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The Effect of Cooking on Dioxin and Furan Concentrations in Beef

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Introduction

Many food components have been analyzed for dioxin/furan concentrations in the uncooked state¹⁻³, but the effect of cooking on dioxin/furan concentrations has not been extensively studied. Several cooking methods on several types of fish substantially decreased the amounts of dioxins in the fish, with smoking yielding the greatest decrease^{4,5}. Schechter, et al., reported on dioxin losses during broiling of ground beef. We report here the effect of pan frying on ground beef obtained from animals in a dioxin/furan feeding experiment⁶.

Experimental

Muscle tissue (rib eye) and back fat were blended to generate ground meat having approximately 20% fat (analyses showed 15.4 to 22.3% fat). Tissues from four control animals and from four animals dosed with the congeners in Table 1 were analyzed separately. The ground meat was made into 110g (9.5cm) patties. The patties were cooked in a 15cm diameter stainless steel frying pan heated with a hot plate. The internal temperature of the patties was measured with a digital thermometer (30cm probe, bent to conform to the frying pan, and to allow a 6.5cm insertion into the patty). The patties were heated to an internal temperature of 74°C. An inverted funnel was placed over the frying pan to facilitate temperature control and to collect some of the volatile components. Raw and cooked patties were mixed with sufficient anhydrous sodium sulfate to yield dry mixtures. Portions of the ground meat/sodium sulfate mixtures were extracted in soxhlets with hexane/methylene chloride, 1:1, and analyzed by EPA method 1613 with a Micromass Ultima mass spectrometer. The fats, juices and volatiles collected on the inverted funnel that drained back into the frying pan were extracted with methylene chloride, and analyzed by EPA method 1613.

Results and Discussion

The effects of pan frying on the dioxin/furan concentrations in ground beef patties having a fat content of approximately 20% are shown in Figures 1-3. All congeners that are substantially above detectability limits are reduced significantly in the edible portions of the ground beef patty (assuming that the fats and juices are not consumed). The reductions that we observed by pan frying are similar to those observed by Schechter, et al. for broiling⁷. Figure 4 shows the percent of the dosed congeners that is unaccounted for. The unaccounted for material could be due to processing losses (equal for all congeners), degradation, and volatility. The losses were greater for the lower chlorinated dioxin congeners than for the more highly chlorinated congeners, but the opposite effect was observed with the furans (Figure 4). These

HUMAN EXPOSURE

results can be explained if volatility is a dominant source of loss in the dioxin series and degradation is a dominant source of loss in the furan series. In conclusion, pan frying of ground beef patties, and likely non-patty ground beef, significantly reduces the amounts of dioxin and furan congeners consumed if the fats and juices are discarded, while congeners released as volatiles may pose a secondary mode of human exposure.

Acknowledgments

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Table 1. Dose components and levels of the feeding study

Dioxin	Toxicity Equivalency Factor	Daily Dose Per Animal (ng)	Total Dose per Animal (µg)
1,2,7,8-TCDD	0	750	90
1,3,7,8-TCDD	0	750	90
1,4,7,8-TCDD	0	750	90
2,3,7,8-TCDD	1	83.3	10
1,2,3,7,8-PeCDD	0.5	83.3	10
1,2,3,6,7,8-HxCDD	0.1	150	18
1,2,3,4,6,7,8-HpCDD	0.01	750	90
OCDD	0.001	750	90
p,p'-DDE	?	750	90
2,3,7,8-TCDF	0.1	150	18
2,3,4,7,8-PeCDF	0.5	83.3	10
1,2,3,4,6,7,8-HpCDF	0.1	150	18
OCDF	0.001	750	90
3,3',4,4',5'-PCB (#126)	0.1	150	18
2,3',4,4',5-PCB (#118)	0.0001	750	90
2,3,3',4,4',5,5'-PCB (#189)	0.001	750	90

Dioxin '97, Indianapolis, Indiana, USA

Figure 1. Control Calves (Averages from four animals)

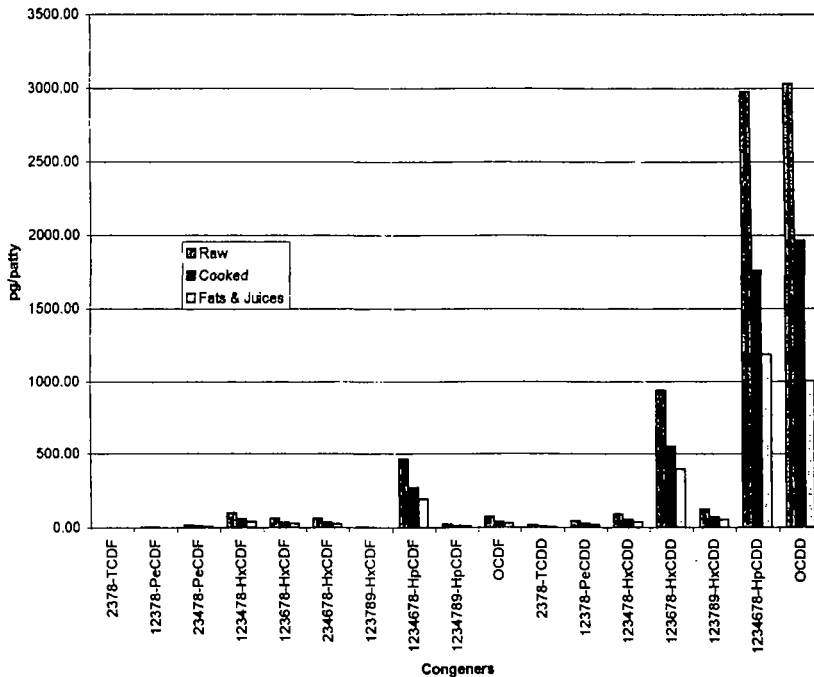
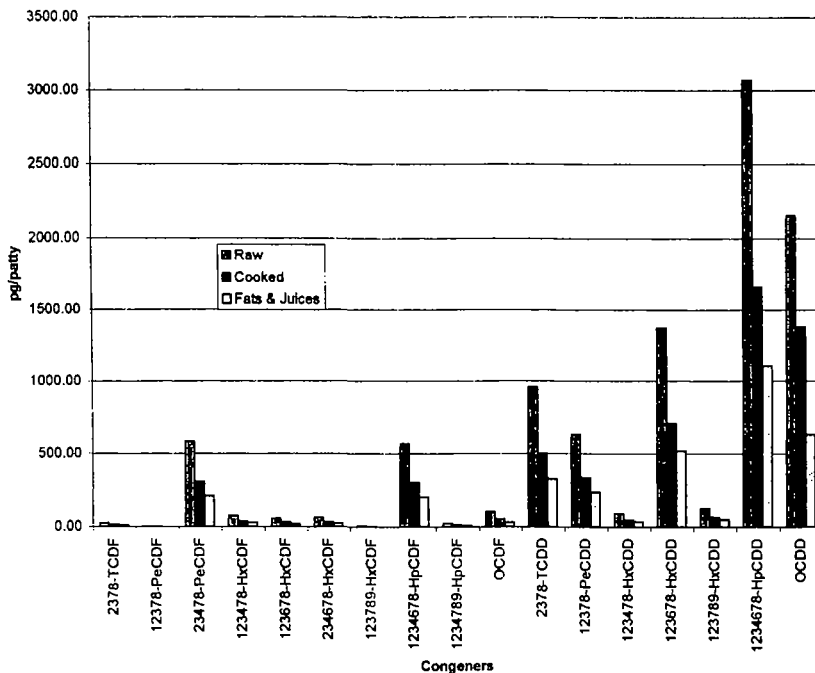


Figure 2. Dosed Calves (Averages from four animals)



HUMAN EXPOSURE

Figure 3. Percent lost during cooking

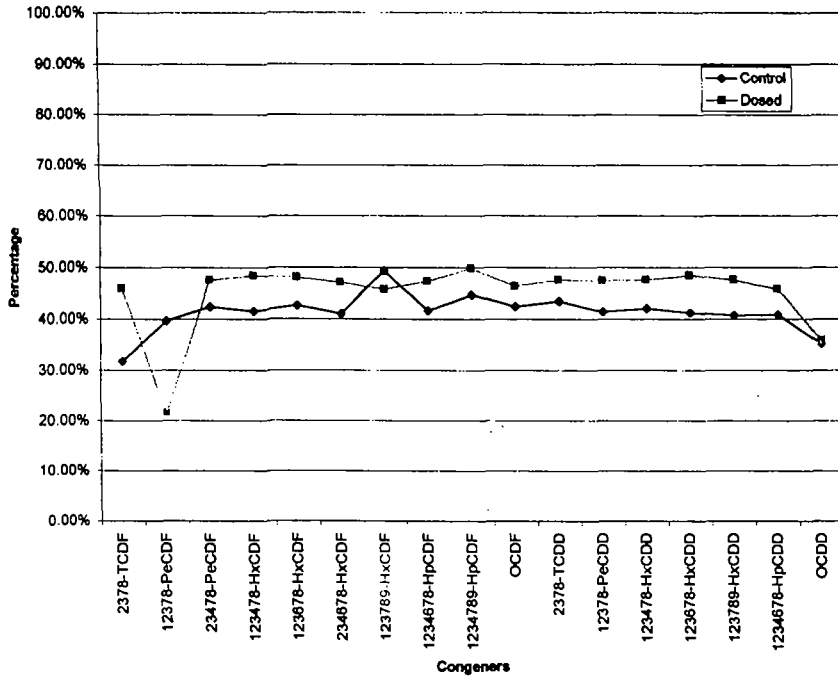


Figure 4. Percent unaccounted for (i.e. volatility, degradation, processing)

