



GC/MS-LC/MS multi-residue method

This multi-residue method is a qualitative tool used to screen liver, GI contents and suspect material for possible toxins. It consists of a general extraction method and analysis of the extract by GC/MS (gas chromatography-mass spectrometry) and LC/MS (liquid chromatography-mass spectrometry) methods.

GC/MS is a method suitable for volatile/semi-volatile, heat stable compounds analysed in the gas phase. The GC/MS method is both targeted (looking for specific known compounds) and non-targeted (looking for unknown compounds). This method involves several targeted analyses (see Table 1) and a non-targeted analysis that screen the extract for compounds and subsequent match with a comprehensive mass spectrum library. Matches are based on the specific mass spectral fingerprint produced for a compound based on the standardized ionization energy of the GC/MS instrumentation.

LC/MS is a method suitable for non-volatile compounds analysed in the liquid phase. LC/MS is a targeted method (Table 1). Routine LC/MS is not suitable for non-targeted screening due to various interferences that affect a compound's ionization.

Table 1 lists the targeted compound included in our GC/MS-LC/MS multi-residue method. Recovery of these compounds in matrix has been confirmed at levels > 2 ppm.

It should also be noted that there are some compounds that we know are not detectable using this method (Table 2)

We will expand the list of targeted compounds as more compound standards are purchased and evaluated using this method.

This is not an all-encompassing toxin screen, but a cost effective way of screen for a large number of potential toxins. Targeted compounds currently include organochloride, organophosphate, carbamate, and other pesticides, barbiturates, tremorgenic mycotoxins, strychnine.

Table 1. List of known compounds currently included GC/MS-LC/MS multi-residue method.

Standard Name	LC/GC
2,3,5-Trimethacarb	LC
2,4-DDE	GC
2-phenylphenol (O-phenylphenol)	GC
3-Hydroxycarbofuran	LC
4,4'-DDD	GC
Acephate	LC
Acetamiprid	LC

Acetochlor	LC
Acibenzolar-S-methyl	GC
Alachlor	GC
Alanycarb	LC
Aldicarb	LC
Aldicarb Sulfone	LC
Aldicarb sulfoxide	LC
Aldrin	GC
Allethrin	GC
Allidochlor	GC
alpha-BHC (benzene hexachloride)	GC
Ametryn	GC
Aminocarb	GC
Anilofos	LC
Aramite	GC
Aspon (Tetrapropyl thiodiphosphate)	GC
Atrazine	GC
Azaconazole	LC
azinphos-ethyl	GC
Azinphos-Methyl	LC
Azoxystrobin	GC
Baytan (triadimenol)	GC
Benalaxyl	GC
Bendiocarb	GC
Benfluralin	GC
Benfuracarb	LC
Benodanil	GC
Benoxacor	LC
Benzoximate	LC
benzoylprop-ethyl	GC
BHC beta isomer	GC
BHC delta isomer	GC
Bifenazate	LC
Bifenox	GC
Bifenthrin	GC
biphenyl	GC
Bitertanol	LC
Boscalid	LC
bromacil	GC
Bromophos-ethyl	GC
bromophos-methyl (bromophos)	GC
bromopropylate	GC
Bromuconazole	LC
bupirimate	GC

buprofezin	GC
Butachlor	GC
Butafenacil	LC
Butocarboxim	LC
Butocarboxim sulfoxide	LC
Butoxycarboxim	LC
butralin	GC
Butylate	GC
Cadusafos	LC
Captafol	GC
captan	GC
Carbaryl	LC
Carbendazim	LC
Carbetamide	GC
Carbofuran	LC
Carbophenothion	GC
Carboxin	LC
Carfentrazone-ethyl	LC
Chlorantraniliprole	LC
chlorbenside	GC
Chlorbromuron	LC
chlorbufam	GC
Chlordane - Gamma (trans)	GC
chlordane-cis (alpha)	GC
Chlordane-oxy	GC
Chlorfenson (Ovex)	GC
chlorfenvinphos	GC
Chlorflurecol-methyl ester	GC
chloridazon (Pyrazon)	LC
Chlorimuron ethyl	LC
Chlormephos	GC
chlorobenzilate	GC
Chlorodimeform	GC
chloroneb	GC
Chloropropylat	GC
chlorothalonil	GC
Chloroxuron	LC
Chlorprofam	GC
Chlorpyrifos	GC
Chlorpyrifos Methyl	GC
Chlorthal-dimethyl (DCPA, Dacthal)	GC
Chlorthion	GC
Chlorthiophos	GC
Chlortoluron	LC

Chlozolinat	GC
Clethodim	LC
Clodinafop-propargyl	LC
Clofentezine	LC
Clomazone	GC
Clothianidin	LC
coumaphos	LC
Crotoxyphos	LC
Cyanofenphos	LC
cyanophos	GC
Cyazofamid	LC
Cycloate	LC
Cycloxydim	LC
Cycluron	LC
cyfluthrin	GC
Cyhalothrin-lambda-1	GC
cypermethrin	GC
Cyproconazol	GC
Cyprodinil	GC
Cyromazine	LC
ddd-o,p'	GC
dde-p,p'	GC
ddt-p,p'	GC
deltamethrin	GC
Demeton-O	GC
demeton-s	GC
demeton-S-methyl	LC
Demeton-s-methyl sulfone	LC
Demeton-s-methyl sulfoxide	LC
des-ethyl-atrazine	GC
Desmedipham	LC
Desmetryn	GC
Dialifos	GC
Di-allate	GC
Diazinon	GC
diazinon-o-analogue (Diazinon-oxon, Diazoxon)	GC
dichlobenil (Dichlorobenzonitrile, 2,6-)	GC
Dichlofenthion	GC
Dichloran (Dichloran)	GC
Dichlormid	GC
Dichlorvos	GC
diclobutrazole	GC
Diclocymet	LC
Diclofop-methyl	GC

dicofol (Kelthane)	GC
Dicrotophos	LC
Dieldrin	GC
Diethatyl-ethyl	GC
Diethofencarb	LC
Difenoconazol	LC
Diflubenzuron	LC
Dimethachlor	GC
Dimethametryn	LC
Dimethenamid-p	LC
Dimethoate	LC
Dimethomorph	LC
Dimoxystrobin	LC
Diniconazole	LC
Dinitramine	GC
Dioxacarb	LC
Dioxathion	LC
Diphenamid	GC
Diphenylamine	GC
Dipropetryn	LC
disulfoton	GC
disulfoton-sulfone	GC
Diuron	LC
Endosulfan - II (beta)	GC
Endosulfan-1 (alpha)	GC
Endosulfan-Sulfate	GC
Endrin	GC
EPN	GC
Epoxiconazol	LC
EPTC	GC
Erbon	GC
Esfenvalerate	GC
etaconazole	GC
Ethalfuralin	GC
Ethiofencarb sulfoxide	LC
Ethion	GC
Ethiprole	LC
Ethirimol	LC
Ethofumesate	GC
Ethoprophos (Ethoprop)	GC
ethylan (ethyl-DDD, perthane)	GC
Etoxazole	LC
Etridiazol (Terrazole, Echlomezol)	GC
Etrimfos	GC

Famoxadone	LC
Fenamidone	LC
fenamiphos sulfone	GC
Fenamiphos sulfoxide	LC
fenarimol	GC
Fenbuconazol	GC
fenchlorophos (Ronnel)	GC
Fenfurman	LC
Fenhexamid	LC
Fenitrothion	GC
Fenobucarb	LC
Fenoxanil	LC
Fenoxycarb	LC
fenpropathrin	GC
Fenpropidin	LC
Fenpropimorph	LC
fensulfothion	GC
Fenthion	GC
Fentrazamide	LC
Fenuron	LC
Fipronil	LC
Flamprop-isopropyl	GC
Flamprop-methyl	GC
Flonicamid	LC
Fluazifop-butyl	LC
Flubendiamide	LC
Fluchloralin	GC
flucythrinate	GC
Fludioxonil	GC
Flufenacet	LC
flumetralin	GC
Fluometuron	LC
fluorochloridone	GC
Fluorodifen	GC
Fluoxastrobin	LC
Fluquinconazole	LC
Flurtriafol	LC
flusilazole	GC
Flutolanil	LC
fluvalinate-tau	GC
Folpet	GC
Fonofos	GC
Forchlorfenuron	LC
Fosthiazate	LC

Fuberidazol (FUB)	LC
Furalaxyl	LC
Griseofulvin	LC
Halofenozide	LC
Haloxyfop	LC
heptachlor	GC
heptachlor-epoxide-endo	GC
Heptanophos	GC
hexachlorobenzene	GC
hexaconazole	GC
Hexaflumuron	LC
Hexazinone	GC
Imazalil	LC
Imazamethabenz-methyl	LC
Imidacloprid	LC
Indoxacarb	LC
iodofenphos (Jodfenphos)	GC
Ipconazole	LC
iprobenfos	GC
Iprodione	GC
Iprovalicarb	LC
Isazophos (Miral, Isazofos)	GC
Isofenphos	GC
Isoprocarb	LC
Isopropalin	GC
Isoprothiolane	GC
Isoproturon	LC
Isoxathion	LC
kresoxim-methyl	GC
Leptophos	GC
Lindane (gamma-HCH, BHC-gamma)	GC
Linuron	LC
Malaoxon (metabolite of Malathion)	GC
Malathion	GC
Mandipropamid	LC
Mecarbam	GC
Mefenacet	LC
Mepanipirim	LC
Mephosfolan	LC
Mepronil	LC
Metaflumizone	LC
Metalaxyl	GC
Metazachlor	GC
Metconazole	LC

Methabenzthiazuron	LC
Methidathion	LC
Methiocarb	LC
Methiocarb sufone	LC
Methiocarb Sulfoxide	LC
Methomyl	LC
methoprotryn	GC
methoxychlor	GC
Methoxyfenozone	LC
methyl-trithion (Carbophenothion-Methyl)	GC
Metobromuron	LC
Metolachlor	GC
Metolcarb	LC
Metoxuron	LC
Metribuzin	GC
Mevinphos(phosdrin)	GC
mirex	GC
Molinate	LC
Monceren (Pencycuron)	LC
monocrotophos	LC
Monolinuron	LC
myclobutanil	GC
Napropamide (Devrinol)	LC
Naptalam	LC
Neburon	LC
Nitenpyram	LC
Nitralin	GC
Nitrapyrin	GC
Nitrofen	GC
Nitrothal-isopropyl	GC
norflurazon	GC
nuarimol	GC
o,p - DDT	GC
octhilinone	GC
Ofurace	LC
Omethoate	LC
oxadiazon	GC
Oxadixyl	GC
Oxamy oxime	LC
oxamyl	LC
oxycarboxin	LC
Paclobutrazol	LC
paraoxon	GC
Parathion	GC

parathion-methyl	GC
Pebulate	GC
Penconazol	GC
Pendimethalin (Prowl) (Penoxaline)	GC
Penoxsulam	LC
permethrin	GC
Phenmedipham	LC
phenthoate	GC
Phorate	GC
Phorate-Sulfone	GC
Phosalone	GC
Phosmet	GC
Phosphamidon	GC
piperonyl butoxide	GC
Piperophos	LC
pirimicarb	GC
pirimiphos-ethyl	GC
pirimiphos-methyl	GC
Pretilachlor	LC
Primisulfuron-methyl	LC
Prochloraz	LC
procymidone	GC
Prodiamine	LC
Profenofos	GC
Profluralin	GC
Promecarb	GC
prometon	GC
Prometryne	GC
Propachlor	GC
Propamocarb	LC
Propanil (DCPA)	GC
propargit	GC
Propetamphos (Safrotin)	GC
Propham	GC
Propiconazole	GC
Propoxur	LC
Propyzamid (Pronamide)	GC
Prothioconazole	LC
Prothiophos	GC
Pymetrozine	LC
Pyracarbolid	GC
Pyraclostrobin	LC
Pyraflufen-ethyl	LC
Pyrazophos	GC

Pyridaben	GC
Pyridaphenthion	LC
Pyrifenox	LC
Pyrimethanil	LC
Pyroxsulam	LC
Quinalphos	GC
quinomethionate	GC
Quinoxifen	LC
Quintozene	GC
Quizalofop ethyl	LC
Ruelene (Crufomate)	GC
Schradan	LC
sebumeton	GC
Siduron	LC
Simazine	GC
Simetryn	GC
Sulfentrazone	LC
Sulfollate	GC
sulfotep	GC
sulprophos	GC
TCMTB (Benthiazole)	GC
Tebuconazol/Folicur	GC
Tebufenozide	LC
Tebuthiuron	LC
tecnazene (TCNB)	GC
Temephos	LC
Tepraloxydim	LC
Terbacil	GC
Terbufos	GC
Terbumeton	GC
terbutryn	GC
Terbutylazine	GC
tetrachlorvinphos	GC
Tetraconazole	LC
Tetradifon	GC
Tetraiodoethylene	GC
Tetramethrin	GC
Tetrasul	GC
Thiabendazole	LC
Thiacloprid	LC
Thiamethoxam	LC
Thiazopyr	LC
Thidiazuron	LC
thiobencarb (Benthiocarb)	GC

Thiodicarb	LC
Thiofanox	LC
Thiofanox sulfone	LC
Thiofanox sulfoxide	LC
Thionazin (zinophos)	LC
Thiophanate-methyl	LC
Tolclofos-methyl	GC
Tolyfluanid	GC
Tralkoxydim	LC
trialate	GC
Triazophos	GC
tribufos (DEF)	GC
Trichlorfon	LC
Tricyclazol (beam)	LC
Trietazine	LC
Trifloxystrobin	GC
Trifloxysulfuron	LC
Triflumizole	GC
Triflumuron	LC
Trifluralin	GC
Triforine	LC
Triticonazole	LC
Vamidothion	LC
Vernolate	GC
vinclozolin	GC
Zectran (mexacarbate)	LC
Zoxamide	LC
Strychnine	LC
Roquefortine	LC
Penitrem A	LC
Butalbital	GC
Amobarbital	GC
Pentobarbital	GC
Secobarbital	GC
Phenobarbital	GC

Table 2. List of known compounds that **cannot** be detected by the GC/MS-LC/MS multi-residue method.

Standard Name	LC/GC
Aclonifen	LC
Carbosulfan	GC
Chlorfluazuron	LC
Chlorthiamid	LC
Cloquintocet-mexyl	LC
Cyanazine	GC
Cymoxanil/zymoxanil	LC
Cyprazine	GC
Dichlofluanid	GC
Dinotefuran	LC
Dodemorph	LC
edifenphos	GC
Emamectin Benzoate	LC
Ethiofencarb	LC
Ethiofencarb sulfone	LC
Etofenprox	LC
Fenamiphos (Phenamiphos)	GC
Fenazaquin	LC
Fenpyroximate	LC
fenson	GC
Flucarbazone-sodium	LC
Flufenoxuron	LC
Formetanate	LC
Furathiocarb	LC
Hexythiazox	LC
Hydramethylnon	LC
Isocarbamide	LC
Lufenuron	LC
Methamidiphos	LC
Novaluron	LC
Oxyflurofen	GC
Picolinafen	LC
Picoxystrobin	LC
Propazine	GC
Pyridalyl	LC
Pyridate	LC
Pyriproxyfen	LC
Quizalofop	LC
Spinetoram	LC
Spinosad	LC

Spirodiclofen	LC
Spiromesifen	LC
Spirotetramat	LC
Spiroxamine	LC
Tebufenpyrad	LC
Tebupirimfos	LC
Teflubenzuron	LC
Tolfenpyrad	LC
triadimefon	GC
Atenolol	GC
Metolprolol	GC
Bisprolol	GC