

# Intense Odorants of Cardboard and their transfer into Foods

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## INTRODUCTION

Paper and cardboard materials are produced predominantly as packaging materials. As consumers do not accept packaging affected with strong odour, the absence of off-odours is a prerequisite for their use. A contamination of cardboard packed foods with malodours may additionally cause negative effects on food quality. Several cardboard volatiles and odorants have previously been identified (1-3) but a comprehensive study on cardboard odorants has not yet been performed. To close this gap, the intense odour-active volatiles of cardboard were identified by Aroma Extract Dilution Analysis (AEDA) and identification experiments.

## MATERIALS AND METHODS

Cardboard (20 g) was cut into squares (5 x 5 mm), moistened with tap water (5 mL), and extracted with dichloromethane (200 mL) for 16 h. The volatiles of the extract were isolated by SAFE-distillation (4). AEDA was performed according to (5) and the odorants were identified by comparing the odour quality, linear retention index and mass spectrum (MS-EI) with the properties of reference compounds. Aroma Profile Analysis (APA) was performed according to (6).

Odour transfer experiments were carried out with sunflower oil (100 mL) filled into a glass flasks (500 mL). Cardboard squares (2 g) were moistened with tap water (1 mL) and placed in a small glass container (80 mL) which was then put into the flask (500 mL). In parallel, the same set was arranged without cardboard. The flasks were covered with a glass lid and stored for 2 days at room temperature in darkness.

## RESULTS AND DISCUSSION

APA of a cardboard sample revealed the typical odour described as cardboard-like, musty, and woody (Fig. 1). After moistening, the cardboard exhibited an off-flavour. This effect was correlated with intensity increases of these attributes and the fatty and mouldy note. The odour-active cardboard volatiles were evaluated by AEDA and identified in additional experiments. As detailed in Table 1, vanillin was detected with the highest intensity. In a FD-range of 128 – 512,  $\gamma$ -nonalactone, (E)-2-nonenal, 2-methoxyphenol,  $\delta$ -decalactone, 4-methylphenol, (tr)-4,5-epoxy-(E)-2-decenal, 4-ethylphenol, and two unknown compounds were found as additional intense odour active compounds.

The transfer of cardboard odour and – in consequence – odorants to food was demonstrated by a sensory experiment using sunflower oil. The oil, which was exposed to moistened cardboard for two days, exhibited a cardboard-like, woody, and sweet odour in addition to the characteristic notes of the oil (Fig. 2). A blank oil sample, which was stored without cardboard exposure, did not exhibit these notes. The results suggest that cardboards contain the identified odorants, most likely in high amounts due to their high FD-factors. In case of improper production, handling and storage (e.g. moistening), cardboards can liberate odorants due to their high aroma impact and cause off-flavours in packaged foods.

## LITERATURE

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Table 1: Intense odorants in cardboard identified by Aroma Extract Dilution Analysis and identification experiments<sup>a</sup>

odorant	odour quality	RI <sup>b</sup> on		FD-factor <sup>c</sup>
		DB-FFAP	DB-5	
vanillin	vanilla-like, sweet	2559	1396	4096
$\gamma$ -nonalactone	coconut-like, sweet	2014	1360	512
(E)-2-nonenal	cardboard-like, fatty, green	1525	1157	512
unknown	woody	2490	2012	512
2-methoxyphenol	smoky, vanilla-like	1851	1086	256
$\delta$ -decalactone	coconut-like, sweet	2185	1496	256
4-methylphenol	horse stable-like, faecal	2077	1075	128
(tr)-4,5-epoxy-(E)-2-decenal	metallic	1997	1382	128
4-ethylphenol	musty, spicy, phenolic	2448	1432	128
unknown	coconut-like	2448	1432	128

<sup>a</sup>Compounds with FD-factors  $\geq 128$  are listed. <sup>b</sup>RI: linear retention index on capillaries DB-FFAP and DB-5. <sup>c</sup>Flavour Dilution- (FD-) factor, determined by Aroma Extract Dilution Analysis (Grosch, 2001).

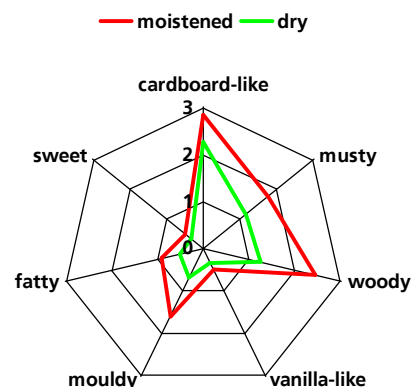


Figure 1: Aroma Profile Analyses of dry and moistened cardboard.

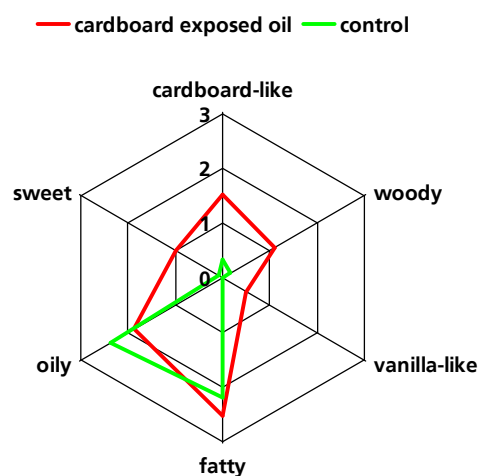


Figure 2: Aroma Profile Analyses of sunflower oil, exposed to moistened cardboard, and an untreated sunflower oil sample (control).

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