/26	0.5 to 23	5.2

Also detected, but in only one of the 26 coating samples tested, were (substance name, level in  $\mu\text{g}/\text{dm}^2$ ): 11'-sulphonylbis(4-aminobenzene) (1); 11'-oxybisbenzene (0.5); 1,2-benzenedicarboxylic acid butylphenylmethyl ester (0.59); 1,3-epimanol (0.62); 1-methyldecylbenzene (1.6); 2,6-bis(11-dimethylethyl-4-methyl)phenol (0.76); 2,6-di(t-butyl)-4-hydroxybenzaldehyde (2.90); 2-ethylhexanoic acid (1.70); 2-methylnaphthalene (0.77); 2-phenylphenol (1.2); 4-(dimethylamino)phenylcarboxylic acid 2-ethylhexyl ester (0.54); 6-phenyl-1,3,5-triazine-2,4-diamine (1.6); 9-octadecenamide (6.5); acetophenone (1.2); benzothiazole (1.2); butyloctanoate (1.3); decanedioic acid dibutyl ester (0.72); dehydroabietate (5.4); diethylene glycol dibenzoate (0.74); hecadedanoic acid 2-hydroxyethyl ester (2.5); hexadecanamide (0.69); hexadecyl ester of octanoic acid (4.6); methyl benzoate (1.8); naphthalene (0.75); octadecanoic acid butyl ester (0.54); octadecanoic acid methyl ester (0.66); octanoic acid butyl ester (5.1); octanoic acid hexadecyl ester (1.9); octanoic acid octadecyl ester (0.94); phosphoric acid tributylester (1.6); tetradecanoic acid (0.58); undecylcyclohexane (0.87).

Table 4. NS 22 extracted with solvents

Retention time (minutes)	Best library match	acetonitrile		chloroform	
		Level in coating (µg/g)	Level in coating (µg/dm <sup>2</sup> )	Level in coating (µg/g)	Level in coating (µg/dm <sup>2</sup> )
11.60	diethyl phthalate	0.8	0.5	1.1	0.7
11.94	2,2,4-trimethylpentan-1,3-dioldiisobutyrate	2.7	1.8	11	7.3
12.03	benzophenone	2.1	1.4	12	8.0
12.33	isopropyldodecanoate	< 0.5	< 0.5	1.9	1.3
ca. 12.86	Three diisopropyl-naphthalene isomers	< 0.5	< 0.5	10.6	7.0
14.01	undecylbenzene	< 0.5	< 0.5	0.9	0.6
14.69	diisobutyl phthalate	9.5	6.3	12	8.0
14.85	unknown	0.8	0.5	1.6	1.1
15.41	1-methyldodecylbenzene	3.7	2.4	7.0	4.6
15.53	hexadecanoic acid, methyl ester	< 0.5	< 0.5	0.9	0.6
15.62	dibutyl phthalate	2.4	1.6	2.9	1.9
16.25	methyl-4-(6'-methylheptan-4'-on-2'-yl)-cyclohex-1-enecarboxylate	1.0	0.7	1.0	0.7
16.81	13-epimanool	< 0.5	< 0.5	0.8	0.6
17.19	9-octadecenoic acid, methyl ester	1.1	0.7	2.0	1.3
17.27	lauric acid, octyl ester	1.4	1.0	2.7	1.8
19.29	unknown	3.9	2.6	< 0.5	< 0.4
20.49	bis(3-t-butyl-5-ethyl-2-hydroxyphenyl)methane	2.2	1.4	< 0.5	< 0.4
20.82	di(2-ethylhexyl) phthalate	3.9	2.6	3.4	2.3
22.53	unknown	15	9.8	11	7.3
22.98	diisodecyl phthalate	3.4	2.3	< 0.5	< 0.4

Table 5. Specific migration of bisphenol A into olive oil

	<b>Exposure</b>	<b>Migration (<math>\mu\text{g}/\text{dm}^2</math>)</b>	<b>Migration (<math>\mu\text{g}/\text{kg}</math>)</b>
NS 6	1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup>	0.09, 0.30, 0.26	0.27, 0.90, 0.79
NS 10	1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup>	1.2, 1.3, 0.8	6.6, 7.1, 4.1
NS 11	1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup>	0.8, 1.1, 0.6	5.8, 7.6, 4.5
NS 14	1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup>	< 0.1, < 0.1, < 0.1	< 0.2, < 0.2, < 0.2
NS 25	1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup>	1.5, 1.3, 1.4	5.6, 5.5, 5.8

Results are the average of 3 specimens tested with exposure conditions of 60 minutes (NS 6) or 30 minutes (all others) at 175°C

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Table 6. Specific migration of certain phthalates into olive oil

Sample	Exposure at 175°C	DEP		DiBP and DBP		DEHP		DiDP	
		Migration (µg/dm <sup>2</sup> )	Migration (µg/kg)	Migration (µg/dm <sup>2</sup> )	Migration (µg/kg)	Migration (µg/dm <sup>2</sup> )	Migration (µg/kg)	Migration (µg/dm <sup>2</sup> )	Migration (µg/kg)
NS 4	30', 60', 90'	nd, nd, nd	nd, nd, nd	nd, nd, nd	nd, nd, nd	nd, nd, nd	nd, nd, nd	nd, nd, nd	nd, nd, nd
	LoD	0.85	5.1	12	73	75	450	185	1100
NS 5	30', 60', 90'	nd, nd, nd	nd, nd, nd	16, nd, 14	190, nd, 160	nd, nd, nd	nd, nd, nd	nd, nd, nd	nd, nd, nd
	LoD	0.46	7.8	9.3	110	56	840	140	1700
NS 14	30', 60', 90'	nd, nd, nd	nd, nd, nd	38, 32, 24	100, 85, 64	*, 68, nd	*, 180, nd	nd, nd, nd	nd, nd, nd
	LoD	0.62	1.6	8.9	24	54	140	130	360
NS 22	30', 60', 90'	nd, 0.9, 2.0	nd, 4.6, 9.3	27, 30, 30	130, 140, 140	nd, nd, nd	nd, nd, nd	nd, nd, nd	nd, nd, nd
	LoD	0.55	2.4	7.2	34	44	210	110	520
NS 24	30', 60', 90'	nd, nd, 1.4	nd, nd, 4.3	31, 35, 38	96, 110, 120	nd, nd, nd	nd, nd, nd	nd, nd, nd	nd, nd, nd
	LoD	1.2	3.6	17	53	100	320	260	790

Results are the average of 3 specimens tested

\* poor triplicate results, average not reported