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BRIEF COMMUNICATION

NEW BRANDS OF ORAL SNUFF

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Abstract—Snuff dipping is causally related to cancer of the oral cavity and pharynx. The most powerful carcinogens in snuff are nitroso compounds, particularly the tobacco-specific *N*-nitrosamines (TSNA). Concentrations of TSNA in snuff exceed the known concentrations of carcinogenic nitrosamines in any other consumer product by two to three orders of magnitude. During the last decade a gradual decrease in TSNA has occurred in the two leading snuff brands in the USA (about 90% of the market). Of two recently introduced snuff brands one has relatively low levels of nitroso compounds while the other contains the highest concentrations of nitrosamines ever reported in smokeless tobacco. This observation suggests that control of nitrosamines in snuff brands on the US market is desirable.

INTRODUCTION

In the USA in 1987 nearly 10,000 people died from cancer of the oral cavity and pharynx (US Centers for Disease Control, 1990). Tobacco smoking, tobacco chewing and alcohol consumption has contributed significantly to the relatively high mortality rate of 5.6/100,000/yr from cancer of the mouth and of the pharynx among men in the USA (IARC, 1985a,b; US Department of Health and Human Services, 1989). While avoiding use of tobacco products is the only safe way to prevent tobacco-related cancers, reduction of the exposure to tobacco carcinogens is regarded as one possible approach to diminishing the risk of cancer (IARC, 1985b; Wynder and Kabat, 1988). During the last two to three decades, the development of cigarettes with lower smoke yields has brought about a significant though gradual decrease in the sales-weighted average tar and nicotine yields in the smoke of cigarettes in the USA and in several European countries (Hoffmann and Hecht, 1990; Hoffmann *et al.*, 1990; Wald and Froggatt, 1989). Long-term smokers of filter cigarettes have a lower risk for cancer of the lung and of the oral cavity and pharynx than smokers of cigarettes without filter tips (Blot *et al.*, 1988; Wynder and Kabat, 1988).

Once a causal relationship between snuff dipping and oral cancer had been established (IARC, 1985a; US Department of Health and Human Services, 1986; Winn *et al.*, 1981), one would have anticipated that a gradual decrease in the carcinogens in snuff would occur. This would be especially important because of a steady rise in snuff production (US Department of Agriculture, 1990) and in the consumption of snuff by young men in the USA (US Centers for Disease Control, 1990).

The known carcinogens in snuff are some volatile aldehydes, benzo[a]pyrene, ^{210}polonium, volatile *N*-nitrosamines, *N*-nitrosamino acids and particularly tobacco-specific *N*-nitrosamines (TSNA) (Hoffmann *et al.*, 1987). The TSNA are carcinogens that are formed from nicotine and from the minor Nicotiana alkaloids by oxidative *N*-nitrosation, during curing, fermentation and ageing of tobacco and tobacco products (Burton *et al.*, 1989). The levels of TSNA in snuff exceed by two to three orders of magnitude those of *N*-nitrosamines in any other consumer products (Hoffmann *et al.*, 1987; National Research Council, 1981; Tricker and Preussmann, 1989). The nitrosamino acids are also formed during tobacco processing. Of the major *N*-nitrosamino acids in tobacco, nitrososarcosine, nitrosomethylpropionic acid and nitrosomethylbutyric acid are known animal carcinogens (Preussmann and Stewart, 1984; Rivenson *et al.*, 1989). Snuff is carcinogenic in the oral cavity of rats (Hecht *et al.*, 1986; Hirsch and Johansson, 1983; Johansson *et al.*, 1989). The nicotine-derived *N*-nitrosonornicotine and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone are powerful carcinogens in mice, rats and hamsters and are the only known carcinogens in snuff that induce oral tumours in laboratory animals (Hecht and Hoffmann, 1989; Hecht *et al.*, 1986).

It was the goal of the present study to evaluate the concentrations of *N*-nitrosamines in the two leading moist snuff brands on the US market and to compare these findings with earlier published data. We also analysed two new moist snuff brands from US test markets in order to determine whether their *N*-nitrosamine concentrations reflect a trend towards the reduction of the highly carcinogenic agents.

MATERIALS AND METHODS

Snuff brands for this study were purchased in 1989/1990 from retailers in Westchester County, NY, and in Göteborg, Sweden. One of the two new snuff brands (I) was bought in Birmingham, Alabama, and the other in Houston and Smithville, Texas, (II-A and

Abbreviation: TSNA = tobacco-specific *N*-nitrosamines.

II-B). Moisture determinations were done according to von Bethmann *et al.* (1961), and pH of the snuff suspensions and analyses for alkaloids, volatile *N*-nitrosamines, *N*-nitrosamino acids and TSNA (Fig. 1) were performed with earlier published methods. The standard deviations for the determination of individual *N*-nitroso compounds were ±5% and ±8%, respectively (Djordjevic *et al.*, 1989).

RESULTS AND DISCUSSION

Table 1 presents the analytical data for the two leading US moist snuff brands A and B (accounting for about 90% of the current market) and for the new snuff brand I, two samples of new snuff brand II, and for three recently purchased popular snuff brands from the Swedish market. The leading US snuff brands A and B show a decreasing trend in the concentrations of TSNA since 1980. The levels of *N*-nitrosonornicotine in brand A in 1980, 1981, 1986, 1988 and 1990 were 26.5, 19.0, 33.0, 13.8 and 10.4 μg/g, respectively, and in brand B were 39, 33, 64, 8.5 and 9.6 μg/g, respectively (Brunnemann *et al.*, 1982; Djordjevic *et al.*, 1989; Hoffmann and Adams, 1981; Hoffmann *et al.*, 1987). The new snuff brand I had relatively low levels of all carcinogenic *N*-nitrosamines, including TSNA. The data for the new brand I are in agreement with those of the three Swedish snuff brands (Table 1). In 1980, TSNA values in 12 samples of five Swedish snuff brands ranged from 7.0 to 17.9 μg/g with an average of 12.6 μg/g (Hoffmann and Adams, 1981); thus, the new data indicate a trend towards lower concentrations of carcinogenic TSNA in Swedish snuff brands.

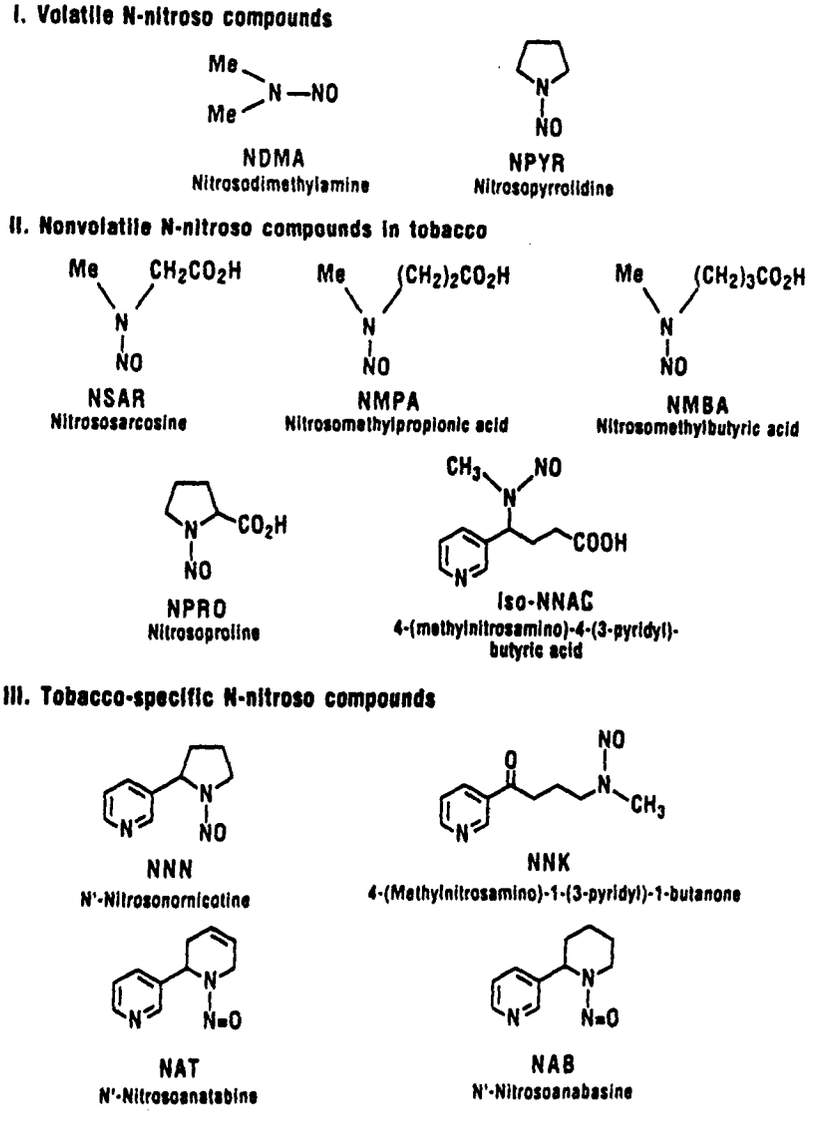

Fig. 1. Nitrosamines in oral snuff.

Table 1. Alkaloids and *N*-nitroso compounds in snuff brands*

Components	Snuff samples							
	US A	US B	New I	New† II-A	New† II-B	Sweden I	Sweden II	Sweden III
Moisture (%)	56.0	57.8	51.8	50.0	57.8	51.6	54.2	46.6
pH	7.11	7.30	5.61	7.72	8.17	7.90	7.94	7.67
Alkaloids (%)								
Nicotine	2.04	2.17	2.15	1.85	2.03	1.24	1.25	1.13
Nornicotine	0.04	0.03	0.01	0.06	0.02	0.04	0.06	0.05
Total alkaloids‡	2.18	2.32	2.32	2.00	2.16	1.34	1.41	1.24
Volatile nitrosamines (ng/g)								
NDMA	ND	ND	ND	147	265	63	51	53
NPYR	44	59	120	245	575	155	ND	13
Nitrosamino acids (μg/g)								
NSAR	0.06	0.06	ND[b]	0.60	0.16	0.09	0.68	0.03
MNPA	5.13	3.62	2.72	25.3	6.68	3.28	3.10	3.15
NMBA	0.47	0.26	0.09	3.09	2.41	0.23	0.19	0.20
NPRO	3.78	3.15	0.74	21.0	12.5	8.33	4.91	6.27
iso-NNAC	0.08	0.16	0.07	1.36	10.5	0.04	0.04	0.11
Total NNAA	9.4	7.1	3.5	51.3	32.2	11.9	8.9	9.7
TSNA (μg/g)								
NNN	10.4	9.57	4.14	36.9	57.1	5.67	5.25	5.24
NNK	2.19	3.14	1.24	16.4	7.16	2.08	1.37	1.44
NAT + NAB	9.76	7.90	2.97	40.3	91.5	3.47	2.89	2.58
Total TSNA	22.3	20.6	8.3	93.6	155.8	11.2	9.5	9.3

*For abbreviations see Fig. 1. ND = not detected (< 0.01 ng/g); ND[b] = not detected (0.01 μg/g). All values are based on dry weight.
†II-A and II-B are samples of the same brand purchased in different cities.
‡Includes nicotine, nornicotine, myosmine, anatabine, anabasine, 2,3′-dipyridyl and cotinine.

The newly introduced US snuff brand II surprisingly showed the highest TSNA concentrations we have observed during the last decade. The levels of other carcinogenic *N*-nitroso compounds were also high (Table 1), even though the levels of nicotine, nornicotine and total Nicotiana alkaloids were comparable with those in the other US snuff brands. The latter data and the elevated pH levels for the aqueous suspensions (pH 7.72 and 8.17) suggest that, by comparison with other methods of processing, the preparation of this new snuff brand II results in increased formation of *N*-nitrosamines. This, in turn, suggests a significantly higher carcinogenic potential for this snuff brand.

A WHO Study Group on 'Smokeless Tobacco Control' recommended in 1988 that "the analysis of smokeless tobacco products and the regulation of harmful substances should be subject to government control." The data obtained in this study reinforce the WHO recommendation for the US market.

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