



## Research paper

## Composition, purity and perceived quality of street cocaine in France

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## ARTICLE INFO

## Article history:

Received 4 December 2009

Received in revised form 10 February 2010

Accepted 11 March 2010

## Keywords:

Purity

Composition

Perceived quality

Street cocaine

Mode of administration

## ABSTRACT

**Background:** There is little knowledge about the composition and cocaine content of street cocaine, nor about what users know about it.

**Method:** 373 cocaine users were face to face interviewed between May and December 2006 about the last sample of cocaine they had consumed and residual amounts of the substances actually used were analysed using gas phase chromatography coupled to mass spectrometry (GC–MS). Users rated the perceived quality of their product (“good”, “average”, “poor”), its “estimated percentage of cocaine” and any cutting agents it contained. Price, quantity, place of purchase (street, dealer’s premise, appointment), mode of administration (sniffing, injection, smoking) and the supposed nature of the sample (natural, synthetic, no distinction ever made) were also reported. Perceived quality was modelled using multivariate multinomial regression.

**Results:** The median cocaine content was 22%. Altogether, 343 samples contained cocaine, among which 75% contained at least one adulterant. The most frequently occurring were phenacetin (54% of the samples), caffeine (17%), paracetamol (14%), diltiazem and lidocaine (11%). Users showed relatively poor discrimination concerning cocaine purity, and only 12% reported at least one of the detected adulterants. The major determinants of their perception of cocaine quality were: place of purchase, natural origin, price per gram, actual cocaine content and mode of administration.

**Conclusion:** The composition of street cocaine is largely unknown to users. Users’ perceptions of cocaine quality are based partly on false beliefs and certain administration modes. This may contribute to favouring very risky practices. The effects of adulterants on users’ health should be investigated.

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## Introduction

Cocaine consumption has increased rapidly in Europe over the last few years (EMCDDA, 2007). In 2007, 12 million people had used cocaine at least once in their lifetime, and lifelong prevalence of use ranged between 0.4% in Romania, Lithuania and Malta and 7.7% in the United Kingdom (7% in Spain) (EMCDDA, 2008). Between 2000 and 2005, lifetime prevalence among people aged 15–64 in France increased from 1.6% to 2.6% and prevalence for the previous year from 0.2% to 0.6% (Beck et al., 2006). A greater increase in lifetime prevalence was recorded among 17-year-olds between 2000 and 2008 (from 0.9% to 3.3%) (Legleye, Spilka, Le Nézet, & Laffiteau, 2009). The increasing number of cocaine users is one of the major concerns for policies to reduce drug related harms in Europe. But, as noted by Caulkins and Reuter (1997), prevalence of use is not a sufficient indicator for monitoring, predicting or indeed prevent-

ing the development of the cocaine epidemic, and additional data is required to understand the phenomenon.

Forensic data provide information about price, purity and strength of the substances on the market (King, 1997; Simonsen, Kaa, & Rolmann, 2003). But it is often difficult to distinguish between large-scale trafficking and local sale of these substances and besides understanding supply and trafficking, we need to establish relationships with user characteristics (preferred products and related behaviours). Increasing awareness among users towards cocaine content and purity and its possible adverse effects, would also be useful, as awareness of damage among heavy users could deter abstinent people from initiation or prevent light users from engaging in more frequent use (Musto, 1987). Behavioural economic studies are a useful method for investigating drug use in relation to price, purity and other market and consumption aspects (Bickel & Marsch, 2001). An economic experiment showed that cocaine purchase may or may not be “income-elastic”, depending on its perceived quality (Goudie, Sumnall, Field, Clayton, & Cole, 2007). This study, however did not explore the dimension of perceived quality and its determinants. Factors other than purity may be involved in perceived quality, such as the place or context of

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purchase, dealers' statements on the source of the cocaine and supposed nature of cocaine, supposed presence of specific cutting agents and even some user characteristics such as the duration of use (Decorte, 2001). These determinants are of major importance in adapting prevention strategies and improving analyses of the market.

To improve cocaine monitoring, early warning systems for emerging drug trends were developed in Western countries during the 1990s (Griffiths, Vingoe, Hunt, Mounteney, & Hartnoll, 2000). The main purposes of these systems are to provide strategic early warning of emerging drug trends in the main illicit drug markets, and to identify emerging problems that require further research. As opposed to cross-sectional quantitative surveys or behavioural economic studies, these systems are based on an ethnographic approach aiming to build strong relationships with subjects so as to improve data quality (Johnson & Golub, 2007). However, with rare exceptions (Brunt et al., 2009), these systems have only been able to examine the relationships between behavioural findings and users' beliefs about cocaine purity set against information on actual purity obtained from seized substances (Shane, Kaye, & Libby, 2002). Indeed, analysing the contents and the potencies of illicit substances obtained from users depends on the ability of research teams to purchase the substances *in situ*, which is rarely possible because most countries lack *ad hoc* legal protection to prevent any risk of arrest (Johnson & Golub, 2007).

Finally, the scientific literature about the adulterants of cocaine (substances deliberately added to mimic or to boost the effects of the drug) is generally focused on the discovery of new substances in seizures (Fucci, 2007; Fucci & De Giovanni, 1998; Kenyon, Ramsey, Lee, Johnston, & Holt, 2005; Kinzie, 2009) and the rare series of data from the streets (Brunt et al., 2009; Musset, Fathi, Magnin, & Mani, 2005) are not derived from sampling designs but from free "testing services". Adulterants may influence the perception of cocaine quality by users, as they do have effects that can mimic cocaine (for example local anaesthetic effect) or alter the pharmacological effect of cocaine. But they can also cause acute intoxication, as in the case of anticholinergic poisoning by cocaine adulterated with atropine or scopolamine (Boermans, Go, Wessels, & Uges, 2006; Nogue, Sanz, Munne, & de la Torre, 1991; Quandt, Sommi, Pipkin, & McCallum, 1988; Sefedov, 2005; Weiner, Bayer, MacKay, Demeo, & Starr, 1998), or chronic intoxication, such as agranulocytosis after exposure to cocaine and levamisole (Zhu, Le Gatt, & Turner, 2009). Again, no study has tried to confront the knowledge that users have about cocaine with its actual composition and cocaine content.

A novel survey was therefore conducted in France on several hundred users in 2006, combining face-to-face interviews about the last cocaine samples they had used and a toxicological analysis of these samples. This study had three aims: first, to describe the composition of street cocaine; second, to evaluate users' knowledge about its purity and composition and third, to find the factors that most influenced their views about the quality of the substances.

## Method

### Participant recruitment

The study was based on the French early warning system survey for emerging drug trends, organised since 2000 in eight conurbations (Cadet-Taïrou, Gandilhon, Toufik, & Evrard, 2008a). Investigators were all professionals from this network specializing in ethnographic approach. They were familiar with the gathering places of users and the places of consumption, so they were able to recruit participants through personal face-to-face contact. The survey design required each participant to be interviewed only once and to possess a residual amount of the cocaine that he/she

had used. Perceived quality and purity were then to be compared with actual cocaine content and composition. This very demanding inclusion criterion excluded random snow-ball sampling usually used in qualitative research. Nevertheless the recruitment criteria favoured a heterogeneous population: different ages, gender, occupational status and social category, seen in different regions and districts and various settings. The purchase price paid by the users was to fall within the range of local market prices at the same period. The cocaine was to be in the hydrochloride form (not crack as crack market is extremely small and specific in France). The residual cocaine sample was purchased from the users at slightly above the local market price to provide them with incentive to release some of the remaining substance, which is difficult for many cocaine users, and to avoid those choosing substances that had unusual or worrying effects that users might prefer to submit to analysis. The collection of these samples was approved by the local and national legal authorities and each investigator had legal permission to submit the samples to laboratory analysis.

### Toxicological analysis

Only adulterants (substances deliberately added to mimic or to boost the effects of the drug) that are pharmacologically active substances were looked for (Hoffman, Kirrane, & Marcus, 2008). Impurities (substances present in the drug as a natural result of the manufacturing process) and diluents (inert substances such as sugar added as a bulking agent) were not tested as they were of little interest in the study context. Cocaine content and identification of the adulterants were performed by gas phase chromatography coupled to mass spectrometry (GC-MS).

### Measures

The perceived quality of the cocaine was rated as "good", "average" or "poor" by the users. They indicated if they had felt the usual effects of cocaine, and if not, were asked to describe the symptoms they had experienced and to list any associated consumption. Users gave their opinion about the purity of cocaine expressed in percentages and the "cutting agents contained in the powder" (the definitions of the adulterants and diluents are not familiar to users and the general term cutting agents was therefore used).

The participants also reported whether they distinguished natural (*i.e.* from coca leaf) from synthetic (*i.e.* synthesized from precursor chemicals) cocaine and if so, what type of substance they had used. Users often associate the term natural with plant substances, less cut and less harmful (Cadet-Taïrou, Gandilhon, Toufik, & Evrard, 2008b; Decorte, 2001). This belief is groundless, as samples of illicit synthetic cocaine are extremely rare (Casale & Klein, 1993). Frequencies of use were measured in numbers of days' use over the previous year and month. All the users had taken cocaine more than 10 times in the previous year, and two classes of frequency were defined: more than 10 occasions in the previous 30 days (regular or daily use) and less (repeated use). The place of acquisition of the substance was reported using three response options: "from a dealer's premises", "in a place set by appointment" and "in the street without an appointment". Purchases at parties where users knew how to find dealers were coded as "in a place set by appointment". The user was asked to report the price and amount of powder he/she had bought. Calculation of a standardized price per unit is complicated by the existence of significant quantity discounts (Caulkins, 2007). People who received cocaine for free were excluded of this part of the analysis, as we wanted to observe the influence of cost on the perceived quality (20 samples excluded). The calculated prices in Euros per gram were therefore classified into the following categories: "50€ or less per gram", "between 51 and 69€ per gram", "70€ or more per gram" and "dis-

counted”, a category containing purchases of more than 10 g which were very likely to be discounted. The cut off for the discounted category was laid out following our knowledge of the market as there is no consensus for dividing price by gram into discrete variable (ONDCP, 2004, p. 17). The price has not been converted to price per gram of pure cocaine as stressed by Caulkins (2007) because we aimed at studying the influence of both actual purity and price per gram on perceived quality. Furthermore, some of the cocaine samples did not contain cocaine at all.

Although the study focused on cocaine powder, the mode of administration and type of substance used (hydrochloride or free-base) were recorded, since users could have converted part of their hydrochloride cocaine in order to smoke it: these so-called “free-basing” practices appear to be relatively common in France (Cadet-Tairou et al., 2008b).

### Statistical analysis

The results for pharmacological analysis of the cocaine samples and the characteristics of participants were first described with percentages, averages and median. Concordance between the actual and the estimated purity (expressed in percentages) was assessed with the weighted kappa index. Estimated and actual purities were both broken down into quintiles. Agreement between the two was rated with the kappa index according to the scale of independence judgments proposed by Landis and Koch (1977). Secondly, the relationships between perceived quality, user characteristics and results of the cocaine sample analysis were examined using  $\chi^2$  tests. Thirdly, variables that were significantly related at a 15% threshold in cross-tabulations were included in a generalised logistic regression in order to explore the relationship between perceived quality and these variables (polytomous modelling could not be used, as the assumption of the proportionality of the odds ratios had to be rejected:  $p < 0.001$ ). The final generalised logistic model was constructed by excluding certain candidate variables according to the Akaike information criterion (AIC) (Akaike, 1974) and log-likelihood ratio tests. All analyses were performed on SAS software, version 9.1.

## Results

### Pharmacological analysis of the cocaine samples

373 samples were obtained between May and December 2006 from the following eight French conurbations: Paris (two million inhabitants; 77 samples), Lille in the north of the country (225,000; 59), Rennes in the north-west (211,000; 39), Marseilles in the south-east (827,000; 32), Bordeaux (203,000; 27) and Toulouse (437,000; 60) in the south-west and finally Dijon (151,000; 23) and Metz (124,000; 56) in the north-east. The median cocaine content of the 373 samples was 22% and the average was 27%. Around 50% of the content values were between 10% and 40% with a maximum of 88%. Overall, 30 powders did not contain cocaine (8% of the samples collected); only two of them contained a narcotic that could mimic the stimulant effects of cocaine (phenmetrazine). The median purity of the 343 samples containing cocaine was 23% and the average purity was 29%.

Table 1 shows that among the 343 samples containing cocaine, 73% contained at least one adulterant. Phenacetin (found in 54% of the samples), caffeine (17%), paracetamol (14%), diltiazem (11%), lidocaine (11%), levamisol (6%) and hydroxyzine (4%) were the most common adulterants: only 12 samples did not contain at least one of them. The other adulterants were found in less than 10 samples.

The median cocaine content of samples that contained an adulterant was lower than that of samples that did not (21% versus 39%,

**Table 1**

Main adulterants detected in the 343 samples containing cocaine. One or more adulterants can be present in each powder.

Name	Nature	Frequency	% Samples
Phenacetin	Antipyretic, analgesic	184	54
Caffeine	Psychostimulant	62	17
Paracetamol	Antipyretic, analgesic	48	14
Diltiazem	Calcium blocker	37	11
Lidocaine	Local anesthetic	36	11
Levamisol	Antiparasitic agent	21	6
Hydroxyzine	H1 antihistaminergic	12	4
Acetylsalicylic acid	Antipyretic, analgesic	6	2
Propoxyphen	Analgesic	6	2
At least one adulterant		251	73

$p < 0.001$ ). The dilution effect however disappeared from the second adulterant onwards: median 23% for one adulterant, 20% for two adulterants and for three or more adulterants (the differences were not significant). The plausibility of the different hypotheses to explain these results (successive adulterations, mixtures of powders containing different adulterants, unintentional contamination during storage or transport) was not assessed, as actual adulterant content was not measured.

### Comparison between supposed and actual compositions

Concordance between estimated and actual purities (broken into quintiles) was assessed with kappa index. Result (0.17, 95% CI = [0.10; 0.25]) was lower than 0.20, showing a “very low agreement” according to Landis and Koch (1977). Duration of use did not influence users’ assessment abilities, as the concordance measures were close for those who had used cocaine for less than 5 years (kappa = 0.20, 95% CI = [0.10; 0.35]), those who had used between 5 and 9 years (kappa = 0.16, 95% CI = [0.05; 0.28]) and those who had used it for 10 years or more (kappa = 0.14, 95% CI = [-0.01; 0.28]).

Only 99 users (27% of the 373 participants) reported the name of at least one cutting agent (only two stated that they had a substance that contained only cocaine). Of these 99 users, 11 reported only substances that were not detected by the analyses performed, mostly diluents (sugar, bicarbonate and talc) and only three reported substances fairly unlikely to be present (plaster, endomorphines and ground glass). Of the 78 people (21% of the participants) who reported at least one substance potentially identifiable by GC–MS, 21 used the general term “medicine”.

Table 2 shows that 57 responses (15% of the respondents) referred to at least one substance detectable by GC–MS: this concerned 10 substances and three general categories (laxative, anesthetic and sleeping pills). Paracetamol and lidocaine were found in proportions close to those reported, but stimulants were found in far smaller proportions than reported by respondents: in one case out of two for caffeine and one case out of 40 for amphetamines. Manicol, Subutex®, strychnine, laxative and sleeping pills were not identified in analyses. Finally, Table 2 shows that only 44 respondents (12% of the total) reported at least one substance that was effectively found in the powders that contained cocaine. More specifically, only five respondents reported a substance that was actually present in their own cocaine: caffeine in four cases and lidocaine in one case.

### Participants’ characteristics

Participants’ characteristics are reported in Table 3. Users were between 18 and 56 years old and 21% was female. Half were in employment at the time of the survey, the other half obtaining their income from a third party (approximately 10% were students) or social services. 36% respondents started to use cocaine within the

**Table 2**  
Actual presence of “cutting agents” reported by users (373 interviews) and potentially detectable by GC–MS. One or more substances can be reported/identified for each powder.

Name	Nature	Substance reported by users		Substance identified by analysis	
		Frequency	% Users' responses	Frequency	% Samples
Caffeine	Psychostimulant	17	5	62	17
Amphetamine	Psychostimulant	15	4	3	0.9
Acetylsalicylic acid	Analgesic	5	1	6	2
Manicol	Laxative	5	1	0	0
Laxative	Laxative	5	1	0	0
Paracetamol	Analgesic	5	1	57	15
Lidocaine	Analgesic	4	1	36	10
Subutex®	Opiate	4	1	0	0
Anesthetic	Anesthetic	3	0.8	46 <sup>a</sup>	13
Codeine	Opiate	2	0.5	3	0.9
MDMA	Psychostimulant	1	0.3	4	1
Strychnine	Psychostimulant <sup>b</sup>	1	0.3	0	0
Sleeping pills	Hypnotic	1	0.3	0	0
Total of substances reported/identified		57	15	251	73
At least one reported substance identified in all samples		44	12		

<sup>a</sup> All anesthetics combined together.

<sup>b</sup> At very low dose.

previous 5 years, 38% between 5 and 9 years and 36% more than 10 years previously. 75% sniffed their cocaine, 16% “free-based” their cocaine to smoke it and 9% injected it. Purchase prices ranged between 25 and 100€/g, for amounts ranging from 0.5 to 1000 g.

### Quality estimation

Table 3 shows that duration of use did not influence users' opinions on quality ( $p=0.468$ ). Substances bought in the street and those that were bought cheap were far more often considered to be poor quality, and conversely substances supplied by dealers from their premises were thought to be better ( $p<0.001$ ). As expected, the description “natural” was linked to powders thought to be of good quality, the reverse being true for the description “synthetic” ( $p<0.001$ ). Powders with very low cocaine content were thought to be of poor quality, unlike powders with high cocaine content ( $p<0.001$ ). Results also showed that paracetamol was more often present in powders thought to be of poor quality ( $p=0.001$ ). Other associations were not significant at the 0.05 level.

Variables that were associated with perceived quality at the 15% threshold in Table 3 (i.e. educational status, mode of administration, frequency of use, place of purchase, price, nature of substance (natural or synthetic), presence of phenacetin, paracetamol or diltiazem, and actual cocaine content divided into tertiles), were introduced into a multivariate generalised logistic model. Some variables were successively removed according to the AIC: first phenacetin, diltiazem and paracetamol, then educational status and finally frequency of use. The log-likelihood ratio test confirmed that the resulting nested model was comparable to the full model ( $p=0.750$ ); so we favoured the most parsimonious model.

Table 4 shows the results obtained in the final logistic model using “average” quality rating as the reference. Powders with high cocaine content were 3.84 times more likely to be thought to be good quality than average quality. But users were no likely to consider them of average quality than of poor quality. Similarly, powders with low cocaine content were 3.03 times more likely to be thought to be poor quality than average. But users were no likely to consider them of average than of good quality. Hence, there was no real “dose–effect” on quality perception but rather a threshold effect. Thus we supposed that users were only likely to correctly assess samples with extreme cocaine content values. Compared to powders bought in the street, powders bought from a dealer's premises were 4.53 times more likely to be thought to be good

quality (3.79 times for buying on appointment) compared to 0.22 times more often poor quality for street purchase (0.44 for buying by appointment, only close to significance). Cheap cocaine was 3.33 times more likely to be thought to be poor quality. The description “natural” was 2.53 times more likely to be related to good quality than was the qualifier “synthetic”. Finally, injectors were 0.24 times more likely to judge their substance to be poor rather than medium quality (injectors judged their substance more often medium than poor quality). Smokers and injectors also tended to find their cocaine to be good rather than medium quality, although this relationship was not significant (the low number of injectors led to caution).

### Discussion

To our knowledge, this study is the first to compare a toxicological analysis of the cocaine consumed by users with the opinions of users about the same cocaine. We found that users were not good at assessing the actual purity of the cocaine that they had used: the agreement between actual and estimated purity was significantly different from zero, but appeared to be poor. Similarly, they showed a limited knowledge of the content of the street cocaine: only 21% of the participants were able to report the presence of an adulterant (identified or not in all the collected powders), while 73% of the samples contained at least one adulterant, and only 12% reported at least one identified adulterant. Confirming Decorte's findings (2001), users who gave an opinion thought that cutting agent were mainly stimulants (caffeine and amphetamine).

The estimate of perceived cocaine quality was not linked to duration of use neither to the presence of any of the main adulterants detected in the analyses. The actual and supposed characteristics of the substance had different but not necessarily opposite influences on its perceived good or bad quality: cocaines with high actual potencies, supposedly of natural origin bought from a dealer or by appointment were thought to be of better-than-average quality whereas cocaines with very low cocaine content bought in the street and at low cost were thought to be of poorer-than-average quality; finally, cocaines prepared for injection were less often thought to be of poor quality.

The average cocaine content of the samples collected, at almost 30%, is comparable to that in the six European countries reporting results for a similar market setting (“analysis of samples at user level” or “small seizures”) (EMCDDA, 2006). Slovenia, Denmark

**Table 3**  
Perceived quality depending on user characteristics and use.

	All (n = 353)		Good (n = 138)		Average (n = 163)		Poor (n = 52)		p <sup>a</sup>
	n	%	n	%	n	%	n	%	
User characteristics									
Sex									
Male	279	79	115	83	126	77	38	73	0.229
Female	74	21	23	17	37	23	14	27	
Educational status									
Higher education	227	64	79	57	115	71	33	63	0.055
Other	126	36	59	43	48	29	19	37	
Mode of administration									
Sniffed	264	75	94	68	126	77	44	85	0.126
Smoked	57	16	30	22	22	14	5	10	
Injected	32	9	14	10	15	9	3	6	
Substance use									
Duration of use									
Less than 5 years	127	36	53	38	55	34	19	37	0.468
5–9 years	133	38	45	33	65	40	23	44	
10 years or more	93	26	40	29	43	26	10	19	
Frequency of use <sup>b</sup>									
Regular or daily	118	37	50	40	57	39	11	23	0.119
Repeated	203	63	76	60	91	61	36	76	
Subjective quality criteria									
Cutting agent reported									
None	259	73	107	78	114	70	38	73	0.331
At least one	94	27	31	22	49	30	14	27	
Place of purchase									
At a dealer's house	141	40	67	49	64	39	10	19	<0.001
Appointment	160	45	64	46	72	44	24	46	
In the street	52	15	7	5	27	17	18	35	
Nature of substance <sup>c</sup>									
No distinction	164	46	59	43	79	49	26	50	<0.001
Natural	104	30	58	42	39	24	7	13	
Synthetic	84	24	21	15	44	27	19	37	
Purchase price									
50€ or less	77	22	20	15	34	21	23	45	<0.001
51–69€ <sup>d</sup>	114	33	43	31	58	36	13	25	
70€ or more	116	33	53	39	51	31	12	24	
Discounted	43	12	21	15	19	12	3	6	
Substance content									
Cocaine content									
1st tertile (<15%)	116	33	28	20	55	34	33	63	<0.001
2nd tertile (15–32%)	119	34	36	26	70	43	13	25	
3rd tertile (>32%)	118	33	74	54	38	23	6	12	
Adulterant present									
Phenacetin	189	51	64	44	92	53	33	60	0.090
Caffeine	62	17	20	14	30	17	12	22	0.373
Paracetamol	57	15	12	21	29	51	16	28	0.001
Diltiazem	39	11	9	6	23	13	7	13	0.101
Lidocaine	36	10	13	9	15	9	8	15	0.411
Levamisole	21	6	4	3	13	8	4	7	0.158
Hydroxyzine	12	3	6	4	5	3	1	2	0.670

<sup>a</sup>  $\chi^2$  tests.<sup>b</sup> 32 missing values.<sup>c</sup> 1 missing value.<sup>d</sup> 3 missing values.

and Austria report very close average values. Three other countries report higher average cocaine content. These are countries through which cocaine enters Europe: Portugal and Spain reported both an average purity at 44%, and Netherland reach 53% (but it should be noted that Netherland provided information from test service predominantly reaching the party scene; the huge difference of purity could also be partly explain by the selection of a specific subpopulation). French seizure data also reported for 2006 describes average cocaine content as being twice as great as that found in the present study (EMCDDA, 2006). This highlights the key feature of collecting samples from users themselves, and should encourage more caution in using average content values obtained from seizure data when analysing changes in the cocaine market.

Our study also shows that users have incomplete knowledge of the actual cocaine content even after use, confirming Decorte's conclusions (2001). For a buyer, the perceived quality of the cocaine

depends on information provided by the dealer, also involving the buyer's own understanding of the illicit substance market. These factors in the decision-making process at the time of the transaction to a large extent continue to determine perceived quality after use, even after adjustment on the actual cocaine content. More precisely, our multivariate analysis shows that users remain sensitive to certain beliefs (an established dealer has access to better products, natural cocaine is of better quality) and also to price, when estimating the quality of the cocaine purchased. This suggests that cocaine users behave like consumers of ordinary commodities: an exclusive and special contact with a retailer gives access to better goods; natural products are better quality, whereas cheap price means poor quality. These findings also recall the signalling value of the brand, its price and its distribution channels in the market for luxury goods (Kort, Caulkins, Hartl, & Feichtinger, 2006). Thus, our study provides evidence that it is not possible to reduce the per-

**Table 4**  
Final multivariate multinomial logistic modelling of the perceived quality of the cocaine using medium quality as reference ( $n = 349$ ).

	Poor		Good	
	OR	95% CI	OR	95% CI
Users' responses				
Route of administration (ref = sniffed)				
Smoked	0.51	[0.16–1.61]	1.64	[0.83–3.22]
Injected	<b>0.24</b>	[0.06–0.99]	1.90	[0.73–4.93]
Place of purchase (ref = street)				
At a dealer's premises	<b>0.22</b>	[0.08–0.61]	<b>4.53</b>	[1.66–12.40]
By appointment	0.44	[0.19–1.04]	<b>3.79</b>	[1.40–10.26]
Nature of substance (ref = synthetic)				
Natural	0.59	[0.21–1.69]	<b>2.53</b>	[1.25–5.14]
No distinction	0.67	[0.30–1.49]	1.44	[0.73–2.86]
Purchase price per gram (ref = 51–69€)				
50€ or less	<b>3.33</b>	[1.37–8.08]	0.90	[0.43–1.90]
70€ or more	1.20	[0.47–3.06]	1.42	[0.77–2.61]
Discounted	0.89	[0.20–3.87]	1.57	[0.68–3.63]
Toxicological analyses				
Measured content (ref = 2nd tertile)				
1st tertile (<15%)	<b>3.03</b>	[1.38–6.65]	0.92	[0.48–1.78]
3rd tertile (>32%)	0.59	[0.18–1.91]	<b>3.84</b>	[2.10–7.01]

In bold type: significant odds ratios.

ceived quality of the cocaine to its actual content, unlike Goudie et al. (2007) did in their study. A promising strategy for prevention could be to combat the misconceptions prevailing in the illicit market by informing consumers about the precise content, purity and dangers of their cocaine.

It was observed that injectors less often perceived their cocaine as being of poor quality. This is of major importance since injection increases health-related risks (Buchanan et al., 2006; Lloyd-Smith, Wood, Li, Montaner, & Kerr, 2009) and need to be confirmed as the number of injectors was low in this study.

Users are not able to discern the presence of a particular adulterant and have incomplete knowledge about cocaine adulterants in general, which supports the conclusions drawn by Decorte's study. Conversely, our results are slightly different from some of Coomber's findings about adulteration practices (Coomber, 1997a, 1997b). Our own results and the findings by the police forces on extensive organised trafficking from Spain for at least one adulterant, phenacetin (OFDT, 2007), are consistent with Coomber (1997a) who stated that "it seems evident that adulteration is at times a market-sensitive activity rather than a haphazard, unpredictable and belligerent activity". Nevertheless, the present results also show that beyond the relatively inoffensive dilution practices with fairly innocuous materials occurring throughout the distribution chain described by Coomber, adulteration practices using pharmacologically active molecules do exist. Except for substances that cause a localized numbing effect similar to that produced by cocaine (lidocaine, procaine or benzocaine), the aims of these practices are unknown. One common theory is that adulterants boost the effects of cocaine (Zhu et al., 2009), enabling material to pass for a higher-quality product. This seems to be disproved by our results as no association was found between any major adulterant and higher perceived quality.

Only a very small percentage of the cocaine samples collected were unadulterated, raising questions about the additional health risks to which users are exposed. The substances found in our study are common adulterants in Europe (Brunt et al., 2009; Fucci, 2007; Fucci & De Giovanni, 1998; Kenyon et al., 2005; Kinzie, 2009; Musset et al., 2005) and North America (Casale, Boudreau, & Jones, 2008; Casale, Corbeil, & Hays, 2008; Kinzie, 2009; Morley, Forrest, & Galloway, 2006). The side effects of these substances, described in the pharmacopoeia, are well documented, but none of these compounds are sniffed or smoked when used medicinally, and there may be increased risks based on these different modes of con-

sumption. The potential risks of interactions between cocaine and adulterants have been little if at all examined (Ansah, Wade, & Shockley, 1993; Derlet, Albertson, & Tharratt, 1991; Rowbotham, Hooker, Mendelson, & Jones, 1987; Schindler, Srihari, Hashim, & Steven, 1995) in a context in which understanding the interactions is complicated by the fact that doses and durations of exposure are not known. All these reasons make evaluating the chronic toxicity of adulterants in cocaine users difficult, although they are suspected to have a negative impact on the users' health (Brunt et al., 2009) and have been the subject of warnings from public health authorities in France (DGS, 2008) and the USA (SAMSHA, 2009). Furthermore, the presence of such wide array of adulterants, in addition to the variability of the cocaine content, can result in unpredictable clinical effects in cases of acute intoxication (Lombard, Levin, & Weiner, 1989; Nogue et al., 1991; Quandt et al., 1988; Weiner et al., 1998). As Weiner noted (1998), when managing the complications of illicit drug use, it is important for emergency physicians to realize that they are not dealing with the abuse of a single substance, but rather with a mixture of active ingredients. Things can be even more complex in case of polydrug use, since the combination of cocaine with other drugs can result in clinical presentations that are difficult to discriminate and that may have important implications for treatment (Vroegop et al., 2009).

In our study, we took the precaution of asking users if the effects they had experienced had been "usual". The link between adverse effects reported and the actual presence of adulterants was checked to test the hypothesis that certain adulterants are damaging for users. However, as expected, the design of the survey did not enable study of this problem due to the lack both of statistical power and of precision of the medical details given by users. Increasing levels of cocaine adulteration combined with ever-increasing use suggest a need to promote specific toxicological studies in order to determine the impact of these adulterants on users' health.

This study is subject to a number of limitations. Since subject selection was not completely random, the results of this study cannot claim to be generalisable. Investigators did not collect information on the users who refused to participate in the survey. Thus, it was not possible to compare respondents and non-respondents. The protocol, however, ensured that a wide range of the specific population was met, and indeed its aim was to test associations and explore users' knowledge about their substance, rather than to provide prevalence figures. In addition, the sample size was quite large for this kind of survey.

The questionnaire was intentionally short in order not to put pressure on people carrying an illicit substance, and contained mainly closed questions requiring fairly straightforward recall. Purchase and selling behaviours were not explored, as these require a strong relationship to be established with the subjects (Johnson & Golub, 2007).

The consumption of other substances was only investigated for users having reported unusual effects. For the other users, the hypothesis was that as users indicated feeling “usual” effects, the consumption of any other product alongside did not influence their perception of the quality of the cocaine. Further research is needed to test this hypothesis. Because the adulterants were not quantified, it was not possible to distinguish between contamination (for example during storage or transport) or intentional addition of adulterants. Although the cocaine analysed was in the hydrochloride form, some was converted into free-base before use. In these cases the actual cocaine content of the substance used was unknown. Additional studies would be needed to separate out the influence of mode of administration and cocaine content when free-base products are used.

Finally, the numbers of smokers and injectors were rather small, resulting in a lack of statistical power, especially for these categories. Further research should try to over-represent these users and to know more about their injection practices and frequencies.

## Conclusion

At the end of the 1990s, Coomber (1997a) described the construction of a “myth”: “the adulteration of illicit drugs with dangerous substances”. According to Coomber, “drug commentators of varying persuasions may ‘invest’ in this idea. To those in favour of drug prohibition, dangerous adulteration is indicative of why drug use and the trade in drugs must be prevented. For those committed to certain harm-reduction approaches, it represents a rationale for the provision of clean, consistent drugs to enhance the users’ safety.” The general subscription to this utilitarian “myth” has undoubtedly slowed the development of scientific research on the actual composition of illicit substances. The identification of massive adulteration with substances listed in the pharmacopoeia and liable to contribute to acute or chronic toxicity is an important issue. User opinions as studied here need to be further examined to enable the scientific community to apprehend the issues and generate information on the common adulterants of illicit drugs and their impact on users’ health. Additionally, improving users’ knowledge about the substances they are using and understanding the determinants of perceived quality could help to improve drug prevention strategies.

## Acknowledgements

This collection of illicit substances was enabled thanks to the support from the local and national legal authorities and MILDT, whom we wish to thank.

Monitoring: a very special thanks to Valérie Mouginot and Nadine Landreau for their precious help during the data collection.

Regional coordinators: Anne Cécile Rahis (Bordeaux), Gérard Cagni (Dijon), Laurent Plancke (Lille), Etienne Zurbach (Marseille), Sylvie Balteau (Metz), Jimmy Kempfer and Nicolas Bonnet (Paris), Guillaume Poullingue and Guillaume Girard (Rennes), Serge Escots (Toulouse).

Laboratory scientific heads: Marie Josée Parent and Daniel Isler (Paris and Strasbourg Inter-regional customs laboratory), Jocelyne Arditti (Department of Toxicology, Salvator Hospital, Marseilles), Danielle Debryne (Department of Pharmacology, Caen University Hospital), Martine Galliot-Guilley (Department of Toxicology, Lari-boisière Hospital, Paris).

## Conflict of interest

None.

## References

- Akaike, H. (1974). A new look at statistical model identification. *IEEE Transactions on automatic control*, 19(6), 716–723.
- Ansah, T. A., Wade, L. H., & Shockley, D. C. (1993). Effects of calcium channel entry blockers on cocaine and amphetamine-induced motor activities and toxicities. *Life Sciences*, 53(26), 1947–1956.
- Beck, F., Legleye, S., Spilka, S., Briffault, X., Gautier, A., Lamboy, B., et al. (2006). Les niveaux d’usage des drogues en France en 2005. Exploitation des données du Baromètre santé 2005 relatives aux pratiques d’usage de substances psychoactives en population adulte. *Tendances* (48), p. 6.
- Bickel, W. K., & Marsch, L. A. (2001). Toward a behavioral economic understanding of drug dependence: Delay discounting processes. *Addiction*, 96(1), 73–86.
- Boermans, P., Go, H., Wessels, A., & Uges, D. (2006). Quantification by HPLC–MS/MS of atropine in human serum and clinical presentation of six mild-to-moderate intoxicated atropine-adulterated-cocaine users. *Therapeutic Drug Monitoring*, 28(3), 295–298.
- Brunt, T., Rigter, S., Hoek, J., Vogels, N., van Dijk, P., & Niesink, R. (2009). An analysis of cocaine powder in the Netherlands: Content and health hazards due to adulterants. *Addiction*, 104(5), 798–805.
- Buchanan, D., Toozé, J. A., Shaw, S., Kinzly, M., Heimer, R., & Singer, M. (2006). Demographic, HIV risk behavior, and health status characteristics of “crack” cocaine injectors compared to other injection drug users in three New England cities. *Drug and Alcohol Dependence*, 81(3), 221–229.
- Cadet-Tairou, A., Gandilhon, M., Toufik, A., & Evrard, I. (2008a). *The eighth national report from the TREND system*. Saint-Denis: OFDT.
- Cadet-Tairou, A., Gandilhon, M., Toufik, A., & Evrard, I. (2008b). *Phénomènes émergents liés aux drogues en 2006 [Emerging phenomena related to drugs in 2006]*. Saint-Denis: OFDT.
- Casale, J. F., & Klein, R. F. X. (1993). Illicit production of cocaine. *Forensic Science Review*, (5), 95–107.
- Casale, J., Corbeil, E., & Hays, P. (2008). Identification of levamisole impurities found in illicit cocaine exhibits. *Microgram Journal*, 6(3–4), 82–89.
- Casale, J. F., Boudreau, D. K., & Jones, L. M. (2008). Tropane ethyl esters in illicit cocaine: Isolation, detection, and determination of new manufacturing by-products from the clandestine purification of crude cocaine base with ethanol. *Journal of Forensic Sciences*, 53(3), 661–667.
- Caulkins, J. P. (2007). Price and purity analysis for illicit drug: Data and conceptual issues. *Drug and Alcohol Dependence*, 90(Suppl. 1), S61–68.
- Caulkins, J. P., & Reuter, P. (1997). Setting goals for drug policy: Harm reduction or use reduction? *Addiction*, 92(9), 1143–1150.
- Coomber, R. (1997a). Adulteration of drugs: The discovery of a myth. *Contemporary Drug Problems*, 24(2), 239–271.
- Coomber, R. (1997b). The adulteration of drugs: What dealers do, what dealers think. *Addiction Research*, 5(4), 297–306.
- Decorte, T. (2001). Quality control by cocaine users: Underdeveloped harm reduction strategies. *European Addiction Research*, 7(4), 161–175.
- Derlet, R. W., Albertson, T. E., & Tharratt, R. S. (1991). Lidocaine potentiation of cocaine toxicity. *Annals of Emergency Medicine*, 20(2), 135–138.
- DGS. (2008). Note d’information sur les risques sanitaires liés à la présence de phénacétine en tant que produit de coupe de la cocaïne [Information and warning about the risks due to phenacetin used as cutting agent in cocaine].
- EMCDDA. (2006). *Purity of cocaine products at retail level 2006*. Lisbon: EMCDDA.
- EMCDDA. (2007). *Cocaine and crack cocaine: A growing public health issue*. Lisbon: European monitoring center for drug and drug addiction.
- EMCDDA. (2008). The state of the drugs problem in Europe. In *Annual report 2008*. Lisbon: EMCDDA.
- Fucci, N. (2007). Unusual adulterants in cocaine seized on Italian clandestine market. *Forensic Science International*, 172(2–3), e1.
- Fucci, N., & De Giovanni, N. (1998). Adulterants encountered in the illicit cocaine market. *Forensic Science International*, 95(3), 247–252.
- Goudie, A. J., Sumnall, H. R., Field, M., Clayton, H., & Cole, J. C. (2007). The effects of price and perceived quality on the behavioural economics of alcohol, amphetamine, cannabis, cocaine, and ecstasy purchases. *Drug and Alcohol Dependence*, 89(2–3), 107–115.
- Griffiths, P., Vingoe, L., Hunt, N., Mountney, J., & Hartnoll, R. (2000). Drug information systems. Early warning, and new drug trends: Can drug monitoring systems become more sensitive to emerging trends in drug consumption? *Substance Use and Misuse*, 35(6–8), 811–844.
- Hoffman, R. S., Kirrane, B. M., & Marcus, S. M. (2008). A descriptive study of an outbreak of clenbuterol-containing heroin. *Annals of Emergency Medicine*, 52(5), 548–553.
- Johnson, B. D., & Golub, A. (2007). The potential for accurately measuring behavioral and economic dimensions of consumption, prices, and markets for illegal drugs. *Drug and Alcohol Dependence*, 90(Suppl. 1), S16–26.
- Kenyon, S. L., Ramsey, J., Lee, T., Johnston, A., & Holt, D. (2005). Analysis for identification in amnesty bin samples from dance venues. *Therapeutic Drug Monitoring*, 27(6), 793–798.
- King, L. A. (1997). Drug content of powder and other illicit preparations in the UK. *Forensic Science International*, (85), 135–147.

- Kinzie, E. (2009). Levamisole found in patients using cocaine. *Annals of Emerging Medicine*, 53(4), 546–547.
- Kort, P. M., Caulkins, J. P., Hartl, R. F., & Feichtinger, G. (2006). Brand image and brand dilution in the fashion industry. *Automatica*, 42(8), 1363–1370.
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33(1), 159–174.
- Legleye, S., Spilka, S., Le Nézet, O., & Laffiteau, C. (2009). Les drogues à 17 ans – Résultats de l'enquête ESCAPAD 2008 [Drug use of the 17 years old – Results of the 2008 ESCAPAD Survey]. *Tendances*(66).
- Lloyd-Smith, E., Wood, E., Li, K., Montaner, J. S., & Kerr, T. (2009). Incidence and determinants of initiation into cocaine injection and correlates of frequent cocaine injectors. *Drug and Alcohol Dependence*, 99(1–3), 176–182.
- Lombard, J., Levin, J., & Weiner, W. (1989). Arsenic intoxication in a cocaine abuser. *New England Journal of Medicine*, (320), 869–1869.
- Morley, S., Forrest, A., & Galloway, J. (2006). Levamisole as a contaminant of illicit cocaine. *Journal of Clandestine Laboratory Investigating Chemists Association*, 16(4), 11.
- Musset, T., Fathi, M., Magnin, A., & Mani, C. (2005). Analyses chimiques d'échantillons d'héroïne et de cocaïne consommés dans les rues de Genève [Chemical analyses of street heroine and cocaine in Geneva]. *Dépendances*.
- Musto, D. (1987). *The American disease: Origins of narcotic control*. New York: Oxford University.
- Nogue, S., Sanz, P., Munne, P., & de la Torre, R. (1991). Acute scopolamine poisoning after sniffing adulterated cocaine. *Drug and Alcohol Dependence*, (27), 115–116.
- OFDT. (2007). Note d'information SINTES du 21 décembre 2007 sur la phénacétine [Information and warning about the risk due to phenacetin use as cutting agent in cocaine]. Retrieved May 2009.
- ONDCP. (2004). *The price and purity of illicit drugs: 1981 through the second quarter of 2003*. Washington, DC: Executive Office of the President.
- Quandt, C., Sommi, R. J., Pipkin, T., & McCallum, M. (1988). Differentiation of cocaine toxicity: Role of the toxicology drug screen. *Drug intelligence and clinical pharmacology*, 22(7–8), 582–587.
- Rowbotham, M. C., Hooker, W. D., Mendelson, J., & Jones, R. T. (1987). Cocaine–calcium channel antagonist interactions. *Psychopharmacology (Berl)*, 93(2), 152–154.
- SAMSHA. (2009). Nationwide public health alert issued concerning life-threatening risk posed by cocaine laced with veterinary anti-parasite drug. Substance abuse and mental health services administration Retrieved October 2009, from [www.samsha.gov/newsroom/advisories/090921vet5101.aspx](http://www.samsha.gov/newsroom/advisories/090921vet5101.aspx).
- Schindler, C. W., Srihari, T. R., Hashim, E. K., & Steven, G. R. (1995). Pharmacological mechanisms in cocaine's cardiovascular effects. *Drug and Alcohol Dependence*, 37(3), 183–191.
- Sefedov, R. (2005). Early warning system. EMCDDA issues alert on cocaine/atropine intoxication. *Drugnet Europe*, 50(April–June), 6.
- Shane, D., Kaye, S., & Libby, T. (2002). Cocaine use in New South Wales, Australia, 1996–2000: 5-year monitoring of trends in price, purity, availability and use from the illicit drug reporting system. *Drug and Alcohol Dependence*, 67(1), 81–88.
- Simonsen, K. W., Kaa, E., & Rolmann, D. N. (2003). Narcotics at street level in Denmark a prospective investigation from 1995 to 2000. *Forensic Science International*, (131), 162–170.
- Vroegop, M., Franssen, E., van der Voort, P., van der Berg, T., Langeweg, R., & Kramers, C. (2009). The emergency care of cocaine intoxications. *The Netherlands Journal of Medicine*, 67(4), 122–126.
- Weiner, A. L., Bayer, M. J., MacKay, C. A. J., Demeo, M., & Starr, E. (1998). Anticholinergic poisoning with adulterated intranasal cocaine. *The American Journal of Emergency Medicine*, 16(5), 517–520.
- Zhu, N., Le Gatt, D., & Turner, A. (2009). Agranulocytosis after consumption of cocaine adulterant with levamisole. *Annals of Internal Medicine*, 150(4), 287–289.