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Review article

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Review article on Analytical Techniques of Lamivudine Determination in Different Matrices

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Abstract

In this literature review, we will introduce most of up-to-date reported methods that have been developed for determination of lamivudine in its pure form, combined form with other drugs, combined form with degradation products, and in biological samples.

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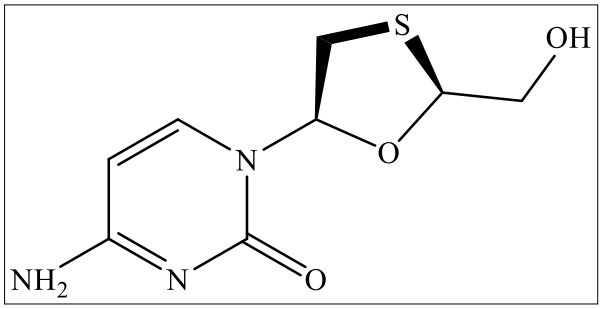
Introduction

Lamivudine

(LAM) is an analogue of cytidine. It can inhibit both types HIV-1 and HIV-2 reverse transcriptase and also the reverse transcriptase of hepatitis B virus. It is phosphorylated to active metabolites that compete for incorporation into viral DNA. They inhibit the HIV reverse transcriptase enzyme competitively and act as a chain terminator of DNA synthesis [1]. The lack of a 3'-OH group in the incorporated nucleoside analogue prevents the formation of the 5' to 3' phosphodiester linkage essential for DNA chain elongation, and therefore, the viral DNA growth is terminated [2].

As such, in this literature review, we will introduce most of up-to-date reported methods that have been developed for determination of LAM in its pure form, combined form with other drugs, combined form with degradation products, and in biological samples.



Review of Analytical Methods

Various techniques were used for the analysis of RIT in pure forms, in their pharmaceutical formulations and in biological fluids. The available reported methods in the literature can be summarized as follows:

1. Spectrophotometric Methods

Drugs	Method or reagent	λ_{max}	Ref
LAM and zidovudine	First drivative spectrphotometry	239.5 and 245.3 nm for LAM and 225.1 and 251.5 nm for zidovudine	[3]
LAM and stavudine	First drivative spectrphotometry	280 for stavudine and 300 nm for LAM.	[4]
LAM and stavudine	3-methyl-2-benzothiozolinone hydrazone hydrocloride and ferric chloride	660 nm for LAM and 630 nm for stavudine	[5]
LAM	chloramine-T and methyl orange, or chloramine-T and indigo carmine	520nm or 610nm	[6]
LAM and zidovudine	derivative spectrophotometry	246 nm for LAM and 263 nm for zidovudine	[7]
LAM	N HCl 0.1 N NaOH	279.6 nm 269.8 nm	[8]
Tenofovir, Disoproxil and LAM	Simultaneous equation method Multicomponent analysis Derivative spectroscopy method	247, 259 and 272 nm	[9]
LAM and zidovudine	Derivative Spectrophotometry	242, and 236 nm	[10]
LAM	methyl orange and indigocarmine	520n and 610 nm	[11]
LAM and zidovudine	UV spectroscopy and multivariate calibration	250 and 267 nm	[12]
LAM and efavirenz	overlain spectra method	271 and 247 nm	[13]
LAM	chloranilic acid and 2,3-dichloro-5,6-dicyano-1,4-benzoquinone	221 and 230 nm	[14]
LAM, nevirapine and zidovudine	overlain spectra method	280.2nm, 312nm and 266.8nm	[15]
LAM, Sofosbuvir, and Ritonavir	Silver nanoparticles synthesis	421 nm for Sofosbuvir and Ritonavir and at 425 nm for Lamivudine LAM	[16]

2. Chromatographic Methods

2.1. HPLC

Matrix	Column	Mobile phase	system	Ref
plasma	Aquasil C_{18} column	ACN : water (15:85 v/v)	HPLC–MS/MS	[17]
Tablet	Spherisorb® C_{18} analytical column	methanol: water: ACN (70:20:10 (v/v/v))	HPLC-UV 265 nm	[3]
plasma	a Shim-pack® C_8 column	Sodium dihydrogen phosphate monohydrate (10 mM): methanol: ACN (94:3:3, v/v/v, pH 4.8)	HPLC-UV 270 nm	[18]
plasma	Phenomenex C_8 column	A gradient elution with 20 mM ammonium acetate buffer with pH 4.5 : ACN	HPLC–MS/MS	[19]
Tablet	Symmetry C_{18} column	methanol: water (20:80 v/v)	HPLC-UV 270 nm	[4]
Tablet	C_{18} column	A gradient elution with 80% of 10 mM acetate buffer (pH 3.5): 20% methanol: 50% CAN: 50% isopropyl alcohol.	HPLC-UV 270 nm	[20]
Plasma and saliva	Zorbax SB-C_{18} column	0.005 M di potassium hydrogen phosphate solution in water (pH 6.8): methanol (92:8 v/v).	HPLC-UV 270 nm	[21]
Tablet	HiQ Sil C_{18} column	0.01 M potassium di hydrogen orthophosphate (pH 3.0): methanol (55:45 v/v)	HPLC-UV 272 nm	[22]
plasma	C_{18} column	a mixture of phosphate buffer (0.05 M) containing TEA (1 mL/L pH 3.5): methanol (91:9, v/v)	HPLC-UV 276 nm	[23]
plasma	Lichrospher® RP- C_{18} column	20 mM ammonium acetate: methanol containing 1% of acetic acid (60:40 v/v)	HPLC–MS/MS	[24]
plasma	a phenyl column with Phenomenex C_{18} guard column	5% methanol in 20 mM dibasic phosphate buffer (pH 6).	HPLC-UV 256 nm	[25]
plasma	octylsilane column	20 mM sodium phosphate buffer with (8 mM 1 octane sulfonic acid sodium salt): ACN (86:14, v/v)	HPLC-UV 265 nm	[26]
plasma	C_{18} analytical column	CAN: water (9:91, v/v)	HPLC-UV 271 nm	[27]
plasma	Aquasil C_{18} column	ACN: water (15:85, v/v)	HPLC–MS/MS	[28]
plasma	A Symmetry Shield RP C_{18} column	A gradient elution with acetate buffer (20 mM potassium acetate pH 4.60): ACN	HPLC-UV 260 nm	[29]
plasma	a Shiseido C_8 column	a gradient elution with methanol: water (80:20, v/v) and water, both containing 10 mM ammonium acetate	HPLC –MS/MS	[30]
Plasma	a Spherisorb® C_{18} analytical column	methanol: water (75 : 25, v/v)	HPLC-UV at 265 nm	[31]
Plasma	a C_{18} column	CAN: water (13:87, v/v)	HPLC-UV at 220 nm	[32]

Tablet	Thermo Hypersil Gold C_{18} column	Agradiant elution with 20 mM sodium phosphate buffer (pH 3.5) with phosphoric acid : methanol	HPLC-UV at 265 nm	[33]
Plasma	a C_{18} column	0.01M sodium dihydrogen phosphate : methanol: ACN (4 : 2 : 3 v/v/v)	HPLC-UV at 285 nm	[7]
Plasma	Phenyl column C_{18} column	ACN: 0.085% phosphoric acid (12:88, v/v)	HPLC-UV at 270 nm	[34]
Plasma	Aquasil® C_{18}	A gradient elution with 0.05% FA in either water or methanol	HPLC – MS/MS	[35]
Plasma	Zorbax® C_{18} column	methanol: water: phosphate buffer (pH 5.65) (80:10:10; v/v/v)	HPLC-UV at 275 nm	[36]
Plasma	A Phenomenex C18	Methanol: Water (85:15%v/v)	HPLC-UV at 270 nm	[37]
Plasma and tissues	a phenyl column	8% ACN in 5 mM 1-heptane sulfonic acid dissolved in 30 mM AF buffer (pH 3.3).	HPLC-UV at 254 nm	[38]
Plasma	a Vydac C_{18} column	A gradient elution, both CAN and ultrapure water solvents contained 0.2% FA.	HPLC – MS/MS	[39]
Rabbit plasma	Hypersil BDS C-18 column	0.25% Triethylamine buffer (pH 3.0): CAN (70:30, v/v)	HPLC-UV at 256 nm	[40]
Plasma	Zorbax SB C_8 column	A gradient elution with methanol: acetic acid sodium acetate buffer (pH 3.9)	HPLC-UV at 260 nm	[41]
Plasma	Prontosil C_{18} column	1 mM ammonium acetate in water (pH 6.5 ± 0.3): ACN (50:50 v/v)	HPLC – MS/MS	[42]
Plasma	A Chromolith C_{18} column	50 mM sodium dihydrogen phosphate : TEA (996:4 v/v)	HPLC-UV at 278 nm	[43]
Plasma	An ACE 5 CN column	0.5% FA in water: ACN (55:45, v/v)	HPLC – MS/MS	[44]
Rat tissue	a C_{18} column	methanol: 7.5 mM ammonium acetate (30:70, v/v)	HPLC – MS/MS	[45]
Plasma	Pack VP - ODS C_{18} column	phosphate buffer (pH7.0): ACN : methanol (91:0.1:9)	HPLC-UV at 274 nm	[46]
Plasma	a C_{18} column	A gradient with 0.1% FA in water and 0.1% FA in methanol	HPLC – MS/MS	[47]
Tablet	a C_{18} column	water: methanol (60:40 v/v)	HPLC-UV 270 nm	[48]
Plasma	A Phenomonex C_{18} column	A queous solution of 15% ACN and 0.1% acetic acid	HPLC – MS/MS	[49]
Tablet	A bondapak C_{18}	0.02 M tri-sodium citrate and methanol (70:30 v/v)	HPLC-UV at 266 nm	[50]
Tablet	A thermo BDS C_{18} column	A formic acid and methanol in the ratio of 50:50	HPLC-UV at 264 nm	[51]
Plasma	a C_8 column	A gradient elution with 10 mM potassium phosphate, 3% ACN, and methanol	HPLC-UV at 272 nm	[52]
Tablet	a Hypersil BDS, C_{18} column	o- phosphoric acid: methanol (70:30)	HPLC-UV at 220 nm	[53]
Plasma	A Peerless Basic C_{18} column	0.1% formic acid in water: methanol (15:85, v/v)	HPLC – MS/MS	[54]
Tablet	a C_{18} column	methanol and water (89:11 v/v)	HPLC-UV at 272 nm	[55]
Tablet	a Diamonsil C_{l8} column	0.025 mol ammonium acetate (pH 3.9 ± 0.1)-methanol (90:10).	HPLC-UV at 270 nm	[56]

Plasma	a C_{18} column	A gradient elution with 10 mM acetate buffer (pH 6.5)- ACN	HPLC-UV at 265 nm	[57]
Plasma	a Hypurity Advance C_{18}	ACN :0.1% FA (76:24, v/v)	HPLC – MS/MS	[58]
Tablet	A LunaC_{18}	A gradient elution with 50mM ammonium acetate buffer (pH = 6.8) and methanol	HPLC-UV at 265 nm	[59]
plasma	a Hypersil BDS, C18 column	0.1 M ammonium acetate buffer in 0.5% acetic acid, v/v and methanol (40:60, v/v)	HPLC-UV at 270 nm	[60]
Tablet	An YMC pack C_8 column	buffer pH 3.5: methanol (90:10 v/v)	HPLC-UV at 265 nm	[61]
Tablet	a Kromasil C_{18} analytical column	methanol: 10 mM phosphate buffer (pH 5.0) (70:30 v\v).	HPLC-UV at 254 nm	[62]
Tablet	A Luna C_{18}	0.1 % triethylamine (pH 5.11: ACN (70:30)	HPLC-UV at 245 nm	[63]
Tablet	a Luna hydrophilic interaction column	ACN /10 mM ammonium formate (95:5, v/v)	HPLC – MS/MS	[64]
Tablet	a C_{18} column	Agradient elution with 0.05 M Phosphate buffer (pH 6.2): ACN	HPLC-UV 260 nm	[65]
Tablet	A Phenomenex Luna C_{18} column	ACN : methanol: water 30: 45: 25 (v/v/v)	HPLC-UV 258 nm	[66]

2.2. HPTLC

Matrix	**Stationary phase**	**Mobile phase**	**detector**	**Ref**
Tablet	silica-gel 60 F_{254} plate	toluene/chloroform/methanol (1:6:3 v/v/v)	UV- 276 and 271 nm	[67]
Tablet	silica-gel 60 F_{254} plate	Acetone: chloroform: methanol (4: 4: 2 v/v/v)	UV- 265nm	[68]
Tablet	silica-gel 60 F_{254} plate	chloroform: methanol: toluene (8: 2: 2, v/v/v)	UV- 265nm	[69]
Tablet	silica-gel 60 F_{254} plate	ethyl acetate, methanol, toluene and conc ammonia (38.7:19.4:38.7:3.2, v:v:v:v)	UV- 254nm	[70]
Tablet	silica-gel 60 F254 plate	n-hexane: chloroform: methanol (1:7:2 v/v/v)	UV- 275 nm	[71]

Other Methods

Titremetry [6, 11], capillary electrophoresis [72, 73], chemometry [74], Voltamitry [75].

Conclusion

This literature review represents an up to date survey about all reported methods that have been developed for determination of the anticancer drug, lamivudine in its pure form, combined form with other drugs, combined form with degradation products, and in biological samples such as liquid chromatography, spectrophotometry, electrochemistry, etc...

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