EQUINE DRUG AND METABOLITE STANDARDS

by

Wojciech Karpiesiuk, Fritz Lehner, W. Edward Woods
and Thomas Tobin

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Lexington, KY 40546

EQUINE DRUG METABOLITES AND STANDARDS

The equine drug metabolites and standards listed in this document were synthesized and characterized by Dr. Wojciech Karpiesiuk of the Equine Pharmacology and Experimental Therapeutics Program in the Maxwell H. Gluck Equine Research Center, Department of Veterinary Science, College of Agriculture, University of Kentucky. These specification sheets present a total ion chromatogram of the specific substance, along with a full scan mass spectrum developed under appropriate mass spectral conditions. The mass spectral analyses were largely performed by Dr. Fritz Lehner. For all of these compounds ^{1}H-nmr spectra, (200MHz), ^{13}CNMR spectra (50 MHz), FT-IR spectra are available and, for many of them, DSC thermograms. Stability studies relevant to standard laboratory procedures are available for some of these agents and were carried out by Mr. Ed Woods.

Synthesis of these agents was made possible by support from the Florida Division of the Horsemen's Benevolent and Protective Association, The National Horsemen's Benevolent and Protective Association and the Kentucky Equine Drug Council and the Kentucky Racing Commission.

A bibliography of research papers based on these metabolites or relevant to these metabolites is presented in the appendix.

This communication is publication #352 from the Equine Pharmacology and Experimental Therapeutics Program in the Maxwell H. Gluck Equine Research Center, Department of Veterinary Science, University of Kentucky.

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Feb-25-1998

No.	DRUG	METABOLITE/ DEUTERATED STANDARD	REMARKS
1.	LIDOCAINE	3-HYDROXYLIDOCAINE	metabolite
2.	MEPIVACAINE	3-HYDROXYMEPIVACAINE	metabolite
3.	BUPIVACAINE	3-HYDROXYBUPIVACAINE	metabolite
4.	ROPIVACAINE	3-HYDROXYROPIVACAINE (in prep)	metabolite
5.	PYRILAMINE	O-DESMETHYLPYRILAMINE	metabolite
6.	ACEPROMAZINE	2-(1-HYDROXYETHYL)PROMAZINE SULFOXIDE	metabolite
7.	ACEPROMAZINE	(1-HYDROXYETHYL)PROMAZINE (uncrystallized)	metabolite
8.	PROMETHAZINE	PROMETHAZINE SULFOXIDE	metabolite
9.	PROMAZINE	3-OH-PROMAZINE	metabolite
10.	PROPIONYLPROMAZINE	2-(1-HYDROXYPROPYL)PROMAZINE SULFOXIDE	metabolite
11.	PROPRANOLOL	4-OH-PROPANOLOL	metabolite
12.	MAZINDOL	2-(2-AMINOETHYL)-3-(4-CHLOROPHENYL)-3-HYDROXY-2,3-DIHYDRO-ISOINDOL-1-ONE	metabolite
13.	TRIPELENNAMINE	3-OH-TRIPELENNAMINE	drug derivative
14.	PHENYLBUTAZONE	PHENYLBUTAZONE-D_9	deuterated standard
15.	PROCAINE	PROCAINE-D_{10}	deuterated standard
16.	FUROSEMIDE	FUROSEMIDE-D_5	deuterated standard

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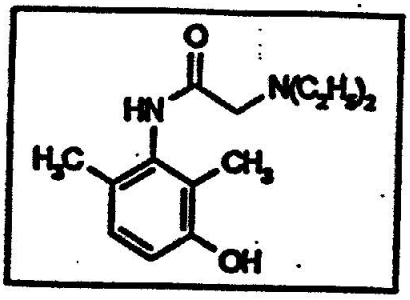
EQUINE METABOLITE STANDARD



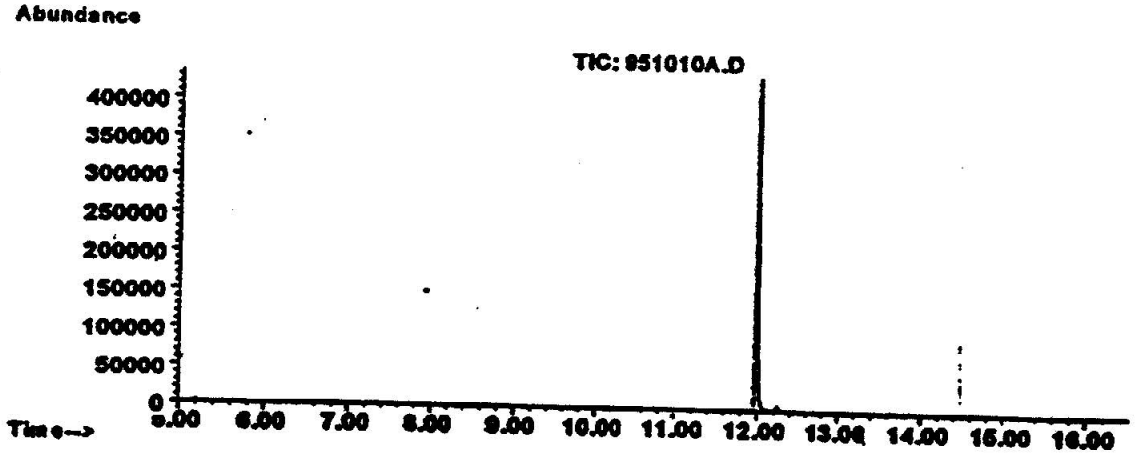
3-HYDROXYLIDOCAINE (lidocaine metabolite)

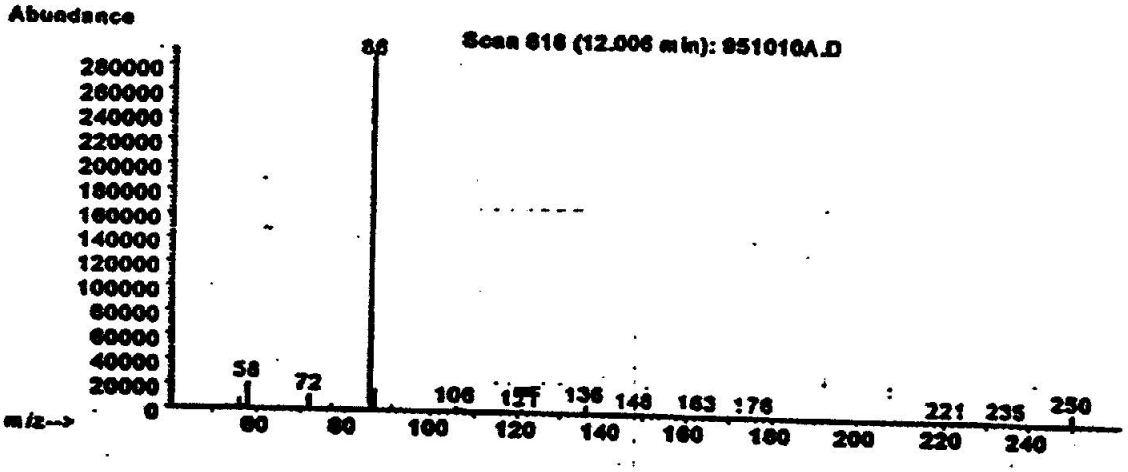
CAS Name: acetamide, 2-diethylamino-N-(3-hydroxy-2,6-dimethylphenyl)-
CAS No.: [34604-55-2]
Molecular Formula: $C_{14}H_{22}N_2O_2$
Molecular Mass: 250.34 g/mol

LOT # LID 0995 Date: 10-10-95

Properties: colorless crystals (from acetone)
Solubility: soluble in methanol
Estimated Purity: 98 %
Melting point: 205-206 °C
Storage: store below room temperature
Quantity: 1 mg

GC/MS data: column 30 m x 0.25 mm x 0.25 µm HP 5MS; temperature 70-280°C at 20 °C/min; flow rate 1 ml/min He; injection: splitless





^{1}H-nmr spectrum (300 MHz, $CDCl_3$), ^{13}C-nmr spectrum (50 MHz, DMSO-d_6), FT-IR spectrum and DSC thermogram available upon request.

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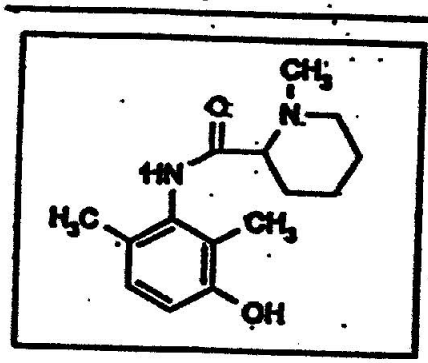
EQUINE METABOLITE STANDARD



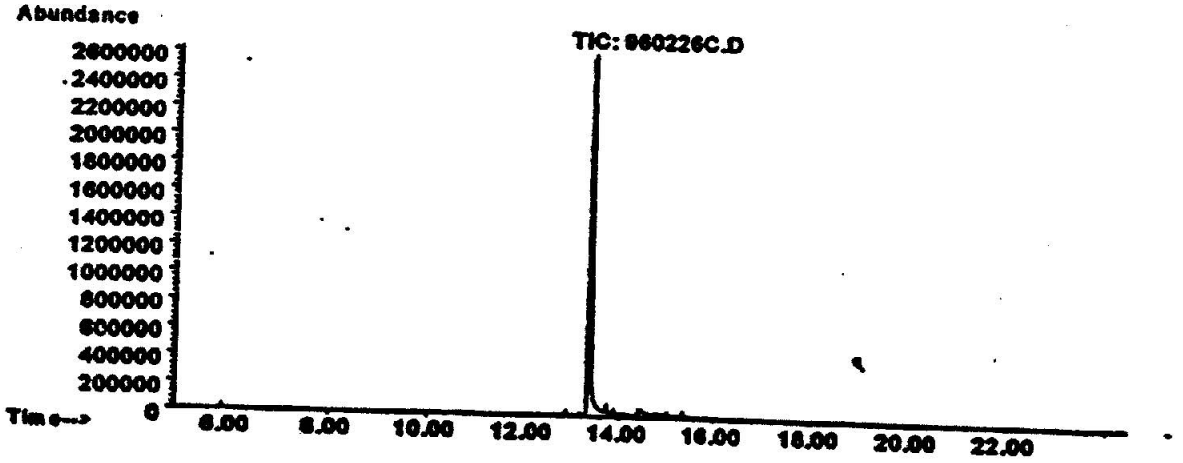
3-HYDROXYMEPIVACAINE (mepivacaine metabolite)

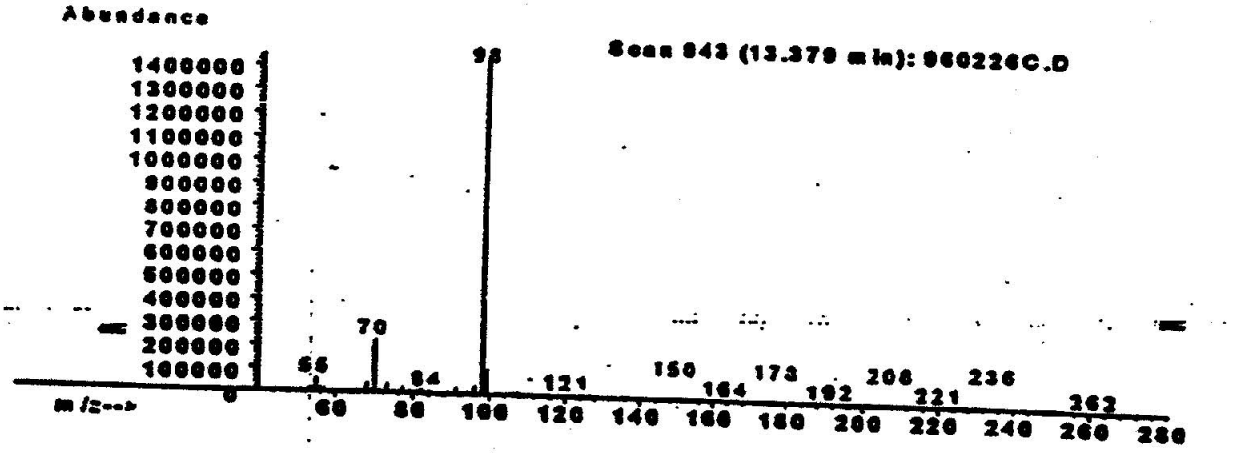
CAS Name: 2-piperidinecarboxamide, N-(3-hydroxy-2,6-dimethylphenyl)-1-methyl-
CAS No.: [37055-90-6]
Molecular Formula: $C_{15}H_{22}N_2O_2$
Molecular Mass: 262.35 g/mol

LOT # MEP 0296 Date: 02-26-96

Properties: white powder
Solubility: soluble in methanol
Estimated Purity: 98 %
Melting point: 194-197 °C
Storage: store below room temperature
Quantity: 1 mg

GC/MS data: column 30 m x 0.25 mm x 0.25 µm HP 5MS; temperature: 70-280°C at 20 °C/min; flow rate 1 ml/min He; injection: splitless





^{1}H-nmr spectrum (200 MHz, $CDCl_3$), ^{13}C-nmr spectrum (50 MHz, $CDCl_3$), FT-IR spectrum and DSC thermogram available upon request

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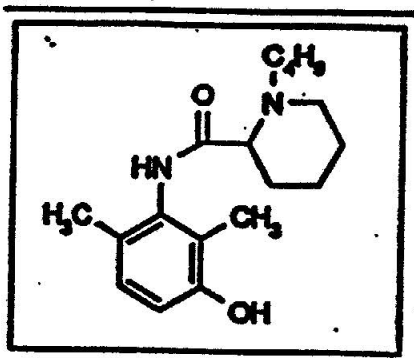
EQUINE METABOLITE STANDARD



3-HYDROXYBUPIVACAINE (bupivacaine metabolite)

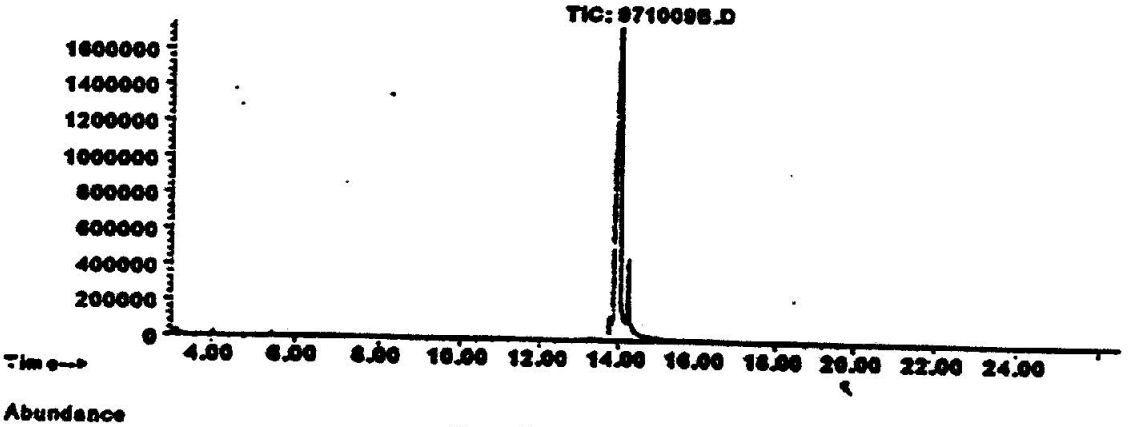
CAS Name: 2-piperidinecarboxamide, 1-butyl-*N*-(3-hydroxy-2,6-dimethylphenyl)-
CAS No.: [51989-46-9]
Molecular Formula: $C_{18}H_{28}N_2O_2$
Molecular Mass: 304.43 g/mol

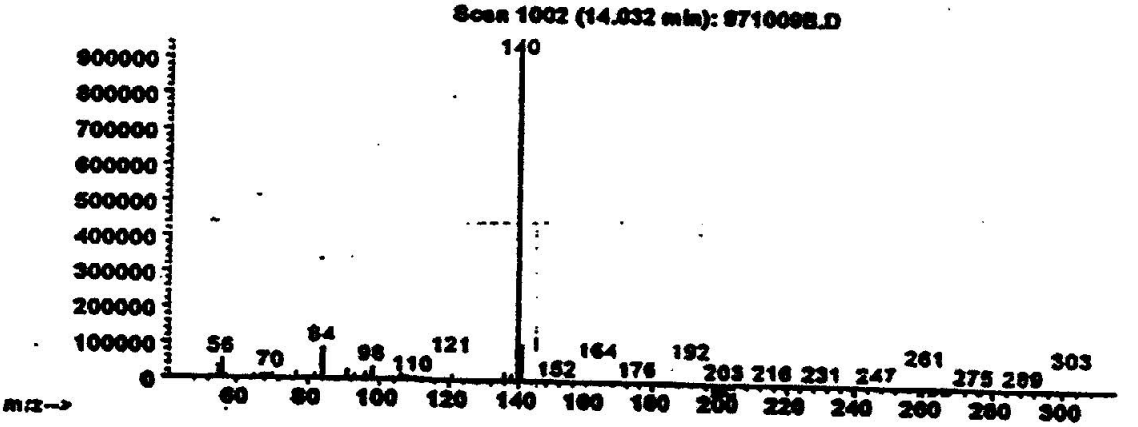
LOT # BUP 0597 **Date: 05-20-97**

Properties: white crystals
Solubility: soluble in methanol
Estimated Purity: 97 %

Melting point: 194-195 °C
Storage: store below room temperature
Quantity: 1 mg

GC/MS data: column 30 m x 0.25 mm ID 0.25 µm HP 5MS; temperature 70-280°C at 20 °C/min; flow rate 1 ml/min He; injection: splitless





^{1}H-nmr spectrum (200 MHz), ^{13}C-nmr spectrum (50 MHz), FT-IR spectrum and DSC thermogram available upon request.

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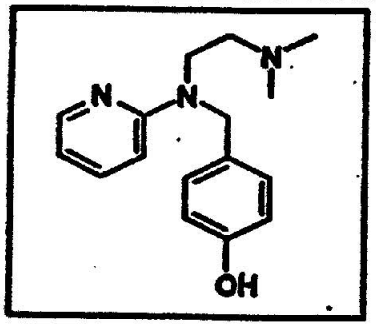
EQUINE METABOLITE STANDARD



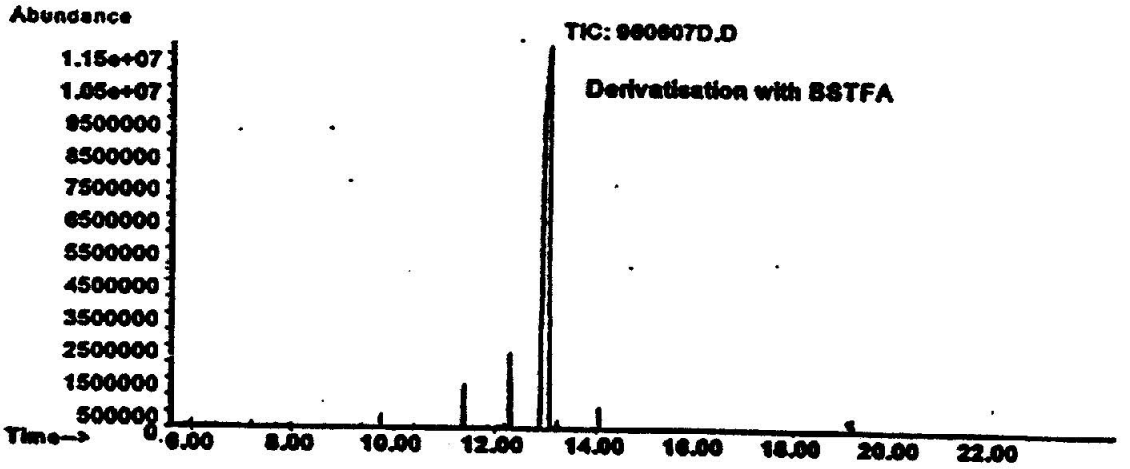
O-DESMETHYLPYRILAMINE (pyrilamine metabolite)

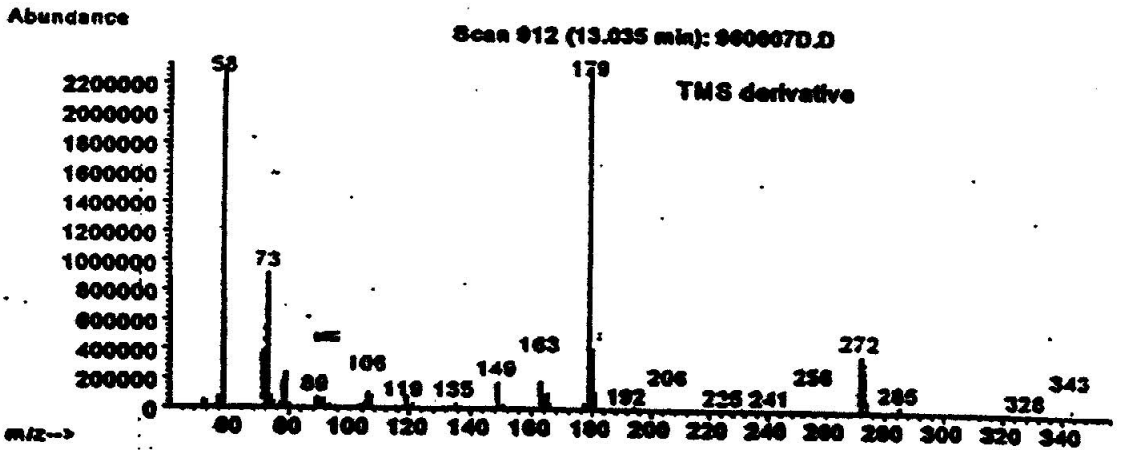
CAS Name: phenol, 4-[[[2-(dimethylamino)ethyl]-2-pyridinylamino]methyl]-
CAS No.: [57830-29-2]
Molecular Formula: $C_{14}H_{21}N_3O$
Molecular Mass: 271.36 g/mol

LOT # DMP 0596 Date: 06-06-96

Properties: white powder
Solubility: soluble in methanol
Estimated Purity: 97 %
Melting point: 119-120°C
Storage: store below room temperature
Quantity: 1 mg

GC/MS data: column 30 m H 0.25 mm H 0.25 lm HP 5MS; temperature: 70-280°C at 20 °C/min; flow rate 1 ml/min He; injection: splitless





^{1}H-nmr spectrum (200 MHz, $CDCl_3$), ^{13}C-nmr spectrum (50 MHz, $CDCl_3$), FT-IR spectrum and DSC thermogram available upon request

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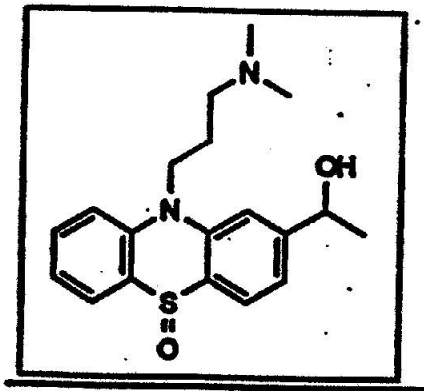
EQUINE METABOLITE STANDARD



2-(1-HYDROXYETHYL)PROMAZINE SULFOXIDE (HEPS, acepromazine metabolite)

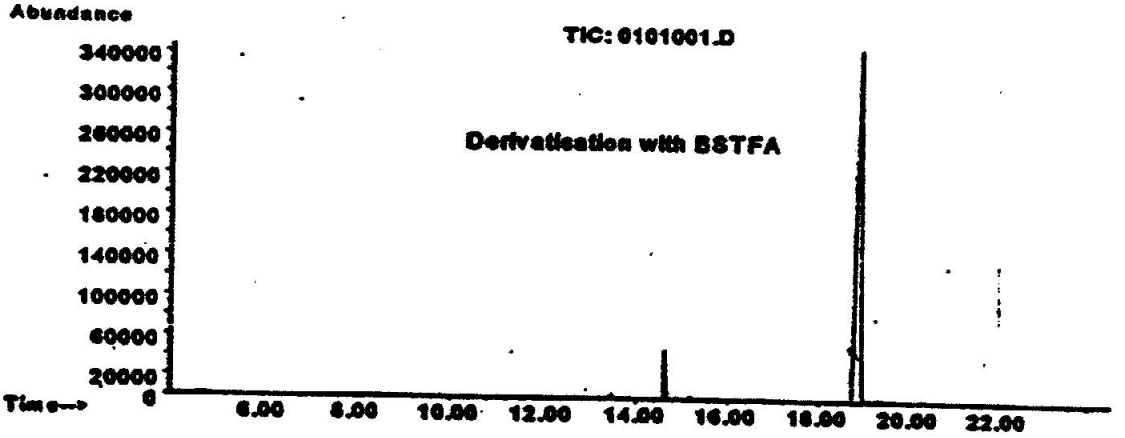
CAS Name: 10*H*-phenothiazine-2-methanol, 10-[3-(dimethylamino)-propyl]-α-methyl-5-oxide-
CAS No.: [73644-42-5]
Molecular Formula: $C_{19}H_{24}N_2O_2S$
Molecular Mass: 344.47 g/mol

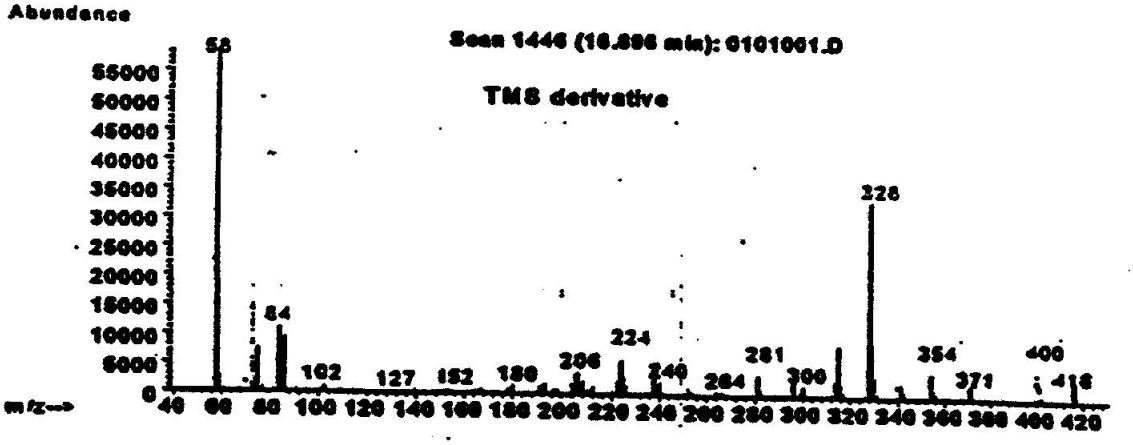
LOT # HEPS 0796 Date: 07-30-96

Properties: white powder.
Solubility: soluble in methanol
Estimated Purity: >97 %

Storage: store below room temperature
Quantity: 1 mg

GC/MS data: column 30 m x 0.25 mm x 0.25 μm HP 5MS; temperature: 70-280°C at 20 °C/min; flow rate 1 ml/min He; injection: splitless





^{1}H-nmr spectrum (200 MHz, $CDCl_3$), ^{13}C-nmr spectrum (50 MHz, $CDCl_3$) and FT-IR spectrum available upon request

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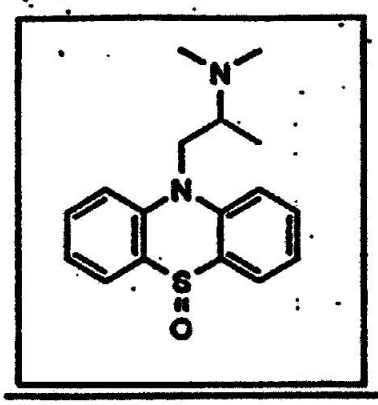
EQUINE METABOLITE STANDARD



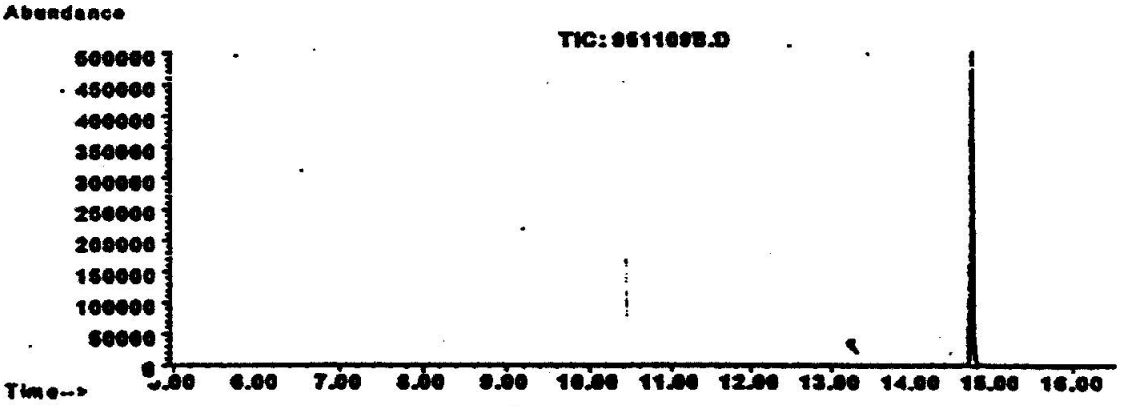
PROMETHAZINE SULFOXIDE (promethazine metabolite)

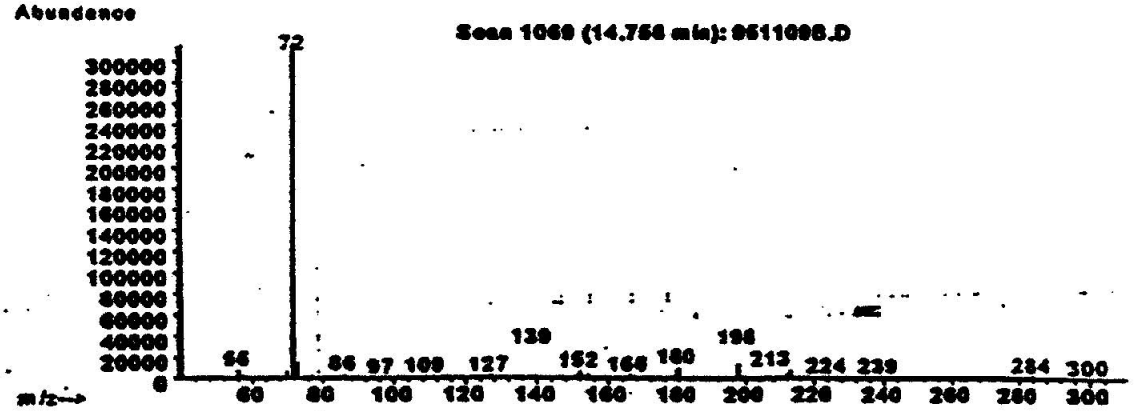
CAS Name: 10*H*-phenothiazine-10-ethanamine, *N*, *N*, α-trimethyl-5-oxide-
CAS No.: [7640-51-9]
Molecular Formula: $C_{17}H_{20}N_2OS$
Molecular Mass: 300.42 g/mol

LOT # PMSO 0796 **Date: 11-09-95**

Properties: colorless crystals (ethyl ether - hexane)
Solubility: soluble in methanol
Estimated Purity: 99%
Melting point: 118-120 °C
Storage: store below room temperature
Quantity: 1 mg

GC/MS data: column 30 m x 0.25 mm x 0.25 μm HP 5MS; temperature: 70-280°C at 20 °C/min; flow rate 1 ml/min He; injection: splitless





^{1}H-nmr spectrum (200 MHz, $CDCl_3$), ^{13}C-nmr spectrum (50 MHz, $CDCl_3$) and FT-IR spectrum available upon request

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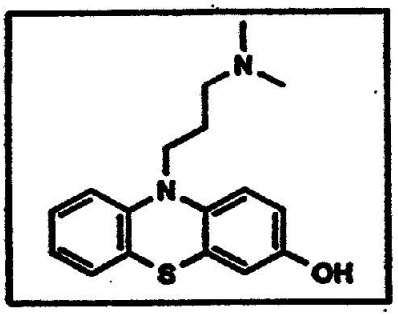
EQUINE METABOLITE STANDARD



3-HYDROXYPROMAZINE (promazine metabolite)

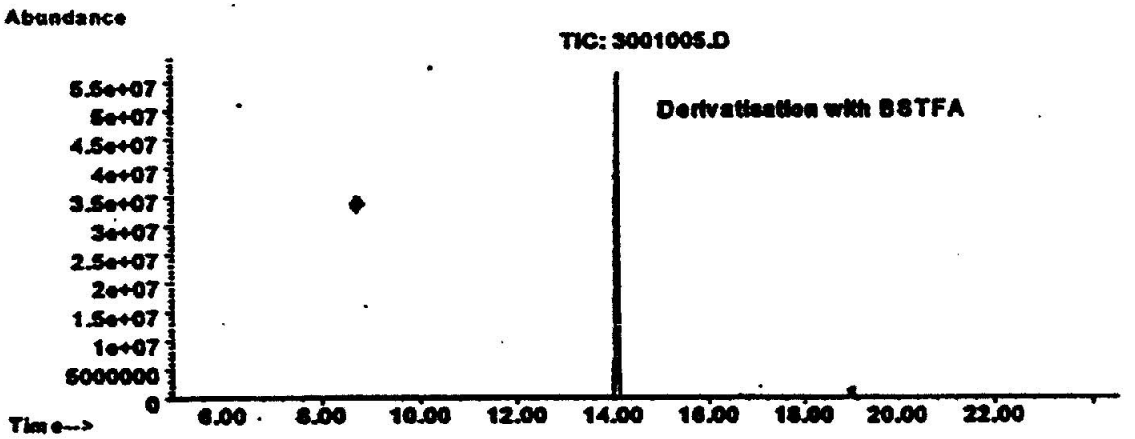
CAS Name: 10*H*-phenothiazine-3-ol, 10-[3-(dimethylamino)propyl]-

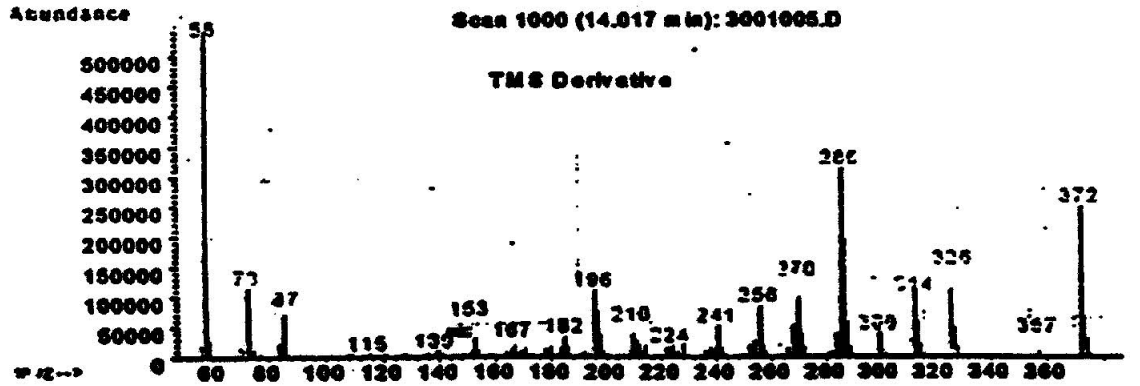
CAS No.: [316-85-8]
Molecular Formula: $C_{17}H_{20}N_2OS$
Molecular Mass: 300.42 g/mol

LOT # 3HPM 1196 **Date: 10-07-97**

Properties: very sensitive to light
Solubility: soluble in methanol
Estimated Purity: >97 %
Storage: store below room temperature in a dark place
Quantity: 1 mg

GC/MS data: column 30 m x 0.25 mm x 0.25 µm HP 5MS; temperature: 70-280°C at 20 °C/min; flow rate 1 ml/min He; Injection: splitless





^{1}H-nmr spectrum (300 MHz, $CDCl_3$), ^{13}C-nmr spectrum (50 MHz, $CDCl_3$) and FT-IR spectrum available upon request

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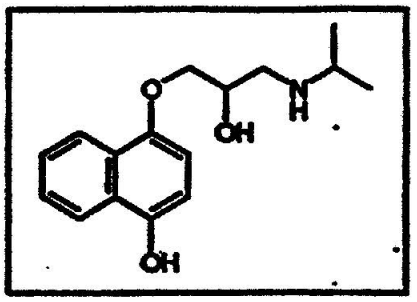
EQUINE METABOLITE STANDARD



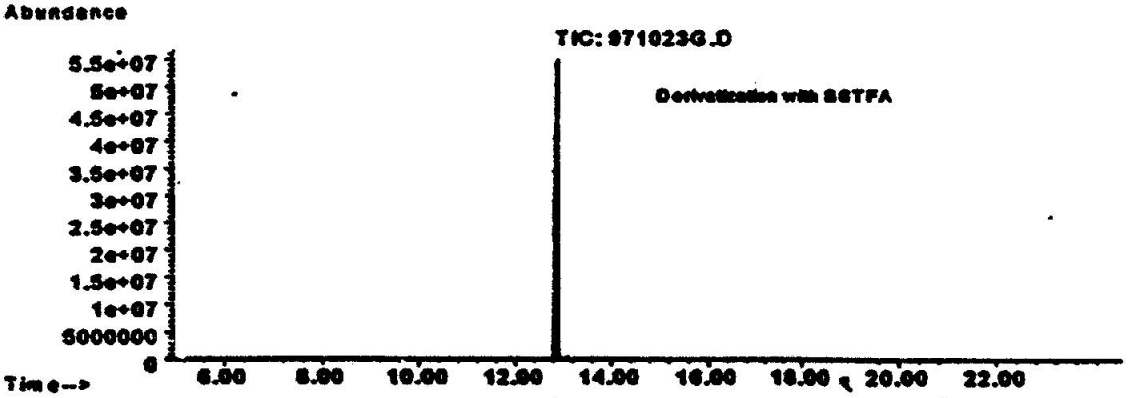
4-HYDROXYPROPRANOLOL (propranolol metabolite)

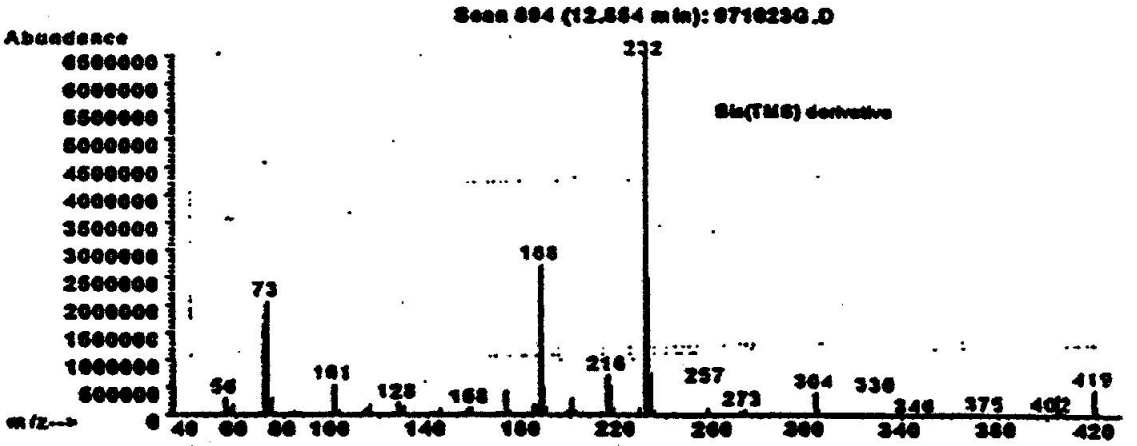
CAS Name: 1-naphtalenol, 4-[2-hydroxy-3-[(1-methylethyl)-amino]propoxy]-
CAS No.: [10476-53-6]
Molecular Formula: $C_{16}H_{21}NO_3$
Molecular Mass: 275.35 g/mol

LOT # HPR 1296 **Date: 12-16-96**

Properties: brownish powder
Solubility: soluble in methanol
Estimated Purity: 99 %
Melting point: 137-141 °C (decomp.)
Storage: store below room temperature
Quantity: 1 mg

GC/MS data: column 30 m × 0.25 mm × 0.25 μm HP 5MS; temperature 70-280°C at 20°C/min; flow rate 1 mL/min He; injection: splitless





^{1}H-nmr spectrum (200 MHz, DMSO-d_6), ^{13}C-nmr spectrum (50 MHz, DMSO-d_6), FT-IR spectrum (KBr) and DSC thermogram available upon request.

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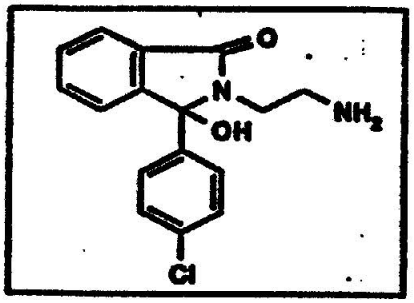
EQUINE METABOLITE STANDARD



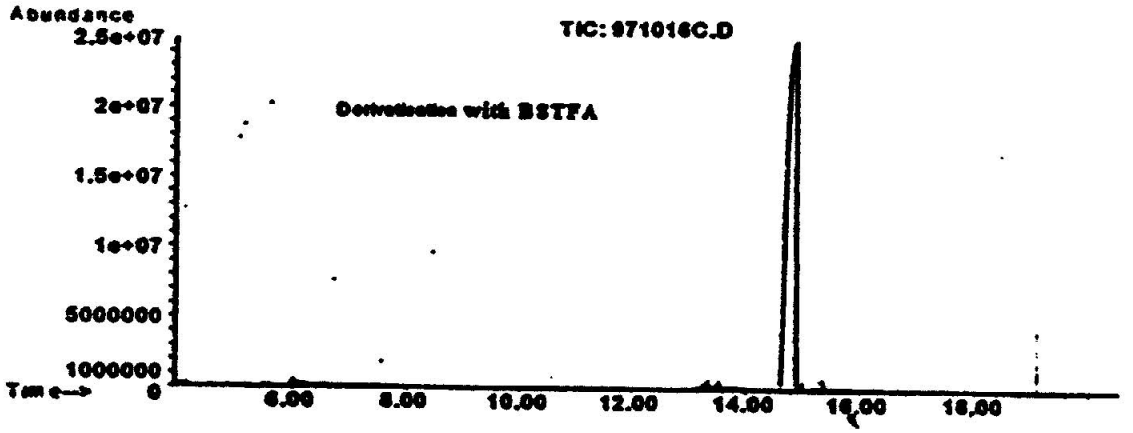
MAZINDOL METABOLITE

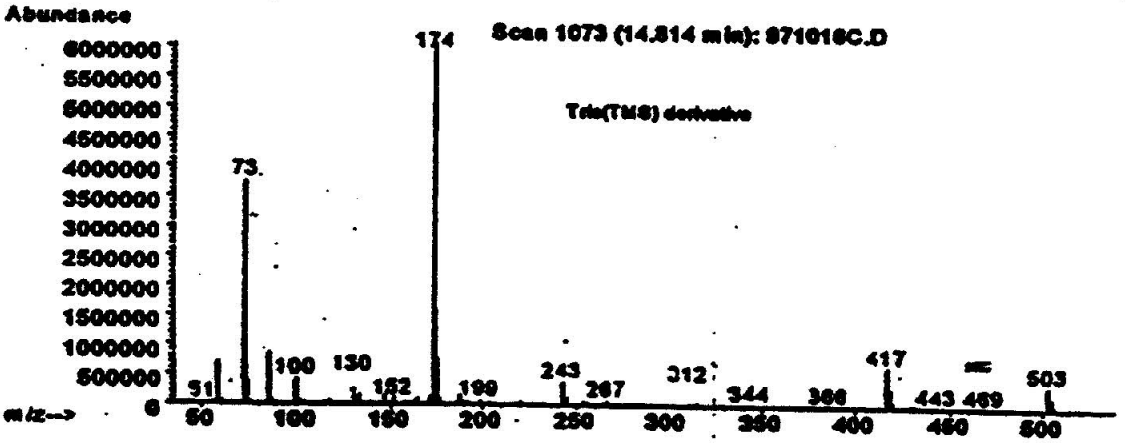
CAS Name: 2*H*-isoindol-3-ol, 2-(2-aminopropyl)-3-(p-chloro-phenyl)-1,3-dihydro-1-oxo-
CAS No.: [5983-84-6]
Molecular Formula: $C_{15}H_{13}ClN_2O_2$
Molecular Mass: 302.76 g/mol

LOT # MAZ 0196 **Date: 01-23-96**

Properties: white powder
Solubility: soluble in methanol
Estimated Purity: 98 %
Melting point: 171-172 °C
Storage: store below room temperature
Quantity: 1 mg

GC/MS data: column 30 m x 0.25 mm x 0.25 µm HP 5MS; temperature 70-280°C at 20 °C/min; flow rate 1 ml/min He; injection: splitless





^{1}H-nmr spectrum (300 MHz, $CDCl_3$), ^{13}C-nmr spectrum (50 MHz, $CDCl_3$), FT-IR spectrum and DSC thermogram available upon request

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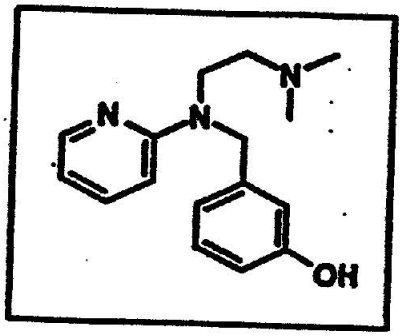
EQUINE MEDICATION DERIVATIVE



3-OH-TRIPELENNAMINE

CAS Name: phenol, 3-[[2-(dimethylamino)ethyl]-2-pyridinylamino]methyl]-
CAS No.: [not registered as yet]
Molecular Formula: $C_{16}H_{21}N_3O$
Molecular Mass: 271.36 g/mol

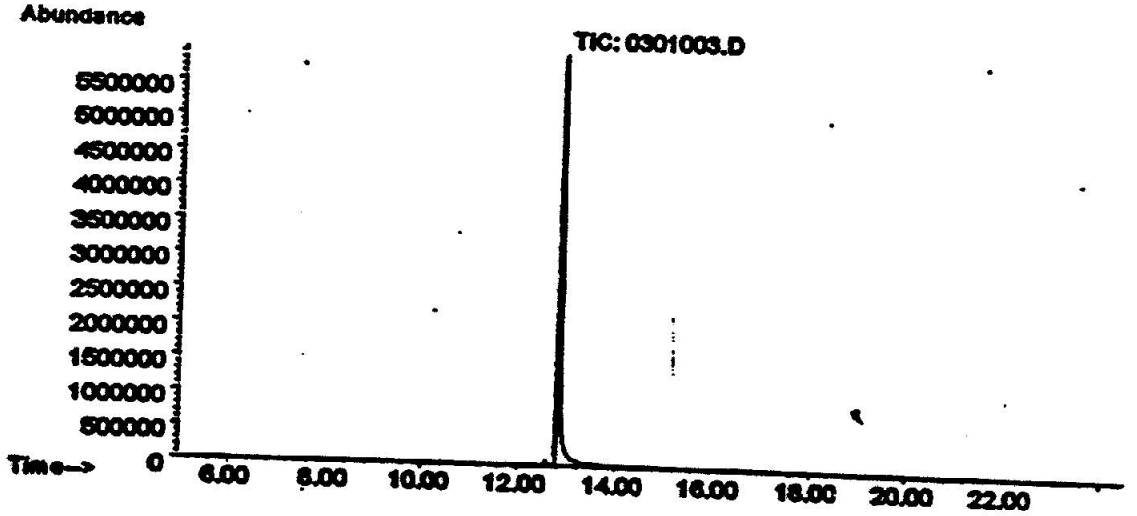
LOT # TPA 0596

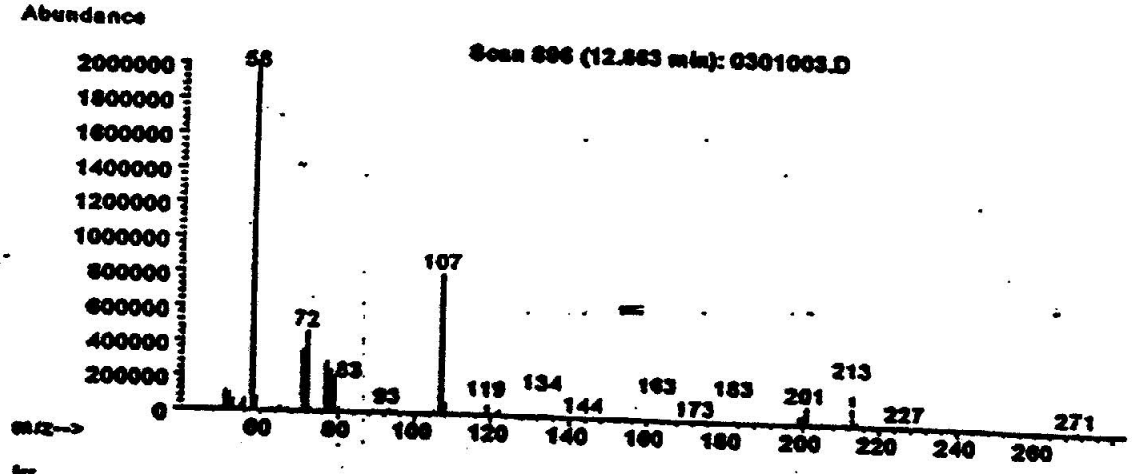
Date: 05-10-96

Properties: white powder
Solubility: soluble in methanol
Estimated Purity: 99 %

Melting point: 126-127 °C
Storage: store below room temperature
Quantity: 1 mg

GC/MS data: column 30 m × 0.25 mm × 0.25 μm HP 5MS; temperature: 70-280°C at 20 °C/min; flow rate 1 ml/min He; injection: splitless





^{1}H-nmr spectrum (200 MHz, $CDCl_3$), ^{13}C-nmr spectrum (50 MHz, $CDCl_3$), FT-IR spectrum and DSC thermogram available upon request

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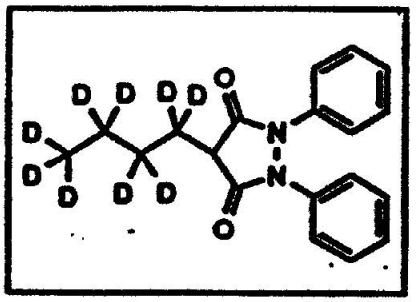
EQUINE MEDICATION DEUTERATED STANDARD



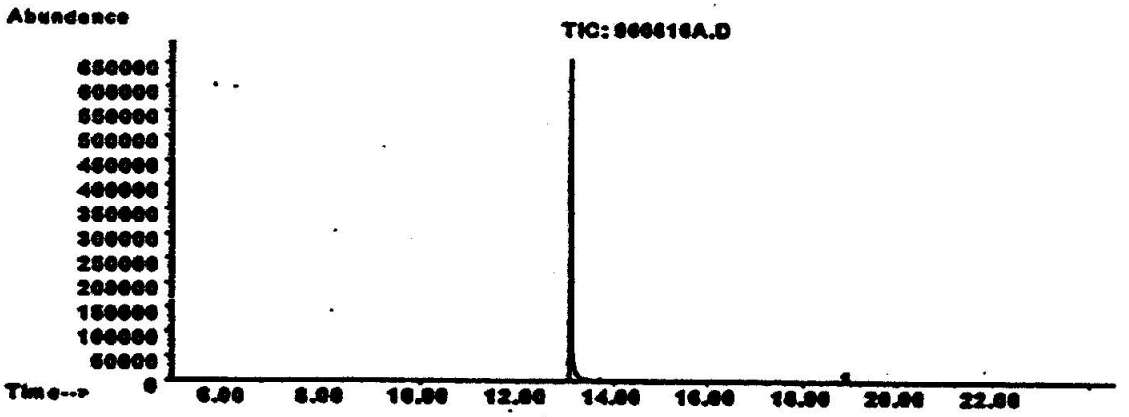
PHENYLBUTAZONE-D_9

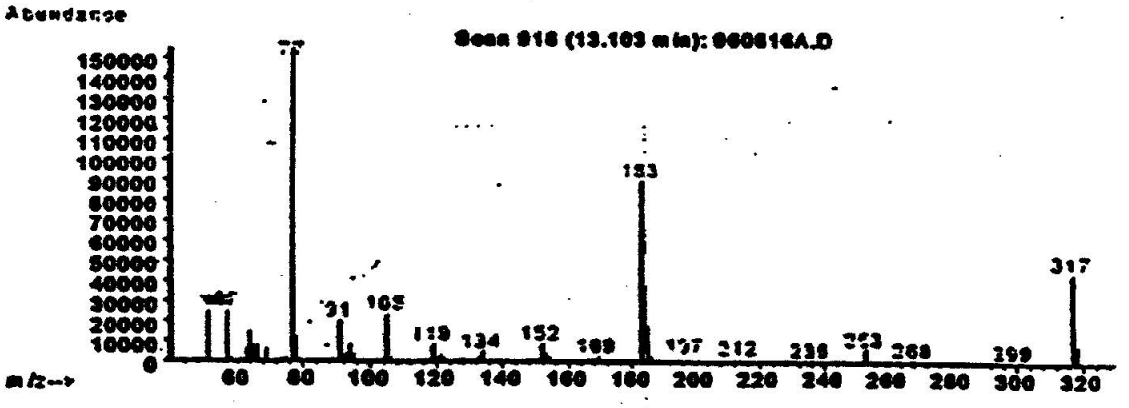
Name: 3,5-Pyrazolidinedione, 4-butyl-d_9-1,2-diphenyl-
CAS No.: [not registered]
Molecular Formula: $C_{19}H_{11}D_9N_2O_2$
Molecular Mass: 317.43 g/mol

LOT # PB-D 0396 **Date: 08-16-96**

Properties: white crystals	Melting point: 105 °C
Solubility: soluble in methanol	Storage: store below room temperature
Estimated Purity: 99 %	Quantity: 1 mg

GC/MS data: column 30 m × 0.25 mm × 0.25 µm HP 5MS; temperature 70-280°C at 20 °C/min; flow rate 1 ml/min He; injection: splitless





^{1}H-nmr spectrum (200 MHz, $CDCl_3$), ^{13}C-nmr spectrum (50 MHz, $CDCl_3$), FT-IR spectrum (KBr) and DSC thermogram available upon request

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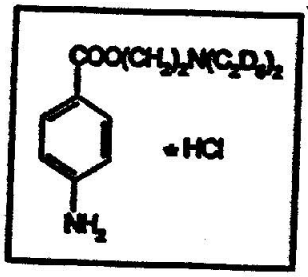


PROCAINE-D_{10} HYDROCHLORIDE

Name: Benzoic acid, 4-amino-, 2-(diethyl-d_{10}-amino)ethyl ester, monohydrochloride
CAS No.: [not registered]
Molecular Formula: $C_{13}H_{10}D_{10}N_2O_2 \cdot HCl$
Molecular Mass: 282.84 g/mol (free base 246.37 g/mol)

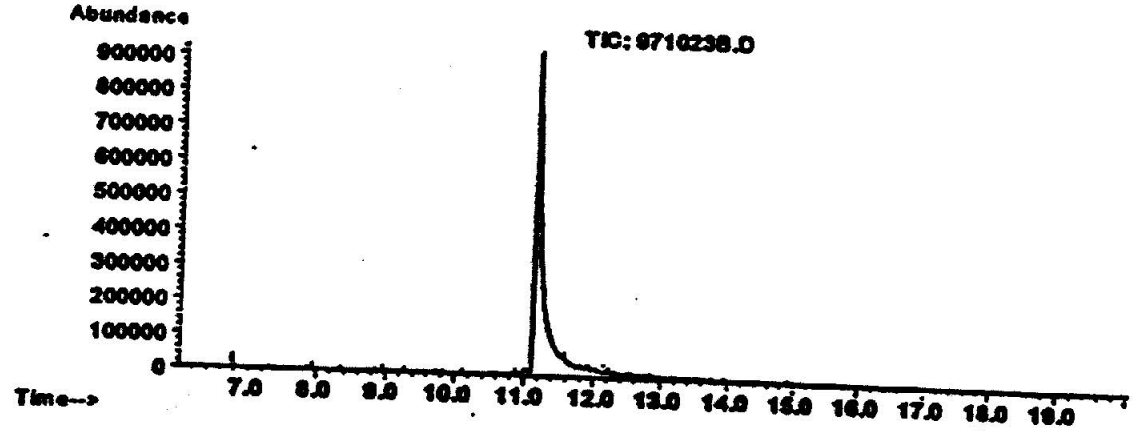
LOT # PROC-D 0997

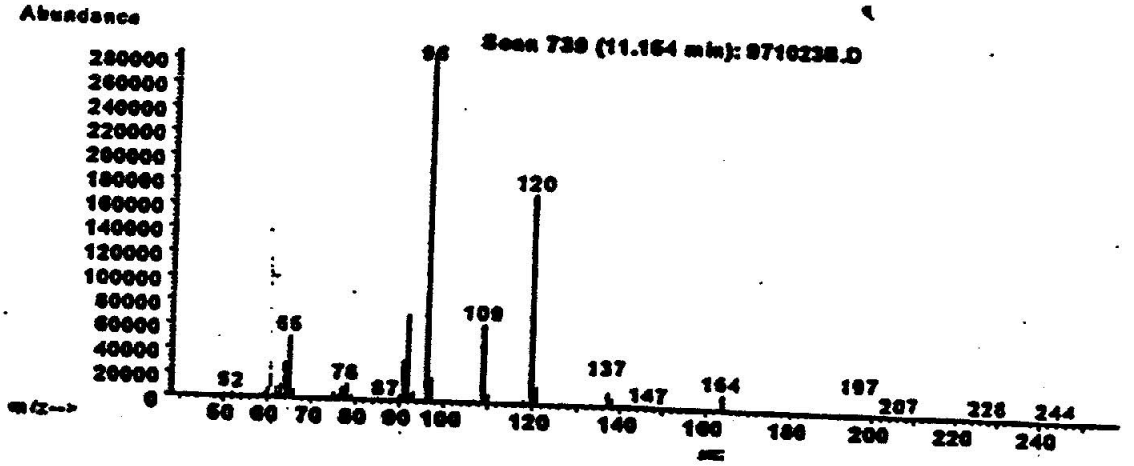
Date: 09-23-96

Properties: white crystals
Solubility: soluble in methanol
Estimated Purity: 99 %

Melting point: 153-154 °C (from ethanol)
Storage: store below room temperature
Quantity: 1 mg

GC/MS data: column 30 m × 0.25 mm × 0.25 µm HP 5MS; temperature: 70-280 °C at 20 °C/min; flow rate 1 ml/min He; Injection: splitless





^{1}H-nmr spectrum (200 MHz), FT-IR spectrum and DSC thermogram available upon request

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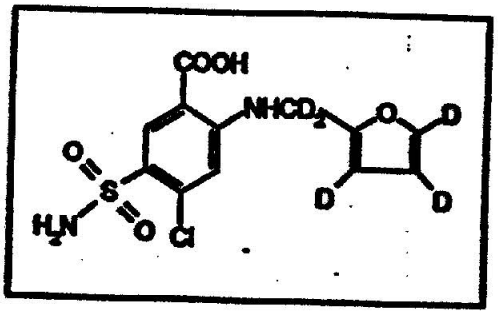
EQUINE MEDICATION DEUTERATED STANDARD



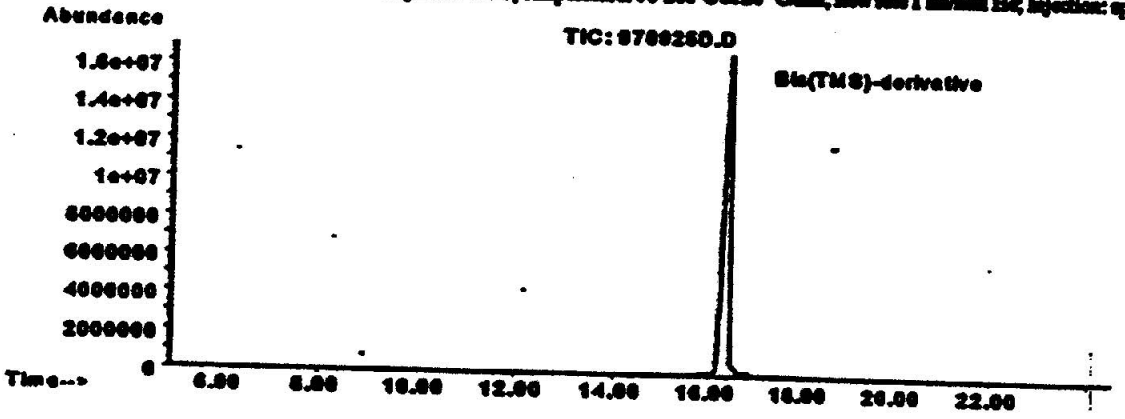
FUROSEMIDE-D_5

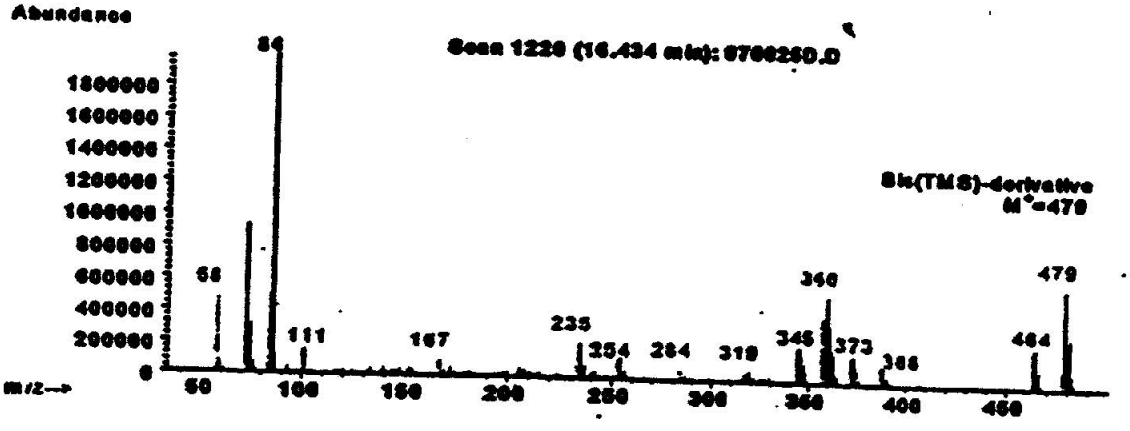
Name: Benzoic acid, 5-(aminosulfonyl)-4-chloro-2-[(2-furanyl-d_3-methyl-d_2)amino]-
CAS No.: [not registered]
Molecular Formula: $C_{12}H_6D_5ClN_2O_5S$
Molecular Mass: 335.78 g/mol

LOT # FUR-D 0997 Date: 09-23-96

Properties: white crystals
Solubility: soluble in methanol
Estimated Purity: 85 % D_5 + 14 % D_4
Melting point: 207-208 °C (from ethanol-water)
Storage: store below room temperature
Quantity: 1 mg

GC/MS data: column 30 m x 0.25 mm x 0.25 µm HP 5MS; temperature: 70-280°C at 20 °C/min; flow rate 1 ml/min He; injection: splitless





^{1}H-nmr spectrum (200 MHz, DMSO-d_6), ^{13}C-nmr spectrum (50 MHz, DMSO-d_6), FT-IR spectrum and DSC thermogram available upon request

BIBLIOGRAPHY

1) Lidocaine (metabolite: 3-hydroxylidocaine)

Thomas, J. and Meffin P., "Aromatic hydroxylation of lidocaine and mepivacaine in rats and humans", *J. Med. Chem.*, 15 (1972), 1046-1049.

2) Mepivacaine (metabolite: 3-hydroxymepivacaine)

Thomas, J. and Meffin P., "Aromatic hydroxylation of lidocaine and mepivacaine in rats and humans", *J. Med. Chem.*, 15 (1972), 1046-1049.

3)* Bupivacaine (metabolite: 3-hydroxybupivacaine) *(only analytical data)

Bouche, R. and Lhoest, G., "Isolation and identification by mass spectrometry of metabolites of bupivacaine", *Pharm. Acta Helv.*, 51 (1976), 223-225

4) Ropivacaine

There is no data about synthesis of 3-hydroxyropivacaine in the literature

5) Acepromazine [metabolite: 2-(1-hydroxyethyl)promazine sulfoxide - HEPS]

Dewey, E. A.; Maylin, G.A.; Ebel, J. G.; Henion, J. D., "The metabolism of promazine and acetylpromazine in the horse", *Drug Metab. Dispos.* 1981, 9(1), 30-36.

6) Propranolol (metabolite: 4-hydroxypropanolol)

Oatis, J. E.; Russell, M. P.; Knapp, D. R.; Walle, T., "Ring-hydroxylated propranolol: synthesis and β-receptor antagonist and vasodilating activities of the seven isomers", *J. Med. Chem.* 1981, 24, 309-314.

7) Promethazine (metabolite: promethazine sulfoxide)

Sackett, P. H.; Mayansky, J. S.; Smith, T.; Kahn, S; McCreery, R. L.; *J. Med. Chem.* 24 (1981) 1342-1347.

8) Promazine (metabolite: 3-hydroxypromazine)

8.1)Dewey, E. A.; Maylin, G.A.; Ebel, J. G.; Henion, J. D.,"The metabolism of promazine and acetylpromazine in the horse", *Drug Metab. Dispos.* 1981, 9(1), 30-36.

8.2)Craig, J. Cymerman; Kray, L. R.,"Synthesis, characterization and properties of phenolic derivatives of some phenothiazines", *Agressologie* 1968, 9 (1), 55-58.

9) **Analytical/Pharmacological References:**

9) Harkins, J.D., S. Stanley, G.D. Mundy, R.A. Sams, W.E. Woods, and T. Tobin. A review of the pharmacology, pharmacokinetics, and regulatory control in the US of local anesthetics in the horse. J.Vet.Pharmacol.Therap. 18, 397-406, 1995

10) Harkins, J.D., G.D. Mundy, S. Stanley, W.E. Woods, W.A. Rees, K.N. Thompson, and T. Tobin. Determination of highest no-effect doses (HNEDs) for local anesthetic responses to procaine, cocaine, bupivacaine, and benzocaine. Eq.Vet.J. 28, 30-37, 1996.

11) Harkins, J.D., G.D. Mundy, S. Stanley, W.E. Woods, J. Boyles, R.A. Arthur, R.A. Sams, and T. Tobin. Regulatory significance of procaine residues in plasma and urine samples: A preliminary communication. Eq.Vet.J. 28, 121-125, 1996.

12) Harkins, J.D., Mundy, G.D., Stanley, S.D., Sams, R.A., and Tobin, T. Lack of local anesthetic efficacy of Sarapin in the abaxial sesamoid block model. J.Vet.Pharmacol.Therap. 20, 229-232, 1997.

13) Harkins, J.D., Mundy, G.D., Woods, W.E., Lehner, A., Karpiesiuk W., Rees, W.A., Dirikolu, L,. Bass, S., Carter, W.G., Boyles, J., and Tobin, T. Lidocaine: Pharmacological effects and their relationship to analytical findings (Submitted to J. Vet. Pharmacol. Therap.)

14) Harkins, J.D., Mundy, G.D., Karpiesiuk W., Woods, W.E., Lehner, A., Rees, W.A., Dirikolu, L,. Bass, S., Carter, W.G., Boyles, J., and Tobin, T. Mepivacaine: Its pharmacological effects and their relationship to analytical findings in the horse (Submitted to J. Vet. Pharmacol. Therap.)

15) Harkins, J.D., Karpiesiuk W., Woods, W.E., Lehner, A., Rees, W.A., Dirikolu, L,. Bass, S., Carter, W.G., Boyles, J., and Tobin, T. Bupivacaine: Its pharmacological effects and their relationship to analytical findings in the horse (Submitted to J. Vet. Pharmacol. Therap.)

16) Harkins, J.D., Karpiesiuk W., Woods, W.E., Lehner, A., Rees, W.A., Dirikolu, L,. Bass, S., Carter, W.G., Boyles, J., and Tobin, T. Ropivacaine: Its pharmacological effects and analytical detection in the horse (In draft)