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<p>Using a smoking machine, reference cigarettes, a commercial brand of nonfilter 85 millimeter cigarettes, a medium priced cigar, and a popular brand of pipe tobacco, both wet ashing and dry ashing procedures were carried out to determine the cadmium (7440439) content to which smokers were being exposed. Cigarettes varied from 1.31 to 1.28 micrograms (microg) of cadmium per cigarette, which corresponded to 1.17 to 1.62microg per gram (g) of cigarette. For cigar tobacco a total of 1.86microg/g was found and in pipe tobacco the content was 0.93microg/g. Only 6 to 7 percent of the cadmium in the smoked portion of the cigarette appeared in the tar, while the unsmoked butts were enriched with 10 to 27 percent of the cadmium of the smoked portion. The ash contained 25 to 34 percent of the cadmium of the smoked portions. The authors suggest that the remaining cadmium, 40 to 55 percent, is lost in the sidestream during smoking and between puffs. This indicated that not only is the one smoking at risk from cadmium exposure, but so are the others present in the vicinity. The indoor pollution of cadmium in a smoker's environment must be considerably more than the levels found in ambient outside air in large cities. As cadmium exposure can affect pulmonary function resulting in bronchitis and emphysema, the authors urge that cadmium exposure from smoking be considered further.</p>			
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CADMIUM IN TOBACCO AND ITS FATE DURING SMOKING

The presence of cadmium, a biologically toxic and non-essential metal, has been shown to accumulate in human tissue (1). It is widely distributed in foods, fuels, and industrial products. Recently Schroeder et al (2) suggested that its presence in cigarettes required further investigation. Nandi et al (3) following this lead found that only about 18.5% of the smoked portion of filter cigarettes was found in the ash. They concluded that the remainder was available for pulmonary absorption by the smokers and estimated that 10 - 20% of that in the mainstream smoke would be absorbed; which from their investigation would amount to 1.5 - 3.0 ug of Cd per pack of twenty cigarettes.

Since these investigators did not use a standard smoking procedure, did not collect the tobacco smoke condensate (tar) from their smoking operation, and used questionable procedures for estimating the cadmium content of both whole cigarettes and ash, we chose to repeat this work with a view to eliminating these errors. This was done because of the importance of assessing the hazard of Cd in tobacco products and its fate during smoking. We not only used a standard smoking procedure, obtained the tar, but estimated the filtration capacity of the butts and calculated the loss of cadmium in the sidestream of cigarette and also determined the cadmium in cigar and pipe tobacco. Our results are given here.

Experimental:

Details of our smoking procedure and tar collection, using the Mason Mark III Smoking Machine are given in a recent publication (4).

We used Kentucky Reference Cigarettes and one commercial brand of non-filter, 85 mm. cigarettes. One popular brand of medium-priced cigar and one popular brand of pipe tobacco were used.

Ashing was carried out by two methods. A) Wet-ashing with concentrated nitric acid and 30% hydrogen peroxide and B) dry-ashing in a muffle furnace at 450°C.

Results:

Our results for the various forms of tobacco are given in Table 1. We see that cigarettes varied from 1.31 - 1.28 ug Cd per cigarette. Since cigarettes weighed 1.12 g this then amounts to 1.17 - 1.62 ug Cd/g. The cigar tobacco contained 1.86 ug Cd/g and the pipe tobacco 0.93 ug Cd/g. Thus the pipe tobacco had the lowest amount and cigar tobacco the highest.

These differences may only reflect the particular batch of tobacco used and not any peculiarity due to type of tobacco, since it should be pointed out that the two batches of Kentucky Reference cigarettes were significantly different.

Table II gives ~~our results~~ for the fate of the cadmium in cigarette tobacco during smoking. The values here are based on the smoked portion of the cigarettes only. This was 74% of the total for K.R. cigarettes and 65% of the total for C.B. cigarettes. These data show that only 6 - 7% of the Cd in the smoked portion appears in the tar, and that the unsmoked butts are enriched with 10 - 27% of the Cd of the smoked portion. They also indicate that the ash contains 25 - 34% of the Cd of the smoked portions. Thus there is left a large amount of Cd which is not accounted for in our experimental

values. This we believe is lost in the sidestream during smoking and between puffs. The amount of Cd lost in the sidestream may be estimated to be 40 - 55% from our data.

Discussion:

These data enlarge and extend the report of Nandi et al (3) in that they show that the major portion of cadmium in cigarettes is lost to the general environment of the smoker in the sidestream. Thus the smoker is not only subjected to the hazard of Cd in tobacco products but his neighbors in the vicinity share also in this hazard during his smoking.

The amount of Cd in tar is low but not inconsiderable. Thus the smoker may inhale and absorb a part of 1.4 - 1.6 ug of Cd from a pack of twenty cigarettes. However, the cigarette smoker is subjected to the sidestream as is any one near him while his cigarette is burning, which amounts to 9.0 - 13.6 ug of Cd per pack of twenty cigarettes. Thus the indoor pollution of Cd in a smoker's environment must be considerably more than the 0.0005 ug/m^3 which is in ambient outside air of Cincinnati and other large cities.

Since cigars and pipe tobacco also contain amounts of tobacco similar to that in cigarettes, it is to be expected that the sidestream of these forms will also send cadmium into the immediate environment of a smoker.

Some of the manifestations of cadmium poisoning (5) involve pulmonary effects such as bronchitis and emphysema. Therefore, the effect of cadmium from smoking on pulmonary function should be investigated further. This is particularly important since Lewis et al (6) have shown that liver Cd of patients dying with emphysema and chronic bronchitis was much higher than that of patients dying from non-pulmonary causes.

Conclusions:

Cadmium is present in tobacco products in amounts from 0.93 - 1.88 ug/g. During the smoking of cigarettes 40 - 55% of the Cd in the smoked portion is released into the smokers environment in the form of sidestream smoke.

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Table 1.

CADMIUM IN TOBACCO PRODUCTS

Tobacco Product	Wgt.	CADMIUM ug/unit	ug/g
1. Ky. Ref. Cigarettes (KRC)	1.12g	1.31	1.17
"	1.12	1.80	1.61
2. Commercial Brand Cigarettes (CBC)	1.12	1.82	1.62
	1.12	1.95	1.74
3. Commercial Brand Cigar	6.50	12.1	1.86
4. Commercial Brand Pipe	--	--	0.93

Table 2

FATE OF CD IN CIGARETTES DURING SMOKING

				Cd ug/unit	% of Smoked Portion
1.	Smoked Portion				
	KRC (74%)*	A		0.97	100
		B		1.33	100
	CBC (65%)*	A		1.22	100
		B		1.27	100
2.	Tar	KRC	A	0.07	7.2
		CBC	B	0.08	6.5
3.	Ash	KRC	A	0.24	24.7
			B	0.45	33.8
		CBC	A	0.33	27.4
			B	0.44	30.0
4.	Smoked Butt**				
	KRC	A		0.61	--
		B		0.60	--
	CBC	A		0.80	--
		B		0.85	--
5.	Unsmoked Butt				
	KRC*	A		0.34	--
	(26%)	B		0.47	--
	CBC	A		0.66	--
	(35%)	B		0.68	--
6.	Enrichment of Butt (Δ 4-5)				
	KRC	A		0.27	--
		B		0.13	--
	CBC	A		0.14	--
		B		0.17	--
7.	Total Accounted For				
	KRC	A		0.58	--
		B		0.65	--
	CBC	A		0.55	--
		B		0.69	--
8.	Sidestream	A		0.39	40
	KRC	B		0.68	52
	CBC	A		0.67	55
		B		0.58	46