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Mycocontamination of Illicit Samples of Heroin and Cocaine as an Indicator of Adulteration

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ABSTRACT: The authors studied the fungal spectrum of the drugs most frequently sold in the streets in Spain (brown heroin, white heroin, and cocaine) in order to ascertain their potential use as indicators of the degree of manipulation or adulteration, as well as the potential pathogenicity of the taxa found. For this purpose we analyzed 205 drug samples (106 brown heroin, 69 white heroin, and 30 cocaine) from sachets seized by the Spanish police; they were cultured in appropriate media, from which 391 colonies of micellar fungi from 53 taxa, of which only 8 were encountered in the three types of drugs, were isolated. The results obtained were subjected to a variance analysis with a single source of variation and to a hierarchical variance analysis, in which brown heroin was shown to be significantly more contaminated by fungi than the other two drugs. This can be explained by considering that brown heroin is the most liable to manipulation of all three drugs because of its characteristics.

KEYWORDS: toxicology, heroin, cocaine, fungi

The difference between contamination and adulteration lies in intentionality; thus while the former is normally considered to be an accidental process, the latter is usually intentional and involves the addition of certain substances to the drug for a given purpose. However, contamination arises from adulteration in a number of cases. Such adulteration may be aimed at potentiating the effect of the drug or at simulating a substance from another. In any case, the final aim of adulteration is increasing the economic benefit at the smallest possible cost. Small- and medium-scale drug dealers thereby increase their benefits by adulterating drugs with inexpensive thinners such as lactose and glucose.

Drug contaminants can be classified into two large groups, namely, abiotic and biotic. The former comprises the foreign chemical substances encountered in drugs, chiefly heavy metals, such as lead, magnesium, and aluminum, and atmospheric pollutants detrimental

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to health and welfare [*1*]. The latter group, which is also the more important, includes the spores of fungi and bacteria, which are readily spread by air owing to their microscopic size. These contaminants may reach the drug at its manufacturing or adulteration stage.

The frequent occurrence of infectious complications in heroin addicts (endocarditis, lung abscesses, serum hepatitis, subcutaneous phlegmons) appear to be related to the lack of asepsis in drug injections and the intrinsic methodology of drug addiction [*2*]. The ubiquity of fungi in the environment and the loss of immunological responsiveness in heroin addicts fosters the development of the above-mentioned infections, which are further favored by the use of lemon or, less frequently, vinegar, to aid the dissolution of the drug powder, which also increases the medium acidity and hence provides an optimal environment for fungal growth [*2*].

A study of 31 illicit heroin samples [*3*] revealed 61.3% of them to be contaminated by *Bacillus* and *Aspergillus* taxa. Other authors [*4*] postulate the occurrence of a relationship between fungal infection and the type of heroin taken.

Another study following the death of three drug addicts revealed aneurysm associated with infections by *Staphylococcus*, *Clostridium*, and *Candida* among others [*5*]. The occurrence of infections in drug addicts is rather commonplace. It increases vascular complications, including infected arteries and vein pseudoaneurysms caused by certain microorganisms such as *Staphylococcus aureus* and *Staphylococcus epidermidis* [*6*].

It is also a known fact that addiction to heroin is associated with the appearance of candidemics or infections by species such as *Candida* species which may induce endocarditis, myocarditis, endophthalmitis, meningitis, arthritis, and skin lesions. Candidiasis has been reported to occur in heroin addicts [*7*], particularly in consumers of the Iranian brown heroin variety.

The infectious responses of addicts to narcotic drugs may arise from a depression of the immunological state of the individual, which may induce the appearance of opportunistic infections, whether bacterial or fungal [*8*].

In previous work [*9*], we showed the presence of fungal taxa in illicit heroin samples with a high sensitizing capacity, which could be related to some suspected overdose deaths as a function of anaphylactic shocks.

The treatment of drug addicts usually focuses on overdose and infectious complications, hence the interest in determining which fungal contaminants a given drug may contain, which, in turn, may facilitate diagnoses and the choice of the appropriate therapeutics in each case. The type of fungal spores present in drugs may occasionally be indicative of the degree of manipulation—usually associated with adulteration—which is reflected in a more quantitatively and qualitatively significant occurrence and, hence, in the greater or lesser purity of the drug sold in sachets.

Street-sold drugs are thus proven to be highly contaminated [*9*]; this prompted us to determine the usual fungal spectrum of the three most common types of illicit street-sold drugs (brown and white heroin and cocaine), their use as indicators of the extent of adulteration, and the toxicological potential of the different taxa encountered.

Materials and Methods

We analyzed 205 drug samples from sachets seized by the Spanish police in Granada, Spain, during 1985 and 1986 and forwarded to the Provincial Health Council of the city.

Of the 205 samples, 106 were of the brown heroin (brown sugar) variety, 69 of white heroin, and the other 30 of cocaine.

Each sample was processed by direct inoculation of a known weight in a culture medium and, depending on the available amount (occasionally very small), they were inoculated in one or two different culture media, namely 2% malt extract agar (MEA), according to Blakeslee, and V-8 juice agar (V-8) [*10*]. The pH of the media was adjusted to about

5, after which they were sterilized in an autoclave at 121°C and at a pressure of 1 atm for 20 min. In order to prevent bacterial growth and hence fungal development, 5 mL of 25% lactic acid per litre was added to the media.

Once the drug samples had been seeded, the petri dishes (ϕ = 90 mm) holding the culture media were incubated in a stove at 27°C for 7 to 10 days, after which the colonies that developed were counted and isolated in axenic cultures.

Statistical Analysis

The results obtained for the three types of drugs were subjected to a variance analysis with a single source of variation and a hierarchical variance analysis in order to determine potential significant differences between the three types of drugs in terms of the degree of contamination and between the two culture media used to seed the samples. The former type of statistical analysis was used to compare all the samples, while the latter was only applied to those which had been seeded simultaneously in the two types of culture. In both cases, the three types of drugs were initially compared globally, and later in pairs.

The number of colonies was made a standardized variable by dividing it by the weight of seeded sample (number of colonies per milligram of sample); this was aimed at offsetting the significant differences between the weights used in the different seedings.

Finally, we also carried out a multivariate correspondence analysis in order to find potential associations of some species to a given drug. Such an analysis was based on the use of absolute frequency tables, so it admitted no standardization of data. This problem was overcome by transforming the data matrix into a presence-absence matrix by coding the presence of a given species, irrespective of its absolute frequency, with "1" and its absence with "0."

Results

A total of 391 micellar fungus colonies were counted: 275 in brown heroin, 68 in white heroin, and 48 in cocaine. An overall 53 taxa corresponding to 21 fungal genera (4 of the *Zygomycetes*, 3 of the *Ascomycetes*, and 14 of the *Deuteromycetes* classes) were detected.

Table 1 lists the average, standard deviation, and variation range of the following variables: weight, number of colonies, number of species, and number of colonies per milligram of sample for each type of drug, and the overall figures for the samples which were inoculated in the two types of culture media.

The proportion of samples of each type of drug found to be contaminated by fungi in each type of culture medium is shown in Fig. 1.

Table 2 lists the actual number of colonies isolated for each taxon in the brown heroin, white heroin, and cocaine samples, respectively, which were inoculated in MEA and V-8. Of the 29 samples of brown heroin cultured in such a medium, 18 were found to be contaminated: they contained 90 colonies of 33 taxa, of which *Aspergillus niger* was the most frequent (7 samples) and *Cladosporium cladosporioides* the most abundant.

Only 6 of the 17 samples of white heroin seeded showed signs of contamination. They contained a total of 20 colonies of 5 taxa, of which *Aspergillus niger* was also the most frequent—and the most abundant in this case.

Only 6 of the 16 samples of cocaine that were seeded in MEA were contaminated. They included 12 colonies of 7 different taxa.

From the 51 samples of white heroin seeded in V-8 that were found to be contaminated, 185 colonies of 32 taxa were isolated. The most abundant and frequent taxon (19 samples) was *Aspergillus fumigatus*.

TABLE 1—*Average (X), standard deviation (SD), and minimum (min) and maximum value (max) of the variables measured for each type of drug in the two culture media used.*

BROWN HEROINE					
	Variable	**X**	**S.D**	**Min**	**Max**
Malt extract agar	Weight	29.1345	22.7267	3.9000	92.2000
	Num.Colonies	3.1034	5.9000	0.0000	27.0000
	Num.Species	1.9310	2.9872	0.0000	11.0000
29 samples	Num.Colonies/mg	0.0971	0.1534	0.0000	0.5921
V--8 agar	Weight	12.5019	17.1631	0.2000	82.9000
	Num.Colonies	1.7453	4.0592	0.0000	30.0000
	Num.Species	0.7830	1.3310	0.0000	9.0000
106 samples	Num.Colonies/mg	0.6352	3.4775	0.0000	35.0000
WHITE HEROIN					
	Variable	**X**	**S.D**	**Min**	**Max**
Malt extract agar	Weight	51.6471	51.4041	10.3000	202.1000
	Num.Colonies	1.1765	2.9630	0.0000	12.0000
	Num.Species	0.4118	0.6183	0.0000	2.0000
17 samples	Num.Colonies/mg	0.0301	0.0576	0.0000	0.1794
V--8 agar	Weight	17.7449	31.5132	0.7000	193.3000
	Num.Colonies	0.6957	2.0242	0.0000	15.0000
	Num.Species	0.4638	0.8674	0.0000	4.0000
69 samples	Num.Colonies/mg	0.0577	0.1227	0.0000	0.4819
COCAINE					
	Variable	**X**	**S.D**	**Min**	**Max**
Malt extract agar	Weight	63.8500	46.9739	6.4000	158.2000
	Num.Colonies	0.7500	1.3416	0.0000	5.0000
	Num.Species	0.5625	0.8139	0.0000	2.0000
16 samples	Num.Colonies/mg	0.0226	0.0501	0.0000	0.1923
V--8 agar	Weight	59.3168	87.3662	1.2000	427.9000
	Num.Colonies	1.2414	1.8833	0.0000	8.0000
	Num.Species	0.7241	0.9218	0.0000	3.0000
29 samples	Num.Colonies/mg	0.1301	0.3420	0.0000	1.6667
TOTAL					
	Variable	**X**	**S.D**	**Min**	**Max**
Malt extract agar	Weight	44.2661	41.1994	3.9000	202.1000
	Num.Colonies	1.9677	4.4610	0.0000	27.0000
	Num.Species	1.1613	2.2117	0.0000	11.0000
62 samples	Num.Colonies/mg	0.0595	0.1164	0.0000	0.5921
V--8 agar	Weight	20.9725	42.3337	0.2000	427.9000
	Num.Colonies	1.3186	3.2576	0.0000	30.0000
	Num.Species	0.6667	1.1433	0.0000	9.0000
204 samples	Num.Colonies/mg	0.3681	2.5207	0.0000	35.0000

The 20 samples of the 69 of white heroin that were found to be contaminated and were seeded in this medium contained 48 colonies of 16 taxa: *Aspergillus niger* was the most abundant and frequent (7 samples).

Regarding the cocaine samples, *Aspergillus fumigatus* was the most frequent of the 11 isolated taxa. Of the 29 samples assayed, 13 were contaminated and contained 36 colonies

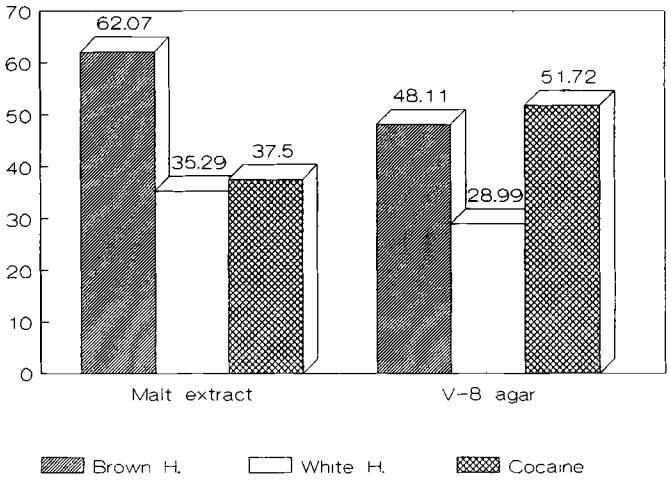

FIG. 1—*Proportion of samples with fungal contamination in each drug and culture medium.*

of micellar fungi, of which the most abundant were those of the *Urticicola* series, particularly the *Penicillium* species.

Table 2 lists the overall number of colonies of each taxon isolated in the study. As can be seen, those found in the largest number of colonies were *Aspergillus fumigatus* (118), *Aspergillus niger* (52), and the *Penicillium* species of the *Urticicola* series (32).

Table 3 gives the number of colonies of each taxon per gram of sample for the three types of drugs in the two culture media used.

The statistical analyses to which the above data were subjected allowed us to establish differences between the three types of drugs.

The results obtained in the one-way variance analysis between brown heroin, white heroin, and cocaine with respect to the number of colonies per milligram of the samples that were seeded in MEA are listed in Table 4. As can be seen, there was a slight significant difference between the three types of drugs in the number of colonies per milligram of sample, so we applied the same type of analysis in order to compare them in pairs.

These analyses revealed no significant differences between brown and white heroin in the number of colonies per milligram of sample, although the significance level was very close to 95%. This was also the case with the brown heroin/cocaine pair. Nor were there any significant differences between white heroin and cocaine in this respect, as follows from the probability, P, value obtained—rather lower than 95%.

No significant differences were found in the number of colonies per milligram of sample in the three types of drugs or in the three paired comparisons involving samples cultured in agar/V-8—the P values were much lower than the 95% in the previous case.

In order to draw more precise conclusions, the above results were subjected to a hierarchical variance analysis by using only the data from the drug samples that were seeded in the two culture media, which did reveal the occurrence of significant differences in the number of colonies per milligram of sample between the three types of drugs. No significant differences, however, were found between the two types of medium used for seeding.

This analysis was also used to make paired comparisons of the drugs (Table 5). No significant differences were found in this respect between the two culture media used. However, there were significant differences between brown and white heroin and between

TABLE 2—*Number of colonies of each taxon isolated in each of the culture media used (MEA = 2% agar-malt extract; V-8 = V-8 juice agar) and each type of drug (BH = brown heroin; WH = white heroin; Cc = cocaine).*

TAXA	MEA				V-8				TOTAL
	BH	WH	Cc	Total	BH	WH	Cc	Total	
1 Absidia ramosa	1			1					1
2 A. sychae					1			1	1
3 Acremonium terricola					1			1	1
4 Alternaria citri	1			1					1
5 A. dendritica	3			3	2			2	5
6 A. longipes					1			1	1
7 A. tenuis	2			2	3			3	5
8 A. tenuissima	3			3	9	1		10	13
9 Arthrinium saccharicola							1	1	1
10 Aspergillus aculeatus	1			1					1
11 A. amstelodami	1			1	2			2	3
12 A. caespitosus					1			1	1
13 A. clavato-nanica						1		1	1
14 A. clavatus			1	1					1
15 A. flavus	1			1					1
16 A. fumigatus	4	3	2	9	98	2	9	109	118
17 A. niger	7	14	1	22	9	18	3	30	52
18 A. oryzae	4			4	2	2	3	7	11
19 A. proliferans	5			5	2	6	3	11	16
20 A. silvaticus						2		2	2
21 A. speluneus	2			2					2
22 A. terreus					1			1	1
23 A. terricola		1		1					1
24 A. ustus	1			1	1			1	2
25 A. varians						1		1	1
26 A. versicolor	1			1	2	1		3	4
27 A. wentii	1			1					1
28 Chaetomium sp.	1			1	1			1	2
29 Cladosporium cladosporioides	17			17	1			1	18
30 C. herbarum					1			1	1
31 Drechslera dematioidea	1			1					1
32 Emericella nidulans					1			1	1
33 Epicoccum purpurascens							1	1	1
34 Eurotium chevalieri	4			4	6			6	10
35 Fusarium sp.					1			1	1
36 Monilia sitophila					3	5	1	9	9
37 Mucor indicus	1			1					1
38 Paecilomyces variotii								1	1
39 Penicillium Ser. Citreonigra					7			7	7
40 P. Ser. Citrina	1			1					1
41 P. Ser. Expansa	6		1	7		2	1	3	10
42 P. Ser. Glabra	1			1	1			1	2
43 P. Ser. Implicata	2			2					2
44 P. Ser. Islandica	1	1		2	1			1	3
45 P. Ser. Miniolutea	1			1					1
46 P. Ser. Oxalica	4			4	2	2		4	8
47 P. Ser. Restricta					1			1	1
48 P. Ser. Urticicola	4	1	5	10	11	1	10	22	32
49 Rhizopus nigricans	1			1	4			4	5
50 Scopulariopsis brevicaulis					1	1		2	2
51 Stachybotrys atra					2			2	2
52 Syncephalastrum racemosum			1	1		1		1	2
53 Ulocladium atrum	1			1					1
54 Mycelia Sterilia	6		1	7	6	2	3	11	18
TOTAL	90	20	12	122	185	48	36	269	391

TABLE 3—*Theoretical number of colonies of each taxon per gram of each type of drug in each of the media used (See caption to Table 2).*

TAXA	MEA				V-8				TOTAL
	BH	HH	Cc	Total	BH	HH	Cc	Total	
Absidia ramosa	13			13					13
A. sychae					88			88	88
Acremonium terricola					63			63	63
Alternaria citri	11			11					11
A. dendritica	33			33	27			27	60
A. longipes					116			116	116
A. tenuis	62			62	38			38	100
A. tenuissima	76			76	149	14		163	239
Arthrinium saccharicola							208	208	208
Aspergillus aculeatus	256			256					256
A. amstelodami	34			34	43			43	77
A. caespitosus					14			14	14
A. clavato-nanica						120		120	120
A. clavatus			36	36					36
A. flavus	11			11					11
A. fumigatus	317	134	46	497	55528	88	404	56020	56517
A. niger	421	202	54	677	2126	1126	88	3340	4017
A. oryzae	82			82	80	91	625	796	878
A. proliferans	109			109	601	370	1218	2189	2298
A. silvaticus						317		317	317
A. speluneus	62			62					62
A. terreus					303			303	303
A. terricola		97		97					97
A. ustus	22			22	14			14	36
A. varians						57		57	57
A. versicolor	11			11	50	19		69	80
A. wentii	20			20					20
Chaetomium sp.	22			22	36			36	58
Cladosporium cladosporioides	388			388	13			13	401
C. herbarum					48			48	48
Drechslera dematioidea	37			37					37
Emericella nidulans					81			81	81
Epicoccum purpurascens							172	172	172
Eurotium chevalieri	83			83	1534			1534	1617
Fusarium sp.					17			17	17
Monilia sitophila					2515	826	34	3375	3375
Mucor indicus	114			114					114
Paecilomyces variotii							25	25	25
Penicillium Ser. Citreonigra					780			780	780
P. Ser. Citrina	20			20					20
P. Ser. Expansa	156		16	172		284	833	1117	1289
P. Ser. Glabra	37			37	127			127	164
P. Ser. Implicata	41			41					41
P. Ser. Islandica	22	45		67	555			555	622
P. Ser. Miniolutea	22			22					22
P. Ser. Oxalica	69			69	43	241		284	353
P. Ser. Restricta					65			65	65
P. Ser. Urticicola	115	33	165	313	3821	200	79	4100	4413
Rhizopus nigricans	16			16	291			291	307
Scopulariopsis brevicaulis					500	200		700	700
Stachybotrys atra					28			28	28
Syncephalastrum racemosum			7	7		7		7	14
Ulocladium atrum	31			31					31
Mycelia Sterilia	105		36	141	426	38	86	550	691
TOTAL	2818	511	360	3689	70120	3998	3772	77890	81579

TABLE 4—F *values and probability,* P, *obtained in the one-way variance analysis applied to the three types of drugs in each culture medium.*[a]

Medium	Drug	*F*	*P*
MEA	BH-WH-Cc	3.052	0.0548
	BH-WH	2.977	0.0915
	BH-Cc	3.535	0.0669
	WH-Cc	0.157	0.6943
V-8	BH-WH-Cc	1.251	0.2885
	BH-WH	1.898	0.1701
	BH-Cc	0.607	0.4373
	WH-Cc	2.394	0.1251

[a]For abbreviations, see the title of Table 2.

TABLE 5—F *values and probability,* P *obtained in the hierarchical variance analysis applied to the three drugs individually and in pairs for each culture medium.*[a]

	F	*P*
BH-WH-Cc		
Between drugs	27.7420	0.0110
Between culture inside drugs	0.2130	0.8874
BH-WH		
Between drugs	24.5009	0.0351
Between culture inside drugs	0.2342	0.7945
BH-Cc		
Between drugs	30.5191	0.0277
Between culture inside drugs	0.2415	0.7889
WH-Cc		
Between drugs	4.7461	0.1620
Between culture inside drugs	0.1283	0.8797

[a]For abbreviations, see Table 2.

the former and cocaine in the number of colonies per milligram of sample, though not between white heroin and cocaine.

Finally, a correspondence factor analysis allowed the three types of drugs to be simultaneously represented according to the media used and the taxa found. The presence/absence matrix corresponding to all the samples, consisting of 6 variables (BH-MEA, WH-MEA, Cc-MEA, BH-V8, WH-V8, and Cc-V8) and 54 rows (taxa), showed that the plot of the taxa along the first two axes of this analyses absorbed 51.23% of the overall inertia and that the first axis set a clear separation of brown heroin and its associated species from the other two types of drugs (Tables 6 and 7, and Figs. 2 and 3).

The results of the analysis carried out with the presence/absence matrix of the paired data (the two media) reflect a clear separation of brown heroin from the other two drugs.

These results also confirm those reported earlier by our group [*9*]: white heroin and cocaine bear greater similarities in the degree of biological contamination than brown heroin. Also, each type of drug gives rise to a different grouping, irrespective of the culture medium used.

TABLE 6—*Coordinates of the correspondence factor analysis applied to the three types of drugs and culture media.*[a]

	Axis 1	Axis 2
BH-MEA	0.4600	0.6772
WH-MEA	−0.2250	0.1424
Cc-MEA	−0.4392	0.1260
BH-V-8	0.3924	−0.6965
WH-V-8	−0.3733	−0.1418
Cc-V-8	−0.5016	0.0075
Autovalue	0.5251	0.3804
Explained variance	29.71%	21.52%
Accumulated variance	29.71%	51.23%

[a]For abbreviations, see Table 2.

TABLE 7—*Coordinates of the correspondence factor analysis applied to the three types of drugs and culture media, though only to those samples inoculated in both types of media.*[a]

	Axis 1	Axis 2
BH-MEA	0.4978	0.5630
WH-MEA	−0.2627	−0.1782
Cc-MEA	−0.5738	0.2452
BH-V-8	0.2394	−0.7598
WH-V-8	−0.2648	0.1069
Cc-V-8	−0.4758	−0.0500
Autovalue	0.5043	0.3355
Explained variance	34.02%	22.63%
Accumulated variance	34.02%	56.66%

[a]For abbreviations, see Table 2.

Discussion

The presence of fungal conidia in drug powder arises basically from contamination during the period extending from its synthesis to its preparation in monodoses (sachets). The spores encountered are from the air and, to a lesser extent, from the substances with which the drugs are adulterated; consequently, the degree of fungal contamination should chiefly depend on the time over which the stuff is manipulated and the degree of contamination of the substances with which it is adulterated.

The statistical analyses carried out in order to compare the three types of drugs in terms of the number of colonies per milligram present in them and the occurrence of fungal contamination revealed brown heroin to be significantly more contaminated by fungi (that is, to contain larger numbers of colonies per milligram of sample) than the other two drugs (white heroin and cocaine).

These results are partly consistent with those obtained in an earlier study [*3*] of brown and white heroin, the latter of which was found to be contaminated to a lesser extent than the former.

Forty-five of the 54 taxa isolated in this work occurred in brown heroin; the seeded

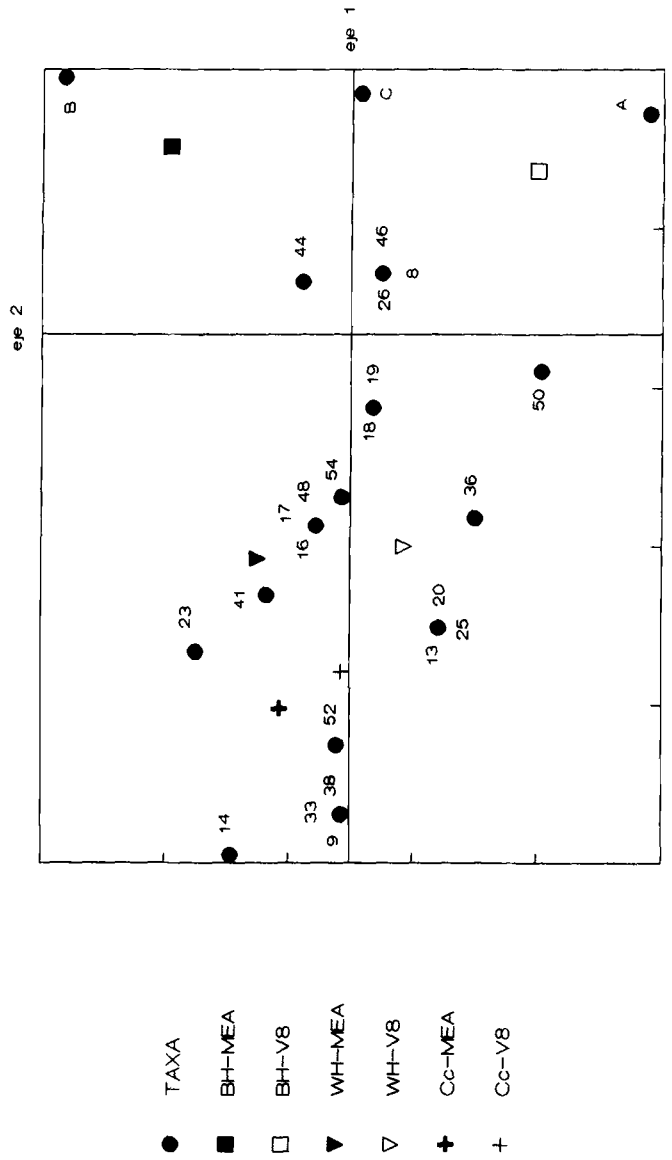

FIG. 2—*Plot of the correspondence factor analysis applied to the samples studied. (See Table 2 for the numbers of identified taxa).*

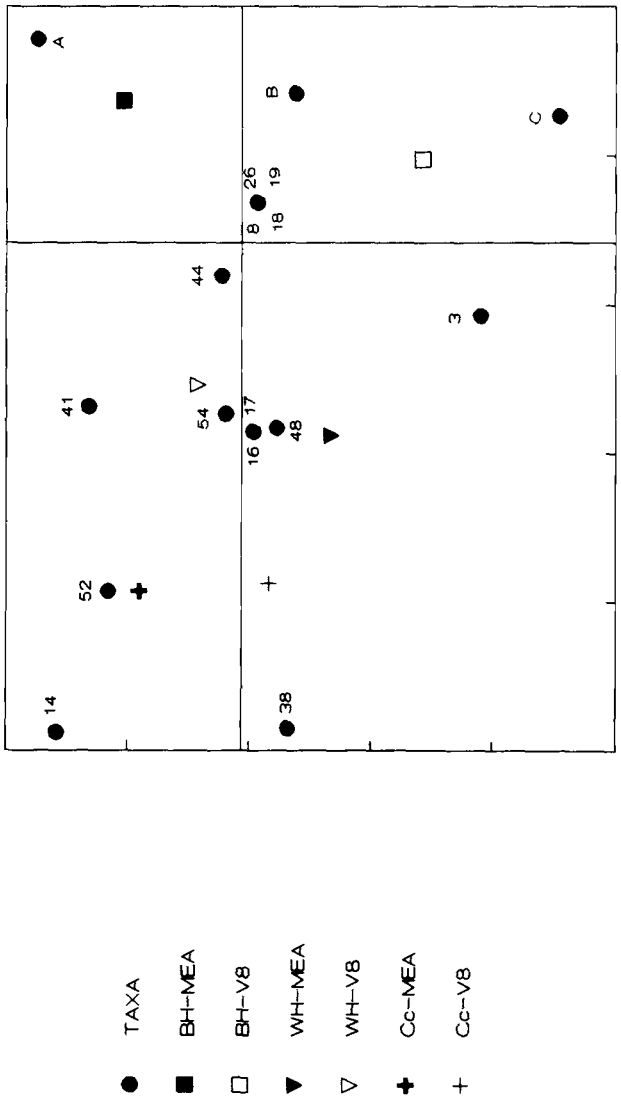

FIG. 3—*Plot of the correspondence paired-data factor analysis. (See Table 2 for the numbers of identified taxa).*

samples were found to contain an overall 275 colonies. On the other hand, the samples of white heroin contained 68 colonies of 18 taxa, while those of cocaine included 48 colonies of 13 taxa.

The results of the correspondence factor analysis (Figs. 2 and 3) showed a clear separation about Axis 2 of brown heroin from the other two drugs (white heroin and cocaine). The species shown in the graph follow a distribution pattern marked by their presence in one, two, or three drugs and/or in the two culture media, so those taxa which occur in the three types of drugs and the two culture media lie in an intermediate position in the graph. Only those taxa exclusive to a given type of drug in a given culture medium are shown as being closer to their corresponding variable in the graph.

There is also a certain closeness between the WH-MEA and WH-V8 variables (white heroin in agar-malt extract and agar-V8) and between Cc-MEA and Cc-V8 (cocaine in the two culture media). This was to be expected as, according to the results obtained in the hierarchical variance analysis, there was no significant difference between the two culture media used or between WH and Cc in the number of colonies per milligram of sample.

The separation of the BH-MEA and BH-V8 variables (brown heroin in agar-malt extract and agar-V8) from the others about Axis 2 is also consistent with the significant difference found between this and the other two types of drugs in the hierarchical variance analysis.

Only 8 of the 54 taxa identified in the different samples were isolated from the three types of drugs: namely, *Aspergillus fumigatus*, *Aspergillus niger*, *Aspergillus oryzae*, *Aspergillus proliferans*, *Monilia sitophila*, *Penicillium* species of the *Expansa* and *Urticicola* series, and *Mycelia sterilia*.

The most frequent taxa were *Aspergillus fumigatus* (30% of all colonies), *Aspergillus niger* (13.3%), and the *Penicillium* species of the *Urticicola* series (8.2%). This is consistent with our previous results [9] for heroin samples. The other taxa occurred very sparsely. The potential pathogenicity to man of the isolated taxa is reflected in Table 8.

Finally, our results do not allow us to state whether a given taxon occurs more often in a given type of drug because those isolated in only one of them occurred in very low proportions, while the most frequent taxa were found in the three types of drugs.

The fact that brown heroin is more contaminated and heterogeneous in the taxa found in its samples may arise from its simpler synthesis and purification in comparison with

TABLE 8—*Potential pathogenicity to man of the different isolated taxa.*[a]

Taxa	Potential Pathology
Absidia ramosa	allergy
A. zychae	allergy
Alternaria tenuis	immediate allergy
Aspergillus sp.	Micotoxines, respiratory aspergillosis, asthma, allergy
Cladosporium cladosporioides	pulmonary mycosis
C. herbarum	allergy
Chaetomium sp.	allergy
Drechslera dematioidea	cheratomycosis, mycetome, allergy
Fusarium sp.	sporosis
Monilia sp.	allergy
Mucor indicus	systemic/subcutaneous mucormycosis
Paecilomyces variotii	paecilomycosis
Penicillium sp.	asthma, pneumonia, sporosis, mycetome, alveollytis
Rhizopus nigricans	mucormycosis, allergy

[a]For abbreviations, see Table 2.

white heroin. This suggests that the contaminants found in this drug may be introduced during its synthesis. This hypothesis is rather arguable since, as stated above, the mycoflora reached the drug chiefly through contact with the air during the manipulation involved in the preparation of monodoses. As this process is common to all three types of drug, contamination must not depend on this factor exclusively. A second hypothesis we may formulate in view of our results is that brown heroin is subject to greater adulteration or that the substances with which it is adulterated are more contaminated. This may arise from the dealers' aim to increase their benefits at little extra cost. To our knowledge, one batch of brown had been adulterated with powdered brick, which appears to validate this second hypothesis.

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