BRIEF REPORT

Levels of toxins in oral tobacco products in the UK

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Tobacco Control 2006;**15**:64–67. doi: 10.1136/tc.2005.013011

Objective: This study examined the constituents of smokeless tobacco products available in the UK and compared them with products available in India, Sweden, and the USA
Methods: Seven UK brands of smokeless tobacco, including a tooth cleaning powder, and four international brands of smokeless tobacco were tested for a range of toxins and known carcinogens, such as tobacco specific N-nitrosamines (TSNA), as well as nicotine availability.
Results: Ten of the 11 brands tested had detectable levels of tobacco specific nitrosamines, which are proven carcinogens, and levels varied 130-fold. All had detectable levels of benzo(a)pyrene, another proven carcinogen (with around 175-fold variation) and several toxic metals (with nearly 150-fold variation). Nicotine availability varied in the UK products from 0.1 mg/g to 63.2 mg/g. All the tobacco products tested are likely to be hazardous to users' health, but the data indicate that it should be possible to reduce key toxins to non-detectable levels.
Conclusions: Smokeless tobacco products should be regulated and standards set for maximum levels of toxins and carcinogens.

Cigarettes are by far the dominant form of tobacco used in the UK, with small numbers of people also smoking tobacco in other forms such as cigars and pipes. Smokeless tobacco products are much less common in the UK than in countries like India where they represent over a third of all tobacco consumed.[1] Nevertheless, one main form of smokeless tobacco, chewing tobacco (a form of smokeless tobacco consisting of loose leaf tobacco in pouches of tobacco leaves, ''plug'' or ''twist'' form), is used in the UK, particularly among people of South Asian origin. Of the 2.4 million South Asians in the UK, estimates of smokeless tobacco usage vary from 27–98% depending on the community and sex.[2] The other main form of smokeless tobacco, oral snuff, is banned throughout the European Union[3] except in Sweden because of the traditional and widespread use there among men of snus (a form of moist oral snuff in which a pinch of tobacco or a teabag-like sachet of tobacco is placed between the lip and gum).

The chewing tobacco forms used in the UK are similar to those commonly used in Southern Asia and often involve other substances, and include:

- Gutkha—a sweet chewing tobacco containing betel leaf, catechu, and saffron.
- Zarda—a moist or dry chewing tobacco mixed with a variety of colourings, spice essences, and perfumes.
- Dried whole and chopped tobacco leaves—often purchased in shops to be used in oral preparations (the leaf can be ground to prepare a type of zarda).
- Tooth cleaning powders—originating from Southeast Asia and comprising abrasive powdered tobacco with aromatic ingredients added to make the breath sweet.

Some of these products, such as zarda and dried leaves, are used in conjunction with paan (or betel quid which is a combination of betel leaf, areca nut, and lime paste) and are individually made to one's own taste, so the ingredients vary and commercialisation of the products is limited.

Smokeless tobacco products deliver nicotine and are dependence forming. In South Asia the use of chewing tobacco causes considerable health risks; in particular, it is a major cause of oral cancer and is also harmful in pregnancy.[4] A recent study[1] demonstrated substantial amounts of tobacco specific nitrosamines (TSNAs) in smokeless tobacco products marketed in India. TSNAs are the most common carcinogens in unburnt tobacco which are formed during the aging, curing, and fermentation of tobacco.[5] Given similar types of tobacco are allowed on the market in Europe, concerns have been expressed that they may also pose health risks. This study therefore examined chewing tobacco products purchased from outlets in the UK and compared their toxin content and nicotine availability with snus and three other forms of smokeless tobacco purchased in India and the USA.

METHODS

Twenty five consumers and 25 shopkeepers (aged 16 or above) were selected opportunistically from South Asian communities from two locations in the UK, chosen because of their high prevalence of people from South Asian communities, and administered a short questionnaire requesting information concerning popular smokeless tobacco products used by these communities. The responses of the two populations were compared in order to identify 17 most popular brands, a method used in other studies.[6] Samples of these were then purchased randomly from different shops and locations and analysed by the Laboratory of the Government Chemist for a variety of toxins. The results of this pilot test were used to identify a smaller subsample of seven products, including some having the highest levels of some of the toxins: two gutkha products (Manikchard and Tulsi mix), three zarda products (Hakim Pury, Dulal Misti, and Baba Zard Gulabi Patti), one tooth cleaning powder (A Quardir Gull) and a tobacco leaf. These products were then tested alongside four international products: the most popular zarda product in India (Baba 120), snus (general pouch) from Sweden, and two smokeless tobacco products available in the USA (US Copenhagen snuff original fine cut, the leading snuff brand for a few decades, and Ariva, a more recent addition to the US market, a tablet of tobacco placed in the mouth and allowed to dissolve slowly). Zarda products in India were recently shown to have

Abbreviations: BaP, benz(a) pyrene; NAB, N-nitrosoanabasine; NAT, N-nitrosoanatabine; NDMA, N-nitrosodimethylamine; NNK, 4(methylnitrosamino)-1-(3-pyridyl)–butanone; NNN, N-nitrosonornicotine; TSNA, tobacco specific nitrosamine

relatively high TSNA levels.[1] In contrast, the manufacturers of snus and Ariva claim that these products have very low levels of certain toxins and carcinogens.[7 8] Levels of TSNA have recently been found to be very low in snus[9] with some evidence that users of this product have minimal levels of carcinogen uptake.[10]

The products were purchased using a consistent methodology. Five samples of each product were chosen randomly from shop displays from each of three shops chosen randomly from the East London area, Mumbai in India, Stockholm in Sweden, and New Jersey in the USA. The products were received over a period of four months and stored in a freezer before being tested when the 15 samples were mixed thoroughly to yield representative samples of each product.[11]

The products were tested for 4 TSNAs (N-nitrosonornicotine (NNN), N-nitrosoanatabine (NAT), N-nitrosoanabasine (NAB), and 4(methylnitrosamino)-1-(3-pyridyl) – butanone, (NNK)), N-nitrosodimethylamine (NDMA), a marker for volatile nitrosamines and a carcinogen, toxic metal content, nitrites (which react with nicotine or other alkaloids contained in tobacco to form TSNAs), and benz(a) pyrene (BaP), another established carcinogen. Total TSNA content was calculated by adding NNK, NNN and NAB. Moisture content, nicotine content, and pH (a measure of alkalinity thought to influence buccal absorption of nicotine through affecting the proportion of nicotine in freebase form) were measured and the latter two measures used to calculate the proportion of freebase nicotine (unprotonated nicotine, absorbed much more quickly through the mucous membrane than protonated nicotine[12 13]). Methodologies used were based on Centers for Disease Control, Health Canada, International Standards Organisation (ISO) Standards or in house techniques based on the most up to date literature.

RESULTS

Table 1 shows the characteristics of the products measured in this study. Dry weight measurements are given as the moisture levels of the samples varied considerably (from 1.7–48%).

TSNA levels ranged from non-detectable (in Ariva) to 5.12 μg/g n the tooth cleaning powder and to 29.7 μg/g in Hakim Pury. Four other samples had significant levels of total TSNAs (>1 μg/g). For benz(a)pyrene (BaP), all the products had detectable levels, ranging from 0.11 ng/g in the tobacco leaf to 19.33 ng/g in the Copenhagen samples. Among the UK purchased products Dalal Misti Zarda had the highest level with 8.89 ng/g content of BaP. All products had non-detectable levels of NDMA except the tooth cleaning powder, and non-detectable levels of nitrite except for Copenhagen. All products had detectable levels of the four toxic metals tested in this study. Although the two UK gutkha products had the lowest toxic metal content, in all cases except for lead (where the highest level was in the Indian purchased brand) the highest toxic metal contents were found in other UK purchased products. The tooth cleaning powder generally showed the highest levels. Nickel was the most predominant metal found.

Nicotine content ranged from 3 mg/g in one gutkha product to 83.5 mg/g in the tobacco leaf. The pH ranged from 4.9 to 9.9 for these samples, the tooth powder and the two gutkha products being the most alkaline. Freebase nicotine was highest in the tooth cleaning powder at 63.2 mg/g nicotine; it was high also in the two gutkha products (at 3 and 8 mg/g nicotine in Manikchard and Tulsi mix, respectively), and in the products originating from Sweden (6.3 mg/g) and the USA (2.4 mg/g for Ariva and 4.9 mg/g for Copenhagen), with the remaining products less than 1 mg/g.

DISCUSSION

To our knowledge this is the first study to examine the toxin content of chewing tobacco products used in the UK. All of the products had detectable levels of at least some of the carcinogens examined, and are therefore likely to be hazardous to users' health. Some UK products (in particular one zarda product and the tooth cleaning powder) are of great concern as they have high levels of some established carcinogens and are clearly putting the health of users at risk. These products also had the highest toxin levels in the pilot test. It is not clear why the levels of toxins varied and further research is needed to establish the contribution played by selection, curing, and manufacturing processes,[14] and shelf life.[15] It cannot be assumed that products with low levels of the toxins measured in this study are safe as only a small number of toxins were measured.

The high levels of carcinogens appear unnecessary as levels of the same toxins in other smokeless tobacco products (some of which are banned in the UK) are considerably lower. In addition, while all the products release nicotine, two UK products had the highest proportions of freebase nicotine suggesting that they may also be the most addictive.

As the UK products have established usage within Asian communities in the UK and are very much part of their culture, we are not suggesting that these products be banned. Instead, toxin standards should be set for all the smokeless tobacco products available on the UK market, with a reasonable timescale for compliance. The toxin standards set by parts of the industry—for example, the Gothiatek Standard by Swedish Match[7]—could be used as a starting point, but it should be possible over a short time frame to reduce the key toxins and carcinogens to the lowest levels which are technically feasible which in most cases would be non-detectable levels (shown in this study and other research to be technically feasible[9]). Standards for other similar products could also be used as a starting point—for example, the tooth cleaning powder should be subject to the same regulations as other toothpastes or removed from the market. It is also clear that standards would need to apply for imported products and such a regulatory framework may therefore need to be agreed internationally so that the proposed standards are implemented and monitored in countries where these products are manufactured. Where the products are not commercially produced (for example, the tobacco leaf) it will be more difficult to set stringent standards for toxins. A starting point may be to set a higher level, with random testing carried out by local trading officers to check that the leaves sold comply with the regulations. Further research into the demand for tobacco leaves is necessary before deciding how to apply stronger regulations to the product or take them off the market.

When reducing carcinogens, however, the products must be monitored to ensure that the reduction of, for example, TSNAs is not accompanied by unwanted side effects in the form of increased levels of other toxins. No communication about these reductions should be made to the consumer because although they are likely to make the products less harmful, they will not make the products safe.

Over time, consideration could be given to setting standards for a broader range of specifications such as pH and free nicotine. However, further research is needed because the consequences of such a strategy are unknown and may lead to greater use of the products to satisfy a consumer's addiction.

The introduction of toxin standards will raise the need to consider lifting the ban on oral snuff in the UK for compliant products.[16] If the ban is lifted, tight regulatory controls would be needed on the marketing of such products to prevent an increase in demand for them. The dangers of smokeless

Table 1 Content of smokeless tobacco products tested in this study*

Brand	Moisture % w/w	TSNA† µg/g	BaP ng/g	NDMA ng/g	Nitrite µg/g	Chromium mg/kg	Nickel mg/kg	Arsenic mg/kg	Lead mg/kg	Nicotine mg/g	Average pH	Free nicotine mg/g
UK purchased products												
Gutkha products												
Manikchard	1.68	0.289	0.40	ND	ND	0.26	1.22	0.04	0.15	3.1	9.19	3.0
Tulsi mix	1.25	1.436	1.28	ND	ND	0.33	1.43	0.06	0.19	8.2	9.52	8.0
Zarda products												
Hakim Pury	4.91	29.705	0.32	ND	ND	2.15	5.35	0.29	1.36	42.7	6.00	0.4
Dalal Misti Zarda	8.96	1.574	8.89	ND	ND	0.87	2.09	0.11	1.14	8.6	6.15	0.1
Baba Zarda (GP)	7.88	0.716	2.04	ND	ND	2.34	5.88	0.24	1.18	48.4	5.32	0.1
Tooth cleaning powder												
A. Quardir Gull	3.35	5.117	5.98	7	ND	3.56	5.31	0.46	1.39	64.0	9.94	63.2
Dried tobacco leaves												
Tobacco leaf	5.16	0.223	0.11	ND	ND	2.34	4.37	0.20	1.06	83.5	5.52	0.3
Products purchased outside UK												
Baba 120 (India)	13.18	2.361	2.83	ND	ND	2.08	2.94	0.40	1.56	55.0	4.88	0.04
Snus (Sweden)	45.84	0.478	1.99	ND	ND	1.54	2.59	0.30	0.50	15.2	7.86	6.3
Ariva (USA)	2.40	ND	0.40	ND	ND	1.40	2.19	0.12	0.28	9.2	7.57	2.4
Copenhagen (USA)	48.10	3.509	19.33	ND	6.7	1.69	2.64	0.23	0.45	25.8	7.39	4.9
Detection limits		0.025 for each		5	0.2							

*All figures are averages of two measurements except for pH which gives the average of three measurements. On average measurements agreed by less than 10%.
†Total TSNA = total tobacco specific N-nitrosamines = NNK+NNN+NAB.
BaP, benz(α)pyrene; NDMA, N-nitrosodimethylamine.

What this paper adds

It is already known that types of smokeless tobacco commonly used in Southern Asia contain high levels of toxins and carcinogens and cause considerable health risks. Similar tobacco products are used in the UK, particularly among people of South Asian origin, but no research has been carried out on their content.

This work demonstrates that smokeless tobacco products available in the UK vary greatly in concentrations of nicotine, toxic metals, and carcinogens, often containing higher levels than products which are not allowed on the market. We recommend that these products are regulated and standards set for maximum levels of toxins and carcinogens, which could be internationally applied.

tobacco use would need to be communicated widely to all consumers in the UK and users should be actively encouraged to give up.[17] However, smokeless tobacco users should also be informed about the much greater health risks of cigarette smoking to prevent them switching to this more dangerous form of nicotine delivery.

ACKNOWLEDGEMENTS

We are very grateful to Keith Darrell for his helpful advice and support at the start of the project, and Ian Axford and Larry Noyes from the Laboratory of the Government Chemist who analysed the samples. We would also like to thank those who collected the samples, in particular Dr F Haq who collected samples in the UK.

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Funding for this work was provided by a grant from the Department of Health. Staff at the Department of Health (RB and initially also SI) who funded this work participated in the study design, data interpretation, report writing and in the decision to submit the paper for publication.

Competing interests: The authors have no competing interests to declare.

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Received 19 June 2005
Accepted 9 October 2005

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