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The Determination of Dithiocarbamate Residues in Tobacco*

Results of Joint Experiments carried out between 1976 and 1978 by Coresta+ Pesticide Sub-Group

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Over the past three years members of the *Coresta* Pesticide Sub-Group have undertaken a number of joint experiments designed to examine in detail two methods which had been proposed for the determination of dithiocarbamate residues in tobacco. The results of these joint experiments are published as they indicate the difficulties which can be encountered when analysing for such pesticide residues in tobacco.

The two methods of analysis (details of which are given in the appendix) which were investigated are basically the same. The dithiocarbamates (DTC) are decomposed by heating with acid to form carbon disulphide, a reducing agent being added to eliminate undesirable oxidation processes before the commencement of the acid hydrolysis. In method A, formic acid is used as the hydrolysing acid and sodium ascorbate as reducing agent, whilst in method B, hydrochloric acid and stannous chloride, respectively, are used. For both the methods carbon disulphide formed is transferred with a current of nitrogen to a scrubber containing concentrated sulphuric acid and then into absorption traps containing methanolic potassium hydroxide. The concentration of potassium O-methyl dithiocarbonate formed under these conditions is measured spectrophotometrically. Earlier tests (1) had shown that concentrated sulphuric acid was more efficient than cadmium acetate for the removal of interfering substances present in tobacco, including casing and flavouring materials.

The first joint experiment was planned to check whether results obtained using the two methods of analysis differed. Six laboratories analysed subsamples of one tobacco sample by the two methods. The results (Table 1) show that method B consistently gave levels greater than those obtained using method A although the differences between the two sets of results varied for different laboratories. In addition, results obtained using method A were more variable than those obtained using method B.

During discussion of these results, members of the Pesticide Sub-Group also reported that calibration curves prepared by means of sodium diethyl dithiocarbamate were identical for each method. However, calibrations carried out in the presence of tobacco, i.e. by adding standard solutions of sodium diethyl dithiocarbamate to a tobacco free of DTC, gave absorbance values which were far more variable, and frequently lower than the corresponding values obtained in the absence of tobacco, being in the range 70 % – 90 % for method A and 85 % – 100 % for method B. In addition, the differences between results by the two methods, when applied to different commercial tobaccos, varied considerably, and one member even reported cases where method B gave lower results than method A for some types of tobacco.

Members investigated the influence of pH, nitrate and sugars content and sample size, on results by the two methods but no consistent trends were found.

At this stage members felt that a possible explanation for the variations found, could lie in differences in the rates of hydrolysis of the various dithiocarbamates under the experimental conditions used. It could be that sodium diethyl dithiocarbamate was hydrolysed more readily and therefore more completely than the dithiocarbamates used in the field and that the rates of hydrolysis of the different commercially used dithiocarbamates also varied

Table 1. Comparison of methods A and B (all results expressed as mg/kg of CS_2).

Laboratory*	Method A	Method B	% increase by method B
5	15	23	53
8	16	24	50
11	14.6	19.3	32
16	14.6	20.7	42
17	17.0	23.4	38
18	21	23	11
Average	16.4	22.2	35
Coefficient of variation (%)	15	8.1	

* A list of the laboratories taking part in the joint experiments is given at the end of the paper.

* Received for publication: 31st October, 1978.

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Table 2. Field-treated tobacco samples (all results as mg/kg CS_2).

Laboratory+	Field-treated with propineb						Field-treated with maneb						Ratio $\frac{B}{A}$	
	Method A			Method B			Method A			Method B				
	mean	high	low	mean	high	low	mean	high	low	mean	high	low	propineb	maneb
1	6.6	8.1	5.0	9.8	10.2	9.5	17.6	18.1	16.9	23.4	24.5	22.4	1.5	1.33
5	5.6	5.7	5.5	8.6	8.8	8.4	13.2	13.3	13.0	20.7	20.8	20.4	1.54	1.57
6	7.99	8.05	7.91	9.91	10.12	9.5	18.44	18.65	18.02	22.18	22.25	22.05	1.24	1.20
8	5.3	5.5	5.2	8.5	8.4	8.4	11.9	12.1	11.6	19.4	20	18.8	1.59	1.63
9	5	6	5	8	9	7	13	14	11	21	21	20	1.60	1.62
11	6	6.1	5.9	10.4	10.5	10.4	15.6	15.8	15.4	23.1	23.4	22.9	1.73	1.48
13				7.1	7.1	7.0	5.1	6.2	3.3	17.8	19.9	16.6	–	3.49
14	0.9*	1.1*	0.8*	4.2*	4.5*	4.0*	9.0	9.2	8.7	17.0	17.2	16.8	4.67*	1.89
15	8	8	8	8	10	7	14.8	18	13	21	24	17	1.06	1.42
16 (analyst 1)	4.0	4.1	3.9	9.1	10.2	8.5	14.0	14.3	13.8	23.5	23.7	23.3	2.3	1.7
16 (analyst 2)	4.2	4.4	4.1	8.6	9.0	8.3	13.6	13.8	13.5	23.6	23.7	23.4	2.0	1.7
17	6	6	5	8	8	7	13	13	12	20	20	19	1.33	1.54
18	5.3	6	5	9.7	10	9	12	12	12	18.3	21	17	1.83	1.53
Overall	5.8	8.1	3.9	9.6	10.5	7	13.8	18.6	8.7	21.1	24.5	17.0	1.67	1.52

Table 3. Pesticide without tobacco (all results expressed as mg/kg CS_2).

Laboratory+	Propineb						Maneb						Ratio $\frac{B}{A}$		Weight of talc + pesticide taken
	Method A			Method B			Method A			Method B					
	mean	high	low	mean	high	low	mean	high	low	mean	high	low	propineb	maneb	
1	273	287	265	239	247	226	294	305	287	267	276	250	0.88	0.91	300 mg
5	221	225	218	267	268	267	249	251	247	76	277	276	1.2	1.1	500 mg
6	207	220	200	257	260	250	237	240	230	268	274	260	1.24	1.13	500 mg
8	199	205	194	223.6	224	223.2	208	214	202	227.2	231.2	223.2	1.12	1.09	500 mg
9	213	225	195	203	220	190	221	228	215	223	235	213	0.95	1.01	
11	245	247.4	242.2	272.8	275	270	221	222.6	218	259.8	261.4	257.2	1.11	1.18	500 mg
13	102.2	111.6	84.8	186.2	186.4	185.8	86.3	108.6	57.8	175.7	183.6	165.0	1.82	2.04	500 mg
14	185	198	178	229	239	219	162	178	152	222	223	211	1.22	1.37	500 mg
15	133.7	170	110	232	269	178	190.7	192	188	265	269	261	1.74	1.39	500 mg
16 (analyst 1)	233	240	222	250	267	237	240	241	239	260	270	247	1.1	1.1	500 mg
16 (analyst 2)	217	259	195	258	272	255	149	164	131	266	284	254	1.2	1.8	500 mg
17	193	204	188	210	220	194	190	208	162	191	214	173	1.09	1.01	1 g
18	200	200	200	252	260	249	188	190	187	234	254	221	1.26	1.24	500 mg
Overall	202	215	192	237	247	226	203	211	194	241	250	232	1.23	1.26	

+ A list of the laboratories taking part in the joint experiments is given at the end of the paper.

* not included in overall average.

Table 4. Untreated tobacco + pesticide (all results expressed as mg/kg CS_2).

Laboratory+	Untreated tobacco + propineb						Untreated tobacco + maneb						Ratio B/A		Weight of talc + pesticide added
	Method A			Method B			Method A			Method B					
	mean	high	low	mean	high	low	mean	high	low	mean	high	low	propineb	maneb	
1	18.9	19.6	18.2	22.6	23.2	21.6	20.1	22.6	17.8	27.3	28.9	26.2	1.2	1.36	300 mg
5	17.3	17.7	17.0	20.0	20.1	19.9	14.9	15.1	14.7	23.4	23.7	23.0	1.16	1.57	500 mg
6	17.2	17.6	16.8	21.5	21.8	21.2	18.5	18.8	18.2	24.1	24.8	23.6	1.25	1.30	500 mg
8	15.7	15.9	15.5	19.3	19.8	18.8	14.4	15	13.8	19.7	20.2	19.2	1.23	1.37	500 mg
11	18.9	19.0	18.8	24.0	24.2	23.7	17.1	17.1	17.1	25.8	25.9	25.7	1.27	1.51	500 mg
13	10.6	11.7	9.4	18.3	18.5	18.0				20.3	20.5	20.1	1.73	–	500 mg
14	8.8	10.3	7.2	17.6	18.6	16.5	5.3	6.4	4.1	9.0	10.1	7.8	1.99	1.70	500 mg
15	15.4	16	15	18.3	20	17	14.3	16	13	24.8	27	23	1.19	1.73	500 mg
16 (analyst 1)	14.6	15.0	13.9	27.5	29.4	25.4	12.7	14.1	11.0	24.8	26.0	24.2	1.9	2.0	500 mg
16 (analyst 2)	12.3	13.6	11.5	29.6	29.1	28.4	12.3	14.0	10.8	25.6	26.0	24.4	2.4	2.1	500 mg
17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
18	13.8	17.3	11.7	20.9	22	20.2	11.5	14.2	9.9	23.3	23.6	23.2	1.51	2.03	500 mg
Overall	14.9	16	14.1	21.8	22.4	21	14	15	13	22.6	23.3	21.9	1.5	1.6	

Table 5. Summary of ratios of method B to method A.

Laboratory+	Ratio method B / method A					
	Propineb			Maneb		
	Pesticide alone	Untreated tobacco + pesticide	Field-treated tobacco	Pesticide alone	Untreated tobacco + pesticide	Field-treated tobacco
1	0.88	1.2	1.5	0.91	1.36	1.33
5	1.2	1.16	1.54	1.1	1.57	1.57
6	1.24	1.25	1.24	1.13	1.30	1.20
8	1.12	1.23	1.59	1.09	1.37	1.63
9	0.95	1.06	1.60	1.01	1.04	1.62
11	1.11	1.27	1.73	1.18	1.51	1.48
13	1.82	1.73	–	2.04	–	3.49*
14	1.22	1.99	4.67*	1.37	1.70	1.89
15	1.74	1.19	1.06	1.39	1.73	1.42
16 (analyst 1)	1.1	1.9	2.3	1.1	2.0	1.7
16 (analyst 2)	1.2	2.4	2.0	1.8	2.1	1.7
17	1.09	–	1.33	1.01	–	1.54
18	1.26	1.51	1.83	1.24	2.03	1.53
Mean	1.23	1.5	1.87	1.26	1.61	1.7
C. of V. (%)	22	28	50	26	21	33
Mean (excluding *)			1.61			1.55
C. of V. (%) (excluding *)			22			12

Table 6. Recovery of added pesticide (as %).

Laboratory+	Propineb		Maneb	
	Method A	Method B	Method A	Method B
1	69	95	68	102
5	78	75	60	85
6	83.1	83.7	76.8	89.9
8	79	86	69	87
9	94	100	92	96
11	77	88	77	99
13	104	98	–	115
14	47.6	76.9	32.7	40.5
15	115	79	75	94
16	63	110	53	95
16 (analyst 1)	57	112	83	96
18 (analyst 2)	69	83	61	100
Mean	78	90.6	68	91.6
Coefficient of variation (%)	24.7	13.7	23.7	19.5

+ A list of the laboratories taking part in the joint experiments is given at the end of the paper.

Table 7. Sample A (all results expressed as mg/kg CS_2).

Laboratory+	Nitrogen flow (ml)		Dithiocarbamate content			
	inlet	outlet	1	2	3	Average
2	n. m.*	50	10.7	11.0	9.8	10.5
3	50	50	12.0	12.1	12.1	12.1
	25	25	12.9	12.8	12.0	12.6
4	50	50	12	10	12	11
	25	25	12	13	13	13
5	50	50	11.9	12.1	12.0	12.0
	25	25	11.7	11.6	11.6	11.6
6	n. m.	50	11.6	11.6	12.0	11.7
7	50	50	14.0	12.2	12.0	12.7
	100	100	12.8	15.4	12.0	13.4
8	80	70	12.4	12.4	–	12.4
	36	30	11.2	11.7	–	11.4
9	50	43	13	14	12	13
10	60	50	12	12	12	12
	35	25	11	12	12	12
11	50	50	12.5	13.0	13.0	12.8
	25	15	12.5	12.5	12.5	12.5
12	50	50	11.5	11.7	11.5	11.6
13	50	50	9.3	9.5	9.8	9.5
	25	25	9.2	10.5	8.5	9.4
14	50	50	11.7	11.4	11.5	11.5
	25	25	11.0	11.2	10.8	11.0
15	50	67	12.0	10.9	10.8	10.9
	25	33	11.8	11.1	10.6	11.2
16	50	50	9.3	9.5	9.8	9.5
	25	25	9.2	10.6	8.5	9.4
17	50	n.m.	12	12		12
	25	n.m.	12	13	13	12
18	50	50	12	12	12	12
	25	25	12	12	12	12
Mean	50					11.6
	25					11.5

Table 8. Sample B (all results expressed as mg/kg CS_2).

Laboratory+	Nitrogen flow (ml)		Dithiocarbamate content			
	inlet	outlet	1	2	3	Average
2	n. m.*	50	64.8	62.0	59.4	62.1
3	50	50	66.3	69.8	74.3	70.8
	25	25	67.8	72.3	72.3	70.1
4	50	50	67	56	63	62
	25	25	64	63	63	63
5	50	50	69.1	68.3	69.1	68.8
	25	25	65.7	66.5	64.8	65.7
6	n. m.	50	68.0	68.0	69.0	68.3
7	50	50	73.0	71.3	70.7	71.7
	100	100	74.4	74.0	75.2	74.5
8	80	70	67.6	67.2	–	67.4
	36	30	61.4	62.5	–	62.0
9	50	43	68	68	64	67
	25	22	66	68	–	67
10	60	50	70	70	72	71
	35	25	65	67	64	65
11	50	50	75.0	73.8	72.5	73.8
	25	25	73.8	72.5	72.5	72.9
12	50	50	67.4	67.6	67.1	67.4
13	50	50	61.6	62.2	60.9	61.6
	25	25	56.6	54.5	55.5	55.5
14	50	50	68.8	69.4	69.2	69.1
	25	25	66.8	66.8	66.7	66.8
15	50	67	62.9	66.9	68.4	66.1
	25	33	71.2	69.8	71.2	70.7
16	50	50	61.6	62.2	60.9	61.6
	25	25	56.6	54.5	55.5	55.5
17	50	n.m.	66	66		66
	25	n.m.	70	70	67	69
18	50	50	67	68	66	67
	25	25	65	67	60	64
Mean	50					67
	25					65

+ A list of the laboratories taking part in the joint experiments is given at the end of the paper.

* n. m. = not measured.

and were dependent on the metallic ion present. This could explain why both methods of analysis gave identical calibration curves and why very large differences were found when commercial tobaccos were analysed.

As insufficient information was known about the rate of hydrolysis of the various dithiocarbamates the next joint experiment was planned to ascertain whether there was any difference in the rate of hydrolysis of maneb and propineb under the experimental conditions of methods A and B which could cause the differences in results by these two methods. Twelve laboratories took part in this second joint experiment. Each analysed in triplicate, using both method A and method B, the following series of samples:

1. Untreated tobacco.
2. Untreated tobacco spiked with propineb.
3. Untreated tobacco spiked with maneb.
4. Tobacco field-treated with propineb.
5. Tobacco field-treated with maneb.
6. Propineb without tobacco.
7. Maneb without tobacco.

Maneb and propineb were added at a level equivalent to 50 µg. Each pesticide was supplied mixed with talc.
The results of this second joint experiment (Tables 2–6) were disappointing because of the large spread of values obtained. However, once again, results by method B were, in general, greater than those by method A. The relative differences in results by the two methods also varied considerably, being greatest for the field-treated samples and least for pesticide samples in the absence of tobacco. Although the spread of values by different members was large the recovery of added pesticide was higher by method B. The results of this second joint experiment did not indicate that either method of analysis was influenced by the type of dithiocarbamate.
As method B consistently gave higher and less variable results, members of the Sub-Group decided that this was the preferred method. The experimental details given for method B were rewritten in more detail, to ensure that, as far as possible, there was no variation in experimental conditions between the various laboratories. A further joint experiment was then planned to check the reproducibility of this method and also to check whether a change in flow rate of 25 ml to 50 ml per minute affected the results. For this last joint experiment, tobacco was specially grown in Turkey to have a residue level of about 50 p.p.m. It was felt that the very low residue levels of some of the samples used in earlier joint experiments had exaggerated errors.
Seventeen laboratories analysed two samples of tobacco, one with a residue level of about 50 p.p.m. and the other a lower residue level. Triplicate analyses were carried out on each sample at each flow rate. The results (Tables 7, 8) were considered by members to be very good. There was no major difference between results obtained using 25 ml and 50 ml per minute flow rates, but for technical reasons, mainly the back pressure of the absorption traps, it was decided to recommend a 50 ml per minute flow rate. It can also be seen that with one exception all results were within ± 10 % of the mean value, and most were within ± 5 % of the mean. It was felt that this last joint experiment confirmed the preference of method B as the *Coresta* recommended method for the determination of dithiocarbamates.
However, certain anomalies remain, in particular the effect of tobacco on the calibration curve. In some cases addition of tobacco has little effect but in general it reduces the absorbance levels by up to 10 %. This reduction appears to be greater for air-cured than flue-cured or Oriental tobaccos.

Appendix

THE DETERMINATION OF DITHIOCARBAMATES IN TOBACCO

Principle

The dithiocarbamates are decomposed on heating with acid in the presence of a reducing agent. The carbon disulphide which is formed, is transferred with a current of nitrogen into a trap containing concentrated sulphuric acid to remove interfering substances, and then into a trap containing a methanolic solution of potassium hydroxide. The concentration of potassium O-methyl dithiocarbonate formed under these conditions is measured by spectrophotometry. As it is not normally known which dithiocarbamate is present, results are expressed as carbon disulphide, and the values obtained using this method are taken to indicate the dithiocarbamate residue level.

Reagents for Methods A and B

1. Concentrated sulphuric acid: chemically pure or AR.
2. Potassium hydroxide reagent: 56 g potassium hydroxide (AR) is dissolved in 1 l methanol (AR) and 50 ml water is added to this solution. If there is any sediment the reagents should be filtered, using fluted filter paper before it is used.
3. Sodium diethyl dithiocarbamate [a]: sodium diethyl dithiocarbamate trihydrate (AR) is used for the calibration.

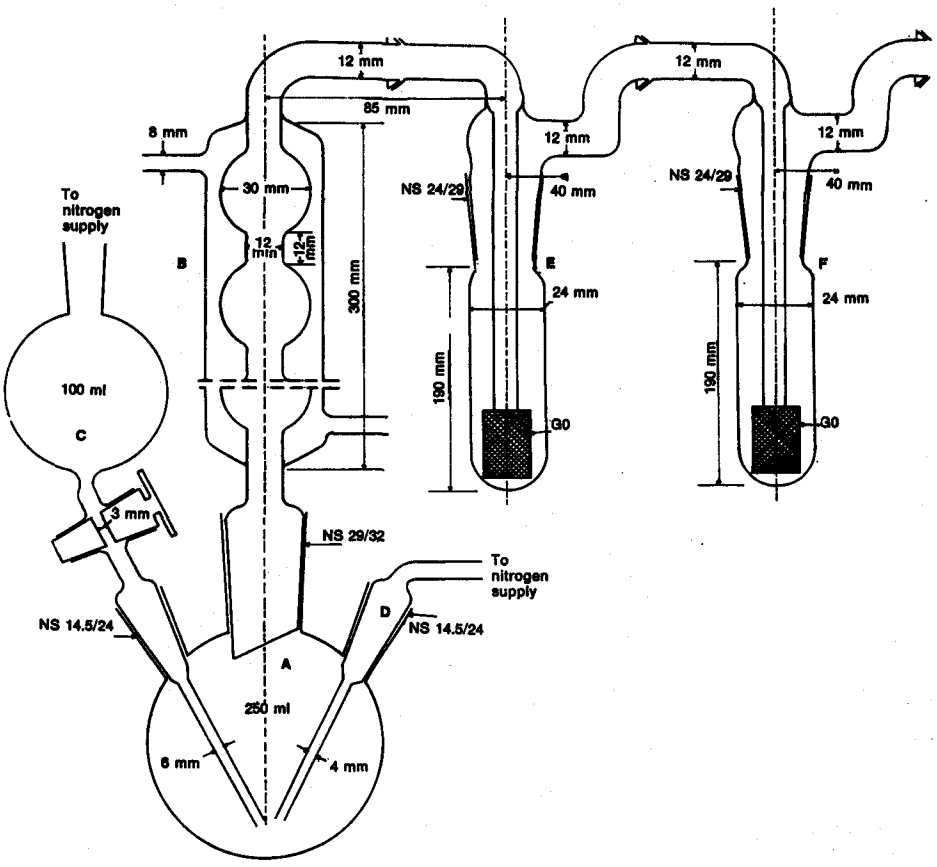
Reagents for Method A Only

1. Formic acid: 70 % v/v diluted with distilled water.
2. Sodium ascorbate solution: Dissolve 5 g sodium ascorbate in 100 ml distilled water.

Reagents for Method B Only

1. Hydrochloric acid aqueous solution: 75 ml concentrated hydrochloric acid (AR) is added to 150 ml distilled water.
2. Stannous chloride: solid $SnCl_2$ (AR).

Figure 1. Apparatus for the determination of dithiocarbamate residues.



Apparatus for Methods A and B (see Figure 1)

A 250 ml three-neck flask A is fitted with a water cooled condenser B (length 30 cm), a 100 ml reservoir C equipped with a stopcock and a tube reaching to the bottom of the flask, and a gas inlet D, which also reaches to the bottom of the flask. Both reservoir C and gas inlet D should be connected to a nitrogen supply, via a 3-way tap. The exit of the condenser is connected with two wash-bottles (E and F). The volume of each of the wash-bottles is about 80 ml and the inner tubes are equipped with G0 sinters. The apparatus should be checked to ensure that there are no leaks.

Procedure (Method A Only)

5 g of tobacco [b], weighed to the nearest 10 mg, is placed in flask A. 50 ml sodium ascorbate solution is added. The flask is shaken until all the tobacco has been impregnated and the suspension allowed to stand for 5 minutes. Immediately after this has been done, flask A is connected to condenser B which is connected with wash-bottle E containing 20 ml concentrated sulphuric acid, and wash-bottle F containing 25 ml potassium hydroxide reagent. Reservoir C and inlet tube D are put in position, and a current of nitrogen, 50 ml per minute [c], is allowed to pass through the whole apparatus via D. Flask A is heated to 30–40 °C. 50 ml formic acid solution is placed in reservoir C and slowly added to flask A. Whilst the acid is being added to the reaction flask the 3-way tap should be turned so that the nitrogen supply is connected to reservoir C as well as passing into flask A via inlet tube D. This prevents any "suck-back" during the addition of the acid. The contents of flask A are then heated to boiling point whilst maintaining a nitrogen flow of 50 ml per minute through inlet tube D. Boiling is sustained for 45 minutes. Condenser B must be well cooled to prevent water passing into the concentrated sulphuric acid in trap E.

Procedure (Method B Only)

5 g of tobacco [b], weighed to the nearest 10 mg, is placed in flask A. 2 g stannous chloride is added followed by 50 ml distilled water. The flask is shaken until all the tobacco has been impregnated. Immediately after this has been done, flask A is connected to condenser B which is connected with wash-bottle E containing 20 ml concentrated sulphuric acid, and wash-bottle F containing 25 ml potassium hydroxide reagent. Reservoir C and inlet tube D are put in position, and a current of nitrogen, 50 ml per minute [c], is allowed to pass through the whole apparatus via D. Flask A is heated to 30–40 °C. As it is absolutely necessary that all of the tobacco is well impregnated by the stannous chloride solution, flask A is allowed to remain for at least 10 minutes in the conditions just described. This also has the advantage of purging any oxygen present in the apparatus. Following the impregnation, 100 ml hydrochloric acid solution is placed in reservoir C and slowly added to flask A. Whilst the acid is being added to the reaction flask the

3-way tap should be turned so that the nitrogen supply is connected to reservoir C as well as passing into flask A via inlet tube D. This prevents any "suck-back" during addition of the acid. The contents of flask A are then heated to boiling point whilst maintaining a nitrogen flow of 50 ml per minute through inlet tube D. Boiling is sustained for 30 minutes. Condenser B must be well cooled to prevent water passing into the concentrated sulphuric acid in trap E.

Procedure Common to Both Methods A and B

At the end of the boiling period, wash-bottles E and F are disconnected and the nitrogen flow is turned off. The content of wash-bottle F is transferred to a 50 ml volumetric flask. Flask F is thoroughly rinsed with distilled water which is also added to the volumetric flask. The volume of the combined solutions is adjusted to 50 ml with distilled water. After mixing and allowing to stand for 15 minutes, the spectrophotometric measurements are made at 272, 302 and 332 nm, using a 10 mm quartz cell, against a reagent blank of 25 ml potassium hydroxide reagent plus 25 ml distilled water [d]. If any precipitation occurs in wash-bottle F, this indicates a high level of DTC, and the solution should be further diluted to 100 ml. Before every new analysis, the following procedure has to be observed:

1. The concentrated sulphuric acid in wash-bottle E must be renewed.
2. Wash-bottles E and F must be cleaned and dried, but acetone should not be used as any residue interferes with the subsequent analysis.

Remarks

[a] Sodium diethyl dithiocarbamate is the only pure dithiocarbamate which is readily available.

[b] If possible, use a test sample that is in the form of cut tobacco or cigarette filler, without further preparation. If a test sample in these forms is not available, cut the laboratory sample into pieces of a suitable size. Grinding and drying lead to loss of dithiocarbamates.

[c] The flow of nitrogen should be measured and preset before connecting to the apparatus.

[d] The measured extinction at 302 nm shall not be over 0.800, nor under 0.100. If the extinction is over 0.800, a further dilution or a smaller amount of tobacco should be used. If the extinction is under 0.100, a quartz cell of longer path length should be used.

Calibration

A solution of 59.2 µg / ml sodium diethyl dithiocarbamate · $3H_2O$, equivalent to 20 µg CS_2 / ml, is prepared in water. This solution must be freshly prepared each day.

A range of standards, equivalent to 40, 60, 80, 100, 120 and 160 µg CS_2, is prepared by analysing 2, 3, 4, 5, 6 and 8 ml of this solution under conditions identical to those used for the analysis of tobacco.

A calibration curve is prepared by plotting amount of CS_2 in µg against extinction (Δ E), calculated using the following formula:

$$\Delta E = E_{302} - \frac{E_{272} + E_{332}}{2} \quad . \qquad [1]$$

A calibration factor (f) may be calculated from the slope of the calibration graph:

$$f = \frac{\Delta E}{\mu g\ CS_2} \quad . \qquad [2]$$

The calibration curve has been found to be very reproducible and a full curve need not be prepared each day. A single point check is normally sufficient.

Calculation

The amount of CS_2 in moisture-free tobacco expressed in mg CS_2 per kg moisture free tobacco (p.p.m.) is:

$$CS_2 \text{ in mg/kg} = \frac{\Delta E \times 100}{f \times M \times (100 - W)},$$

where

ΔE = extinction, corrected as formula 1,
f = calibration factor calculated as formula 2,
M = tobacco weight (g),
W = moisture content of tobacco (%).

Note

Method A is based on the work of *Rastetter* (2, 3) and method B on the work of *Keppel* (4) and *Schurer* (5).

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SUMMARY

The *Coresta** Pesticide Sub-Group has examined various methods for the determination of dithiocarbamate residues in tobacco. As a result of this work the method described in this paper is recommended.

ZUSAMMENFASSUNG

Der Unterausschuß für Pestizide der *Coresta** prüfte verschiedene Verfahren zur Bestimmung von Dithiocarbamatrückständen in Tabak und empfiehlt — als Ergebnis dieser Untersuchungen — die Anwendung der in der vorliegenden Arbeit beschriebenen Methode.

RÉSUMÉ

La sous-commission «Pesticides» du *Coresta** a examiné différentes méthodes pour la détermination des résidus de dithiocarbamates dans le tabac. Au vu des résultats obtenus, la méthode décrite dans cet exposé est recommandée.

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