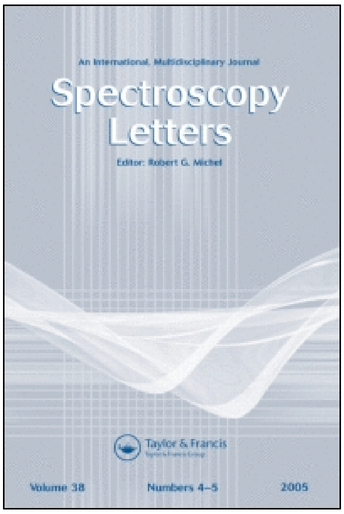


Spectroscopy Letters
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713597299

In Situ Spectrodensitometric Determination of Methyl and Propyl Parabens, Benzoic and Sorbic Acids in Bulk Powder, Foods, and Pharmaceutical Formulations

A. El-Bayoumi[a]; M. S. Tawakkol[a]; J. M. Diab[b]
[a] Anal. Chem. Depart., Faculty of Pharmacy, Cairo University, [b] Anal. and Food Chem. Depart., Faculty of Pharmacy, Damascus University,

To cite this Article El-Bayoumi, A. , Tawakkol, M. S. and Diab, J. M.(1997) '*In Situ* Spectrodensitometric Determination of Methyl and Propyl Parabens, Benzoic and Sorbic Acids in Bulk Powder, Foods, and Pharmaceutical Formulations', Spectroscopy Letters, 30: 2, 355 — 366

To link to this Article: DOI: 10.1080/00387019708006994

URL: http://dx.doi.org/10.1080/00387019708006994

SPECTROSCOPY LETTERS, 30(2), 355-366 (1997)

IN SITU SPECTRODENSITOMETRIC DETERMINATION OF METHYL AND PROPYL PARABENS, BENZOIC AND SORBIC ACIDS IN BULK POWDER, FOODS, AND PHARMACEUTICAL FORMULATIONS

KEY WORDS

Spectrodensitometry, methyl and propyl parabens, benzoic and sorbic acids.

A. El -Bayoumi*, M.S. Tawakkol* and J.M. Diab**

*Anal. Chem. Depart., Faculty of Pharmacy, Cairo University

**Anal. and Food Chem. Depart., Faculty of Pharmacy, Damascus University

ABSTRACT

ATLC spectrodensitometric procedure was developed for the determination of methyl paraben, propyl paraben, sorbic acid and benzoic acid as bulk powders or in pharmaceutical dosage forms and foods. The procedure was used for the determination of the two parabens singly or together and also was used for the determination of benzoic and sorbic acids singly because they were found singly in some commercial food and pharmaceutical products. The cited compounds were separated on silica gel with fluorescent indicator in systems, acetone-ethanol-aqueous ammonia 28%- ethyl acetate (84:3:9:9) for the determination of benzoic and sorbic acids and n-hexane- ethyl acetate-acetic acid (80:5:20) for the determination of the two parabens. Absorbance measurement (detection of reflectance) of separated compounds was carried out .in situ. at 254 nm for the two parabens, sorbic acid, and at 228 nm for benzoic acid using multilevel calibration curves in the concentration ranges of 0.2-2.5 µg/spot, 0.5-3 µg / spot, and 2.5-12.5µg / spot for sorbic acid, the two parabens, and benzoic acid, respectively. The results were evaluated by linear regression analysis. The mean % accuracies were found to be, mean ±C.V.(%), 99.65 ±0.963, 99.45±1.02, 99.60±0.825 and 99.34±0.969 for benzoic acid, sorbic acid, methyl paraben and propyl paraben in bulk powders, respectively. While in case of benzoic and sorbic acids in foods the mean % accuracies were found to be: 97.72±1.231 and 98.81±1.296, respectively. The mean % accuracies of methyl paraben, propyl paraben, sorbic acid in pharmaceutical dosage forms were found to be: 98.19±0.874, 97.830±0.799 and 98.36±0.572, respectively.

INTRODUCTION:

The esters of p-hydroxybenzoic acid (parabens), benzoic acid and sorbic acid have been extensively used as preservatives to protect cosmetics, foods and pharmaceutical preparations from microbial and fungal attack. They are the most widely used preservatives and are generally considered to be safe in application (1). The use of the cited compounds in foods is related to the food characteristics and to the specific laws of the different countries. In Egypt the investigated preservatives are authorized at various concentrations in foods according to values issued by World Health Organization (WHO) and Food and Agriculture Organization (FAO).Many methods have been reported for the determination of the cited compounds including visible spectrophotometry(2,3) ultraviolet spectrophotometry,(4-6) thin layer and high performance thin layer chromatography (TLC, HPTLC),(7-10) gas chromatography,(11-13) and high performance liquid chromatography.(14-21). The aim of our investigation is to develop a procedure sensitive and suitable for routine determination of the cited compounds singly or simultaneously in pure forms or in samples.

The present work describes a TLC densitometric procedure for the determination of trace amounts of benzoic. sorbic acids, methyl and propyl parabens in dosage forms and foods. The procedure is simple, rapid, sensitive and specific.

EXPERIMENTAL

Apparatus. TLC Scanner CS 9000, Shimadzu.

Chemicals. All the chemicals used were of analytical reagent grade.

Standard substances. Bulk powders of benzoic acid, sorbic acid, methyl paraben and propyl paraben were kindly supplied by Kahira Pharm. & Chem. Ind. CO. Cairo, Egypt. Their purity was ascertained by procedures indicated by the USP XXII pharmacopoeia.(16)

Procedures

Standard preparation

Stock standard solutions were prepared containing 12.5 mg/ml of benzoic acid in methanol, 2.5 mg/ml of sorbic acid, methyl and propyl parabens in methanol. TLC standards were prepared by taking 1-5 ml of benzoic acid stock solution, 0.5-5 ml of sorbic acid stock solution, and 1-6 ml of methyl and propyl parabens stock solutions; each into 50 ml volumetric flask and diluted to the volume with methanol. 10μL aliquots of standard solutions were applied to TLC plate by 10μL syringe.

Sample preparation.

1. Pharmaceutical liquid dosage forms

An amount of (5 - 10 g) of the sample was accurately weighed into separating funnel, 2.5 ml of H_2SO_4 10% (v/v) and 10 ml of water were added and extracted with 40, 30 and 20 ml of ether. The ethereal extracts were washed with distilled water (2x10 ml), filtered on anhydrous sodium sulfate and evaporated on water bath. The residue was dissolved in methanol and 5-15μl aliquots of the methanolic extract were applied to TLC plate.

2. Liquid foods (Juices)

An amount of 25 g or 25 ml of the sample was transferred into a separating funnel, 25 ml of distilled water and 3 ml of H_2SO_4 10% (v/v) were added and extracted three times with 100, 50 and 50 ml of ether, then treated as mentioned under pharmaceutical liquid dosage forms.

3. Semisolid food (as jams)

About 30.00g of jam was accurately weighed into a 250 ml beaker, 75 ml of distilled water, and 3 ml of H_2SO_4 10% were added and mixed by the aid of a stirrer. The aqueous solution was extracted with 100, 50 and 50ml of ether, then treated- as mentioned under pharmaceutical liquid dosage forms.

4. Antacid Suspension:(8)

An amount of 5.00 g of suspension was weighed into a 50 ml volumetric flask, 1.0 ml phosphoric acid and 20 ml of methanol were added and the volume was completed with acetone to the mark. The suspension was filtered and 10μl of the filtrate was applied to TLC plate

5. Ointments and creams(8)

An amount of 1.00 g of the sample was weighed into a beaker, 15 ml of acetone was added and heated, after dissolution of the sample, the solution was transferred into a 50 ml volumetric flask, and the volume was completed with acetone to the mark the suspension was filtered, and 10μl aliquots of the filtrate were applied to TLC plate.

Chromatography of the samples

The samples were spotted on the TLC silica gel plates in small spots and developed by ascending technique in saturated chamber. Solvent mixture, ethanol- aqueous ammonia 28%- ethyl acetate (84:3:9:9), was used for the separation of the two acids and solvent mixture, n-hexane- ethyl acetate-acetic acid (80:5:20) used for the separation of the two parabens. After developing the plates were dried, visualized under uv lamp at 254 nm and then measured densitometrically.

Conditions of measurement

photomode: reflection; scanning mode: zigzag; optical density: 0-4.0; chart speed:50 mm/min.; monochromator bandwidth:10 nm;wavelengths:228 nm for benzoic acid and 254 nm for sorbic and the two parabens.

Results and Discussion

Table(1) lists R_F values of the investigated compounds in four developing systems namely; solvent 1, acetone- ethanol- ethyl acetate- aqueous ammonia 28%(84:3:9:9) was used for the determination of benzoic and sorbic acids and solvent 2, n-hexane- ethyl acetate- acetic acid (80:5:20) was used for the determination of methyl and propyl parabens. The limit of detection was found to be about 2, 0.1 and 0.2μg for benzoic acid, sorbic acid and the two parabens, respectively. The wavelengths used for densitometric quantification were 228 nm for benzoic acid and 254 nm for sorbic acid and the two parabens. Figure(1) shows a typical separation of a standard solution of sorbic acid spots, scanned by rapid zigzag mode with its corresponding spectrum and calibration curve. Figure (2) shows the chromatogram of propyl paraben. Calibration curves were employed in the concentration ranges of 2.5-12.5 μg for benzoic acid, 0.2-2.5 μg for sorbic acid and 0.5-3.0 μg for the two parabens. The regression equations for the investigated compounds were calculated and found to be:

$y = 0.52+3.65x$ for benzoic acid with correlation coefficient of 0.9997;

$y = 0.32+22.91x$ for benzoic acid with correlation coefficient of 0.9999;

$y = 0.42+10.50x$ for methyl paraben with correlation coefficient of 0.9998 and

$y = 0.15+9.90x$ for propyl paraben with correlation coefficient of 0.9998;

Table (1)

R_F values of some preservatives in four solvent systems*

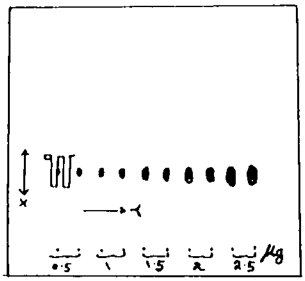
preservatives	S1	S2	S3	S4
Benzoic acid	0.25	-	-	0.57
Sorbic acid	0.35	-	-	0.48
Methyl paraben	-	0.25	0.55	0.30
Propyl paraben	-	0.35	0.60	0.38
P-hydroxybenzoic acid	0.12	-	-	0.14

* **Solvent 1**, acetone-ethanol-aqueous NH_4OH 28%-ethyl acetate (84:3:9:9).

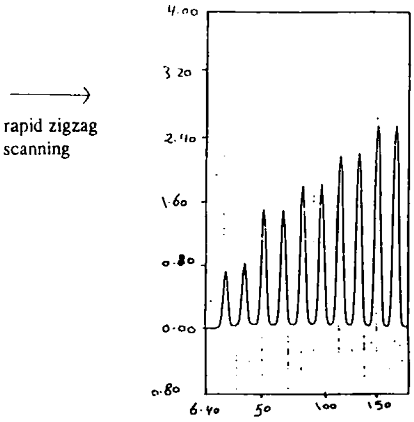
Solvent 2, n-hexane-ethyl acetate-acetic acid (80:5:20).

Solvent 3, chloroform-methylene chloride- acetone (60:10:10).

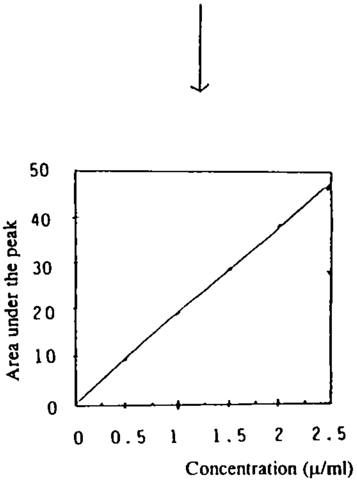
Solvent 4, n-hexane-ether-ethanol-formic acid (80:10:15:5).



(a) Standards of sorbic acid chromatographed on a TLC plate; mobile phase, acetone-ethanol-ethyl acetate-aqueous ammonia 28% (84:3:9:9)



(b) Spectrum of sorbic acid by TLC densitometry



(c) Calibration curve of sorbic acid by TLC densitometry

Figure 1 (a-c). Typical separation of sorbic acid spots (a) with their corresponding spectrum (b) and calibration curve (c).

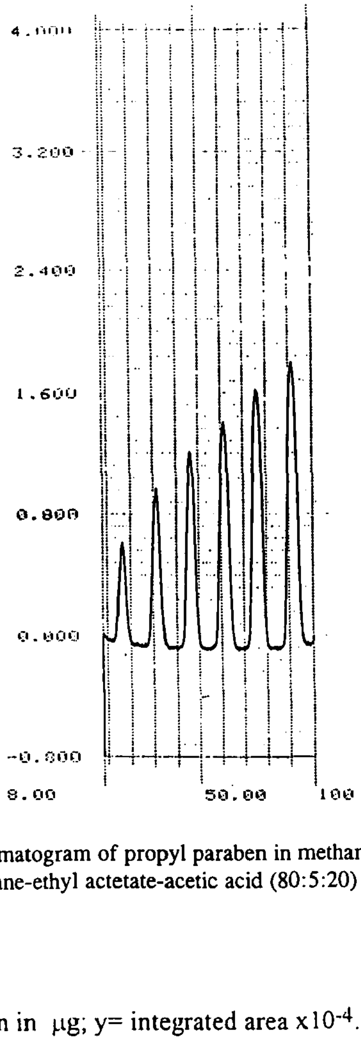


Figure 2. TLC chromatogram of propyl paraben in methanol; adsorbent, silica; mobile phase: n-hexane-ethyl actetate-acetic acid (80:5:20) λ max, 254 nm.

where x = concentration in μg; y= integrated area $x10^{-4}$.

Table (2) shows the recoveries of the cited compounds in bulk powder samples. It is obvious that the compounds were determined in authentic samples with an accuracy and precision of 99.65 ±0.963 for benzoic acid, 99.45±1.02 for sorbic acid, 99.60±0.825 for methyl paraben and 99.34±0.969 for propyl paraben.

Table(3) show the determination of synthetic mixtures of benzoic-sorbic acids and methyl-, propyl parabens. It was found that no significant difference between the proposed and pharmacopoeial methods concerning both precision and accuracy as shown in table(4). Since the preservatives and their amounts

Table (2)

Spectrodensitometric determination of methyl paraben, propyl paraben, benzoic acid and sorbic acid in bulk powder samples

Methyl paraben			Propyl paraben			Benzoic acid			Sorbic acid		
Taken μg	μg	% Recovery	Taken μg	Found* μg	% Recovery	Takn μg	Found* μg	% Recovery	Taken μg	Found* μg	% Recovery
1	0.985	98.50	0.5	0.49	98.00	2.5	2.46	98.40	0.5	0.49	98.00
1.5	1.50	100.00	1	0.99	99.00	5	5.02	100.40	1	1.00	100.00
2	2.01	100.50	1.5	1.50	100.00	7.5	7.46	99.47	1.5	1.51	100.67
2.5	2.50	100.00	2	2.01	100.50	10	10.08	100.80	2	1.98	99.00
3	2.97	99.00	2.5	2.48	99.20	12.5	12.40	99.20	2.5	2.49	99.60
Mean ±C.V.%	99.60 ± 0.825			99.34 ± 0.969			99.65 ± 0.963				99.45 ± 1.02
St. D.	0.822			0.963			0.960				1.015
Variance	0.675			0.928			0.922				1.030

*Mean value of at least four determinations

Table (3)

Accuracy of mixtures of benzoic-sorbic acids and methyl-propyl parabens in bulk powder samples by TLC densitometric method

Benzoic acid			Sorbic acid			Methyl paraben			Propyl paraben		
Taken, μg	Found* μg	% Recovery	Taken, μg	Found* μg	% Recovery	Taken, μg	Found* μg	% Recovery	, μg	Found* μg	% Recovery
2.5	2.47	98.80	0.5	0.490	98.00	1	0.980	98.00	0.5	0.490	98.00
5	5.00	100.00	1	0.989	98.90	1.5	1.490	99.33	1	0.990	99.00
7.5	7.48	99.73	1.5	1.50	100.00	2	1.990	99.50	1.5	1.490	99.33
10	9.95	99.50	2	1.996	99.80	2.5	2.510	100.40	2	2.00	100.00
						3	2.990	99.67	2.5	2.48	99.20
Mean ± C.V%	99.51± 0.512			99.18± 0.926			99.38± 0.878				99.11± 0.730

* Mean value of at least four determinations.

Table (4)

Statistical comparison between the results of TLC spectrodensitometric and pharmacopoeial methods for the determination of methyl paraben, propyl paraben, benzoic acid, and sorbic acid.

	Proposed method		Pharmacopoeial method(11)
Methyl paraben			
Mean recovery ± SD	99.60 ± 0.822		99.20 ± 0.550
N	5		4
V	0.675		0.303
$t_{.95}$	0.210	(2.36)	
$F_{.05}$	2.228	(9.12)	
Propyl paraben			
Mean recovery ± SD	99.34 ± 0.963		99.22 ± 0.427
N	5		4
V	0.928		0.182
$t_{.95}$	0.249	(2.36)	
$F_{.05}$	2.173	(9.12)	
Benzoic acid			
Mean recovery ± SD	99.65 ± 0.960		99.41 ± 0.726
N	5		4
V	0.922		0.527
$t_{.95}$	0.413	(2.36)	
$F_{.05}$	5.10	(9.12)	
Sorbic acid			
Mean recovery ± SD	99.45 ± 1.015		99.15 ± 0.381
N	5		4
V	1.030		0.145
$t_{.95}$	0.552	(2.36)	
$F_{.05}$	7.172	(9.12)	

Table (5)

Detection and determination of methyl paraben, propyl paraben and sorbic acid in some pharmaceutical preparations by TLC densitometric method.

Sample	Concentration µg/g (ppm)*		
	Methyl paraben	Propyl paraben	Sorbic acid
Osinex Syrup	-	134.08 ± 1.33	-
Tarophen Syrup	457.33 ± 1.10	154.33 ± 3.60	-
Mucogel Syrup	1617.15 ± 1.244	-	-
Triactin Syrup	-	-	238.75 ± 3.169

* Mean value of four determinations ± C.V.%

Table (6)
Detection and determination of benzoic acid and sorbic acid in some commercial samples by TLC densitometric method.

Sample	Concentration (µg/g) ppm*	
	Benzoic acid	Sorbic acid
Apple drink (Juhayna)	-	44.25 ± 0.82
Orange juice (Best)	198.80 ± 0.60	-
Mango juice (Capri-Sonne)	181.60 ± 1.253	-
Apple juice (Capri-Sonne)	181.50 ± 1.25	-
Mango juice (Kaha)	156.70 ± 1.54	-
Apple-nectar (Dolce)	-	42.20 ± 1.40
Fig jam (Vitrac)	87.63 ± 2.00	-
Apricot jam (Vitrac)	88.67 ± 1.72	-

* Mean value of four determinations ± C.V.%

Table (7)
Spectrodensitometric determination of fortified pharmaceutical samples applying the standard addition technique.

Samples	Methyl paraben		Propyl paraben		Sorbic acid	
	Added, µg/g (ppm)	% Recovery*	Added, µg/g (ppm)	% Recovery*	Added, µg/g (ppm)	% Recovery*
Tarophen Syrup	200	99.25	100	98.00		
	300	97.67	150	97.67		
	500	97.00	200	97.00		
Mean ± C.V.%	700	96.60	250	96.00		
		97.63 ±1.195		97.32 ± 0.651		
Farcoline Syrup	200	98.50	100	97.00		
	400	98.50	150	99.00		
	500	98.00	200	98.00		
Mean ± C.V.%	750	97.00	300	97.70		
		98.00 ±0.722		97.93 ± 0.848		
Osinex Syrup			75	97.00		
			150	98.30		
			250	99.00		
			200	98.70		
Mean ± C.V.%				98.25 ±0.897		
Mucogel	250	99.80				
Suspension	500	99.00				
	750	98.87				
	1000	98.10				
Mean ± C.V.%		98.94 ± 0.704				
Triactin Syrup					125	98.60
					250	99.00
					300	97.70
					350	98.14
Mean ± C.V.%						98.36± 0.572

*Mean value of at least four determinations

Table (8)

Spectrodensitometric determination of fortified food samples applying the standard addition technique.

Samples	Benzoic acid		Sorbic acid	
	Added, µg/g (ppm)	% Recovery*	Added, µg/g (ppm)	% Recovery*
Mango juice (Capri-Sonne)	50 100 200 300	96.00 98.50 99.00 98.00		
Mean ± C.V.%		97.88 ± 1.344		
Orange juice (Best)	50 150 200 250 400	96.00 99.33 97.50 97.80 98.50		
Mean ± C.V.%		97.83 ±1.268		
Fig jam (Vitrac)	50 100 200 250	96.00 98.50 97.50 97.80		
Mean ± C.V.%		97.45 ± 1.081		
Apple juice (Juhayna)			50 100 150 200	97.00 99.00 100.00 99.25
Mean ± C.V.%				98.81± 1.296

* Mean value of at least four determinations.

weren't labeled in most commercial products, the proposed method was applied qualitatively for detection of the kind of preservatives found in analyzed samples. Many samples were tested and most liquid dosage forms found to contain the two investigated parabens either singly or in a combination. One sample was found to contain sorbic acid. Benzoic acid was found in some cough and sedative syrups used as sedative rather than a preservative. Ointments were tested qualitatively, they were found to contain methyl and propyl parabens as preservatives.

For liquid food samples, They were mostly found to contain benzoic acid and its salts as preservatives. Some little samples had sorbic acid as preservative. The proposed method was applied quantitatively for the determination of the two parabens and sorbic acid in dosage forms as listed in table(5). The coefficients of variation values ranged from 0.19 to 3.6%. The method was also used to analyze some commercial foods as fruit liquids and jams which contain mostly benzoic acid. The results were listed in table(6). The coefficients of variation values ranged form 0.6 to -2.0%. The accuracy of these results was validated by applying the standard addition technique, where known amounts of authentic compounds were added to dosage forms and food samples. The results were listed in tables(7,8). The mean % recovery values ranged from 97.63-98.94% and averaged 98.19% for methyl paraben, 97.32-98.25% and averaged 97.83% for propyl paraben and 98.36% for sorbic acid in liquid dosage forms. The mean % recovery values ranged from 97.45-97.88% and averaged 97.67% for benzoic acid and 98.81% for sorbic acid in food samples. The results of analyzed samples were in agreement with those issued by WHO/FAO.

The method described can be used for simultaneous determination of methyl, propyl parabens and benzoic, sorbic acid in bulk powder and commercial samples. The method is reproducible, rapid, sensitive and cheap. We consider it suitable for the routine determination of methyl, propyl parabens, sorbic and benzoic acids in dosage forms and foods.

REFERENCES

1. J.Giese; J. Food Technology, **48**, 102(1994).
2. K.Helrich, Ed., Official Methods of Analysis, 5th ed., Association of Official Analytical Chemists, Arlington, ,V.A,U.S.A, Section **974.10** (1990).
3. D.W.Fink, H.C. Tolan and S.W. Blodinger; J. Pharm. Sci.,**67**,837(1987).
4. K.Helrich, Ed.; Official Methods of Analysis, 5th ed., Association of Official Analytical Chemists, Arlington,V.A,U.S.A, Section **960.38** (1990).
5. J. Dumain, A. Paramentier, C. Banner, F.M. Pailler; Ann. Falsif. Expert. Chem. Toxicol., **80**,85, (1987).
6. M. Blanco, J. Coello, F.Gonzalez, H.Iturriaga and S.Maspoch; J. Pharm. Sci., **82**, 834(1993).
7. P. Majlat and E. Barthos; J. Chromtogr.,**294**, 431(1984).
8. H. Tomankova, M. Pinkasova; Anal. Lett.,**23**, 131(1990).
9. M. Smith; J. Sherma; J. Planar Chromatogr-Mod. TLC, **8**, 103(1995).
10. S.H. Khan, M.P.Murawski, J.Sherma; J. Liq. Chromatogr., **17**, 855(1994).
11. USP XXII, NF XVII United States Pharmacopoeia, National Formulary, Convention Inc., Rocville, Maryland, USA(1990).
12. M. Kakemoto; J. Chromatogr., **594**, 253 (1992).
13. Guillaume and C. Guinchard; Chromatographia, **39**, 438(1994).

14. G. Burini; J. Chromatogr., 664, 213 (1994).
15. H. Klein, R. Leubolt; J. Chromatogr., 640, 259 (1993).
16. M. A. Abuirjeie, M. E. Abdel- Hamid, A. A. A. Ahmed, E. S.A. Ibrahim; Anal. Lett., **23**, 67 (1990).
17. M. J. Thomposon, B. J. Clark, A. F. Fell And M. L. Robinson; Anal. Proc., **30**, 106 (1993).
18. F. J. E. M. Kuppers and J.A.Jams; J. A. O. A. C., 71, 106 (1988).
19. M. Moors. C.R. R. R. Teixeira, M. Jmidar, And D. L. Massart; Analytical Chimica Acta, 255, 177 (1991).
20. A. Weimar, H. W. Stuurman; Git. Fachz. Lab., **8**, 652 (1993)
21. H. S. Lee ; J. A. O. A. C.-Int., **78**, 80 (1995).

Received: August28, 1996
Accepted: Oct. 15, 1996