Available online at www.sciencedirect.com
ScienceDirect
J. Biochem. Biophys. Methods 70 (2007) 151–162
JOURNAL OF biochemical and biophysical methods
www.elsevier.com/locate/jbbm

Review

Matrix solid phase dispersion (MSPD) ☆

Steven A. Barker *

School of Veterinary Medicine, Department of Comparative Biomedical Science, Louisiana State University, Baton Rouge, Louisiana 70803, United States

Received 5 May 2006; accepted 30 June 2006

Abstract

A review of the many uses of matrix solid phase dispersion (MSPD) in the extraction and analysis of a variety of compounds from a range of samples is provided. Matrix solid phase dispersion (MSPD) has found particular application as a somewhat generic analytical process for the preparation, extraction and fractionation of solid, semi-solid and/or highly viscous biological samples. Its simplicity and flexibility contribute to it being chosen over more classical methods for these purposes. MSPD is based on several simple principles of chemistry and physics, involving forces applied to the sample by mechanical blending to produce complete sample disruption and the interactions of the sample matrix with a solid support bonded-phase (SPE) or the surface chemistry of other solid support materials. These principles are discussed as are the factors to be considered in conducting a MSPD extraction.

Keywords: Matrix solid phase dispersion (MSPD); Solid phase extraction (SPE); Drug analysis; Tissue analysis; Food analysis

Contents

1. Introduction

Since its introduction in 1989 [1], matrix solid phase dispersion (MSPD) has been cited as the extraction method employed in over 250 publications [1–262]. It has proven to be an efficient and somewhat generic technique for the isolation of a wide range of drugs, pesticides, naturally occurring constituents, and other compounds from a wide variety of complex plant and animal samples (Table 1). MSPD was patented in 1993 [226] and its many uses have been extensively reviewed [52,76,110,133,139,157,159,161,163,190,192,199,200,215,222,228,230,231,236,237,245,246,251].

Matrix solid phase dispersion (MSPD) has found particular application as an analytical process for the preparation, extraction and fractionation of solid, semi-solid and/or highly viscous biological samples. Its simplicity and flexibility have been cited as contributing to it being chosen over more classical methods for these purposes. Indeed, MSPD is based on several simple principles of chemistry and physics, involving forces applied to the sample by mechanical blending to produce

☆ Submitted as a review to the *Journal of Biochemical and Biophysical Methods* at the invitation of Dr. Eric Heftmann for the "Special Issue on Sample Preparation".

* Tel.: +1 225 5078 3602; fax: +1 225 578 3086.
E-mail address: sbarker@vetmed.lsu.edu.

0165-022X/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.jbbm.2006.06.005

Table 1
Sample matrices that have been examined for the analytes noted

Matrix	Analyte(S)	Reference
Almonds	Ethylene bisdithiocarbamate	[72]
Animal [a] fats	Acetylgestagens	[213]
	DDT	[19]
	DDTs, aldrin, dieldrin	[77]
	Hexachlorobenzene	[116]
	Organochlorine pesticides	[204]
	PCBs	[55,132]
	Pesticides	[173,256,257]
Animal* feed	Chloramphenicol	[30]
	Dibenzo[a,l] pyrene	[143]
	Pesticides, PCBs	[37]
Animal* kidney	Aminoglycoside antibiotics	[223]
	Atrazine	[151]
	Avoparcin	[134]
Animal* liver	Benzimidazoles	[261]
	Beta-agonists	[205,219]
	Clenbuterol	[152,182,232,233]
	Ivermectin	[244]
	Mycotoxins	[122]
Animal* liver, kidney	Microcystins	[34]
	Sulfonamides	[107]
Animal* muscle	Aminoglycosides	[249]
	Antibiotics	[220]
	Benzimidazoles	[50,153,257]
	Cefquinome	[218]
	Chloramphenicol	[117]
	Diethylstilbestrol	[86]
	Furazolidone	[258]
	Moxidectin	[196]
	Nicarbazin	[243]
	Pesticides, anthelmintics and antibiotics	[1]
	Penicillin	[181]
	Sulfamethazine	[225,212,234]
	Sulfonamides	[90,140,217]
	Tetracyclines	[6]
	Thyreostats	[32]
	Veterinary drugs	[191]
Apples	Azoxystrobin, trifloxystrobin	[93]
	Pesticides	[3]
Apple juice	Pesticides	[9,13,48]
Beans	Pesticides	[78]
Biological samples	Beta-2-agonists	[160]
	Methomyl	[155]
	Pesticides	[184]
	Verapamil	[119]
Biota	Pcbs	[36,138]
	Surfactants	[91]
Bovine tissues and milk	Amoxicillin, ampicillin	[74]
Cattle and fish	Sulfonamides	[113]
Cheese	Biogenic amines	[35]
Chili peppers	Aflatoxins	[4]
Chocolate	Fatty acids	[64]
Confections	Coal-tar dyes	[197]
Corn	Carbofuran	[211]
Crayfish	Pesticides	[229]
Crustaceans and their parasites	Carotenoids	[61]
Cyanobacteria cultures	Microsystins	[56]
Dairy products	PCBs, dibenzodioxins, dibenzofurans	[169]
Eggs	Furazolidone	[75]
Fish	Alcohol ethoxylates	[175]
	Alkylbenzene sulfonates	[120]
	DDT	[135]
	Ivermectin	[216]
	Mycotoxins	[53,92]
	Microcystins, nodularin	[27]
	Oxolinic acid	[247]
	Oxytetracycline	[260]
	Pesticides	[227,255,256]
	Pesticides and PCBs	[207]
	PCBs	[29,224]
	Sulfadimethoxine	[214,221,259]
	Sulfonamides	[241,254]
	Surfactants	[170]
	Triazenes	[158]
Fish and mussels	Alkylphenol ethoxylates	[178]
Foods	Aflatoxins	[81]
	Chloramphenicol	[201]
	Dioxins and PCBs	[59]
	Isoprocarb, deltamethrin	[31]
	N-methylcarbamates	[46]
Fruit-green tea	Phenolics	[62]
Fruit juice	Carbendazim	[14]
	Pesticides	[101,130]
Fruits	Avermectin	[148]
	Abamectin	[166]
	Benzoyl ureas	[165]
	Organophosphorous pesticides	[187]
	Pesticides	[26,63,149,176]
Fruits and nuts	Pesticides	[177]
Fruits and vegetables	Carbamates	[83,167]
	Carotenoids	[141]
	Fungicides	[127,128,131,137,189]
	Organophosphorous pesticides	[111]
	Pesticides	[40,41,144,202]
	Pirimicarb, amitraz	[80,208]
Fruits, vegetables and cereals	Dithiocarbamates	[82]
	Pesticides	[124]
Fruits, vegetables and insects	Oxamyl and methomyl	[248]
Garlic	Pendimethalin	[10]
Honey	Insecticides	[136]
	Organophosphorous pesticides	[114]
	PAHs	[103]
	Pesticides	[145]
Honeybees	Pesticides	[121]
Infant formula	Retinyl acetate	[174]
	Tocopherol acetate, retinyl palmitate	[183,186]
	Vitamin K1	[162,168]
Insects	Pesticides	[65]
Krill	Astaxanthin and esters	[22]
Leaves	Isoflavones	[58]
Marine Species	Antibacterials	[180]
Medical foods	Beta-carotene	[172]
	Tocopherol acetate, retinyl palmitate	[179]
	Vitamin K1	[156,164]
Medicinal plants	Isoflavanoids	[79]
	Organophosphorous pesticides	[129]
	Pesticides	[16,102]
	Phenolic acids	[118]
Milk	Aminoglycoside antibiotics	[45]
	Carbamate insecticides	[57]
	Clorsulon	[240,252]

Table 1 (*continued*)

Matrix	Analyte(S)	Reference
Milk	Cypermethrin	[73]
	Doxycycline, fumequine	[67]
	Enrofloxacin, ciprofloxacin	[20]
	Fenbendazole	[193]
	Ivermectin	[210]
	Organochlorine and phosphorous pesticides	[206]
	PCBs and organochlorine pesticides	[142]
	Tetracyclines	[262]
Milk, muscle, organ tissues	Methomyl	[198]
	Pesticides	[185]
	Sulfonamides	[25]
Milk, cheese, meat	Tetracyclines	[188]
Milk and eggs	Alkylphenols, bisphenol A	[24]
	Sulfonamides	[106]
Milk, eggs, avacados	Pesticides	[38]
Milk, eggs, tissues	Sulfonamides	[242]
Milk, infant formula	Vitamins A And E	[60]
Milk and meat	Sulfonamides	[253]
Milk and urine	Thyreostats	[23]
Mycobacteria	Biologic compounds	[97]
	Natural products	[235,239,250]
Okra	Pesticides	[51]
Olive oil	Benzo(a) pyrene	[84]
	Organophosphorous pesticides	[87]
	Terbuthylazine	[11]
Olives, olive oil	Pesticides	[44]
Oranges	Pesticides	[66,125,147,203]
	Thiabendazole	[69]
Oysters	Pesticides	[238]
Pistachio nuts	diazinon, ethion	[94]
Plants	Aflatoxins	[96]
	Alkylphenols	[115]
	Carbendazin	[85]
	Natural products	[112]
	Pesticides	[195]
Rat feces	Bilastine	[146]
Rice	Carbofuran	[105]
	Isoprocarb	[39]
	Pesticides	[54]
Root bark	Flavanones, xanthones	[49]
Sewer sludge, sediments	Phenolics	[2]
Soil	Fenpropathrin	[99]
	Pesticides	[12,104]
	Phenthoate	[123]
	Uniconazole	[109]
Spinach	Carotenoids	[25,108]
Spinach and retina	Carotenoids	[171]
	Lutein and zeaxanthin	[154]
Sugar cane	Simazine	[71]
Starfish	Saponins	[150]
Tea	Caffeine	[33]
	Pesticides	[15]
Tobacco	Pesticides	[18]
Tomato	Glyposate, aminomethylphosphonic acid	[21]
Tomato juice	Pesticides	[100]
Toothpaste, gingival tissues	Tocopherols	[126]
Vegetables	Carotenoids	[47]
	Pesticides	[194]
	Pyrethroids	[209]
	Tebufenpyrad	[42]
Vegetable and fruit juices	Herbicides	[70]
Wheat grain	Carbindazim	[88]
	Carbofuran	[89]
	Fungicides	[7]

DDT, 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane; PCBs, polychlorinated biphenyls; PAHs, polycyclic aromatic hydrocarbons.

[a] Excluding marine species.

complete sample disruption and the interactions of the sample matrix with a solid support bonded-phase (SPE) or the surface chemistry of other solid support materials.

In its original conception, the blending of a bonded-phase [such as octadecylsilyl (ODS)-derivatized silica (C_{18})] solid support material with a biological sample is seen as acting as both an abrasive, producing shearing and grinding forces that induce disruption of the sample architecture, and as a "bound" solvent that assist in accomplishing complete sample disruption and dispersion. In this manner, the sample is dispersed over the surface of the bonded-phase support material, producing, through hydrophobic and hydrophilic interactions of the various components, a unique mixed-character phase for conducting target analyte isolation. Indeed, blended samples (muscle tissue and ODS-silica support) have been examined by scanning electron microscopy (SEM) and show that sample architecture is completely disrupted and that sample matrix components are, apparently, evenly distributed over the surface of the bonded-phase/support, forming an observable layer of approximately 100 um in thickness, similar to that of some micelle or membrane bilayers [1]. More recently, many applications of MSPD have involved the blending of samples with underivatized silicates (silica gel, sand, etc.) [for example, see 49,85,74,113,121,130] or other organic (graphitic fibers) [19,82] or inorganic (Florisil, alumina, etc.) [10,77,138,140] solids which cause sample disruption but do not, apparently, possess the same dispersive properties [159,237].

MSPD has found favor in its many applications because it eliminates most of the complications of performing classical liquid–liquid and/or solid phase extractions of solid and semi-solid samples, particularly complex biological samples. Indeed, all classical forms of liquid chromatography require that the sample be applied in a solubilized state to the head of the column. To accomplish this, the overall method must include steps to render the sample and its components into a non-viscous, particulate-free and relatively homogeneous liquid state. While many biological fluids, such as urine or blood plasma or serum, can be applied to columns directly, most other samples are not directly applicable to SPE, particularly the solids and semi-solids which are derived from biological origins. Such samples may be obtained from animal tissues or vegetable material and consist of a non-homogeneous array of fat and/or other tissues, such as fiber and pulp in the case of plants.

Thus, classical approaches for the preparation of solid or semi-solid samples for chromatography usually consist of

various combinations of methods of mincing, shredding, grinding, pulverizing and/or pressurizing of the sample to disrupt sample architecture. This step is usually followed by the addition of solvents, acids, bases, buffers, abrasives, salts, detergents and/or chelators in an effort to more completely disrupt cellular and architectural composition and initiate the extraction and fractionation of various sample components from the analyte(s) of choice. At this point in the preparation the sample may need to be filtered, centrifuged or otherwise treated to separate sample "debris" prior to further processing. In some of these steps, the analyst may encounter the creation of often intractable emulsions as a consequence of these actions. In many cases repeated centrifugation, re-extraction and sample manipulation may be required to render the sample suitable for application to an SPE column.

MSPD has been found to eliminate these complications in dealing with solid and semi-solid samples. This is achieved by literally combining the sample directly with the bonded-phase or other solid support, simultaneously accomplishing several steps in the more classical approach to sample preparation described above while producing a unique SPE extraction/fractionation column for isolation of target analytes.

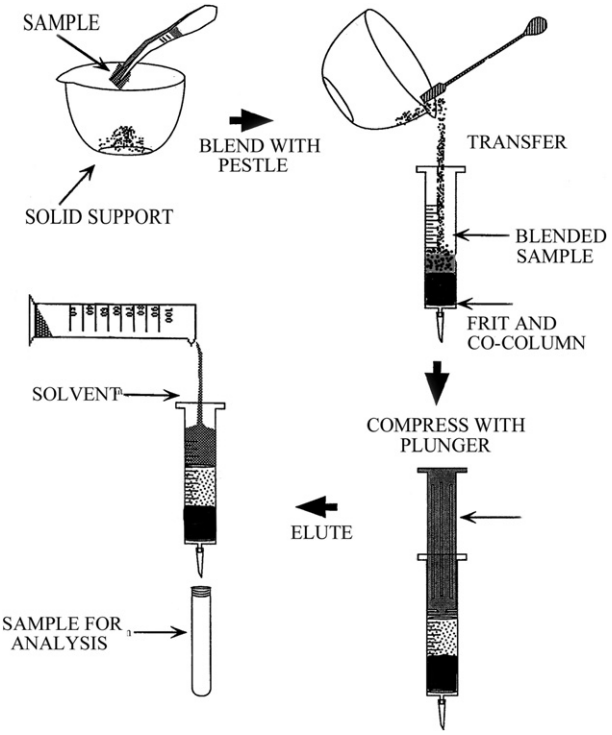

Fig. 1. Steps in a typical MSPD extraction.

2. MSPD extraction

Thus, in the MSPD process, a sample (liver, fruit, etc.) is placed in a glass or agate mortar containing an appropriate bonded-phase or other solid support material, such as octadecylsilyl (ODS)-derivatized silica (C_{18}) or other suitable support. The solid support and sample are manually blended together using a glass or agate pestle, a step that takes about 30 s. Internal standards or spikes may be added prior to this step. The blended material is then transferred and packed into a column suitable for conducting sequential elution with solvents.

The entire length of the column consists of blended sample components and their distribution in the bonded-phase and support, producing a new phase that exhibits unique character for sample fractionation. In this manner, an appropriate solvent or a sequence of solvents may be used to clean the column or directly isolate the compound(s) of choice. Co-columns, consisting of other solid phase or chromatographic supports, may also be incorporated into the column to assist in analyte isolation or further clean-up (Fig. 1).

2.1. Factors to consider in performing a MSPD extraction

Several factors that have been examined for their effect in conducting MSPD extractions include 1) the effect of average particle size diameter. As expected, very small particle sizes (3–10 μm) lead to extended solvent elution times and the need for excessive pressures or vacuum to obtain adequate flow. A blend of silicas possessing a range of particle sizes (40–100 μm) works quite well, and such materials also tend to be less expensive. 2) Non-end-capped vs. end-capped materials or materials having a range of carbon loading (8–18%), 3) the character of the bonded-phase. Depending on the polarity of the phase chosen, rather dramatic effects on the results may be observed. Applications requiring a lipophilic bonded-phase may use C_{18} and C_8 materials interchangeably. 4) The use of underivatized silica or other solid supports. Use of non-modified or underivatized solids, such as sand, to blend samples do not work in exactly the same manner as originally described for bonded-phase solid supports, such as ODS. However, the same basic principles will apply; abrasion and sample disruption will occur during the blending process. However, the further disruption of the sample and component dispersion will only occur to the degree that the components interact with the chemical characteristics of the particulate surface and each other. All surfaces have a definable chemistry and many substances, including a variety of minerals, may well serve to enhance isolation of specific compounds or classes of compounds and may even be blended together to form unique interactions to accomplish desired results. To date, silica-based support materials (derivatized silica, silica gel, sand, Florisil) have been almost exclusively reported for use in MSPD. One recent report has demonstrated the use of an activated carbon fiber for the isolation of dithiocarbamates from fruits, vegetables and cereals [82] while another has reported the isolation of DDT [1,1,1-trichloro-2,2-bis(*p*-chlorophenyl] from fat samples [19]. Two others have reported the use of polymeric materials (XAD-7) for sample dispersion and extraction of atrazine [151] or the antibiotic avoparcin [134]. The blending of samples with alumina has also been used in several extraction methods [10,77,140]. The further use and effect of synthetic polymer-based solid supports and of granular minerals is a subject for further study, particularly of supports that possess unique surface and/or pore chemistries, such as hydrophobic interaction supports. For silica-based materials, however,

studies have shown that the pore size is of minor importance in MSPD. This effect could vary with the sample and should, nonetheless, be considered. 5) the best ratio of sample to solid support material. The most often applied is 1 to 4, respectively, but has varied from application to application. Most protocols use lipophilic bonded-phase (C_{18}, C_8) materials, blending 2.0 g of solid support with 0.5 g of sample. This ratio is dependent on the application and must be examined as a major variable during method development. Both smaller and greater ratios have been used successfully. 6) Chemical modification of the matrix or matrix solid support blend. Addition of chelating agents, acids, bases, etc. at the time of blending affect the distribution and elution of target analytes from the sample. The elution profile of matrix components is likewise affected. 7) The optimum choice of elution solvents and the sequence of their application to a column. Elution solvent sequence attempts to isolate the analyte or further clean the column of interfering substances with each solvent step. MSPD columns permit isolation of different polarity analytes or entire chemical classes of compounds in a single solvent or in differing polarity solvents passed through the column, making MSPD amenable to conducting multi-residue isolation and analysis on a single sample. Several recent studies have reported the use of hot water as an eluting solvent as well as the addition of pressure, a process known as pressurized-liquid extraction (PLE) or accelerated solvent extraction (ASE) [12,27,45,57,83,106,107,134]. Such applications demonstrate the potential to make extraction methods based on MSPD free of hazardous solvents and even less expensive to perform. Preconditioning of the support materials used for any MSPD application enhances analyte recovery and speeds the process of sample blending and dispersal. This is due to the breaking of surface tension differences that may exist between the sample and bonded-phase solid support. As with SPE, washing or rinsing the solid support materials also eliminates contaminants from the final eluates. 8) The elution volume. It has been observed that for an 8 ml elution of a 2 g MSPD column blended with 0.5 g of sample that target analytes usually elute in the first 4 ml, approximately one column volume. This will vary for each application and should be examined to reduce the use of solvent and the unintended co-elution of potential interferences. Miniaturization of the MSPD technique, using smaller sample sizes and proportionately less support or solvent [56,65,146,149], as well as the potential for on-line LC methods, using valve switching to accomplish elution and concentration of the sample, may permit the overall use of less solvent and the opportunity for automation and 9) the effect of the sample matrix itself. All of the components of the sample are dispersed throughout the column, covering much of the bonded-phase solid support surface, creating a new phase that can have dramatic effects on isolation in going from one matrix to another [1,159,161,163,199,226,231,236,237,246].

The eluates obtained in MSPD may be taken directly to instrumental analysis, being adequately "clean" for direct injection. However, in some cases additional steps are required to remove co-eluting matrix components. This may involve a more classical SPE approach, using a second solid phase material, co-column or a separate column technique. For example, bonded-phase or other support materials of varying character may be packed at the bottom of the MSPD column (co-column). Alternatively, the MSPD column may be eluted directly onto a standard SPE column or disc material. Some studies have applied a variety of such approaches, including liquid–liquid extraction. However, the advent and availability of LC/MS and MS/MS instrumentation make many of these extra steps unnecessary by simultaneously enhancing sensitivity and selectively.

3. MSPD and SPE

MSPD has been found to be physically and functionally different from classical SPE in several ways: 1) it accomplishes complete sample disruption and dispersal onto particles of very small size, providing an enhanced surface area for subsequent extraction of the sample. In SPE sample disruption must be conducted as a separate step in preparing samples for SPE and many of the sample components must be discarded in the process of making the sample suitable for addition to an SPE column. 2) In SPE the sample is usually absorbed onto the top of the column packing material, not throughout the column as in MSPD. 3) The physical and chemical interactions of the components of the system are greater in MSPD and different, in many respects, from those seen in classical SPE or other forms of liquid chromatography. These have been previously reviewed [159,161,163,199,226,231,236,237,246] and encompass the interaction of a) the sample components with the solid support, b) the sample components with the bonded-phase, c) the analyte with the solid support, d) the analyte with the bonded-phase, e) the analyte with the dispersed sample components, f) all of the above interacting with the elution solvent(s) and their sequence of addition and g) the dynamic interactions of all of the above occurring simultaneously. Nonetheless, general chemical principles involved in conducting SPE and other forms of chromatography are also operable in applying MSPD. Thus, the chemical composition and characteristics of the solid support and bonded-phase are expected to affect the retention and elution of the analytes. These same properties will also apply to the dispersed sample components and the unique phase that is created.

4. Conclusions

The list of representative MSPD applications for the isolation of an assortment of compounds from a variety of matrices (Table 1) illustrates the rather generic character of MSPD. Where examined, MSPD has been found, in many cases, to provide equivalent or superior results to older official methods conducted by more classical countercurrent extraction and/or SPE techniques. Further, it has been rather consistently observed that MSPD requires approximately 95% less solvent and can be performed in 90% less time when compared to such classical methods. The use of smaller sample sizes, combined with lower solvent consumption, purchase and disposal, make MSPD competitive with such methods on several levels and should be considered as an alternative when developing new

analytical protocols. This is especially the case for solid or semi-solid biological materials. The continuing development of new supports and bonded-phases and the potential for miniaturization and automation of the MSPD process suggest several areas for future uses and research.

References

[1] Barker SA, Long AR, Short CR. Isolation of drug residues from tissues by solid phase dispersion. J Chromatogr 1989;475:353–61.

[2] Blanco E, Casais MC, Mejuto MC, Cela R. Approaches for the simultaneous extraction of tetrabromobisphenol A, tetrachlorobisphenol A, and related phenolic compounds from sewage sludge and sediment samples based on matrix solid-phase dispersion. Anal Chem 2006;78: 2772–8.

[3] Domotorova Milena, Matisova Eva, Kirchner Michal, de Zeeuw Jaap. MSPD combined with fast GC for ultratrace analysis of pesticide residues in non-fatty food. Acta Chim Slov 2005;52:422–8.

[4] Zheng Ping, Sheng Xuan, Yu Xiaofeng, Hu Yanyun. Determination of aflatoxins in hot chili products by matrix solid-phase dispersion and liquid chromatography. Sepu 2006;24:62–4.

[5] Kristenson E Maria, Brinkman Udo A Th, Ramos Lourdes. Recent advances in matrix solid-phase dispersion. Trends Analyt Chem 2006;25: 96–111.

[6] Bogialli Sara, Curini Roberta, Di Corcia Antonio, Lagana Aldo, Rizzuti Gabriella. A rapid confirmatory method for analyzing tetracycline antibiotics in bovine, swine, and poultry muscle tissues: matrix solid-phase dispersion with heated water as extractant followed by liquid chromatography–tandem mass spectrometry. J Agric Food Chem 2006;54: 1564–70.

[7] Michel Monika, Gnusowski Boguslaw, Buszewski Boguslaw. Comparison of various extraction techniques to determine fungicide residue in wheat grain. J Liq Chromatogr Relat Technol 2006;29:247–61.

[8] Teixeira D Martins, Patao R Ferreira, Coelho A Varela, Teixeira da Costa C. Comparison between sample disruption methods and solid–liquid extraction (SLE) to extract phenolic compounds from Ficus carica leaves. J Chromatogr A 2006;1103:22–8.

[9] Hu Xiaozhong, Chu Xiaogang, Yu Jianxin, Li Jing, Huang Xin, Lin Yanfei, et al. Determination of 22 organochlorine and 15 pyrethroid pesticide residues in apple juice by matrix solid-phase dispersion and gas chromatography–mass spectrometry. Fenxi Ceshi Xuebao 2004;23 (47):38–42.

[10] Zhang Zhichao, Zeng Min, Li Chaoyang, Zhang Ling, Leng Lian. A matrix solid-phase dispersion method using $AgNO_3$-loaded basic alumina as solid phase for determination of pendimethalin in garlic. Nongyaoxue Xuebao 2005;7:264–8.

[11] Ferrer Imma, Thurman Micahel, Zweigenbaaum Jerry. Analysis of terbuthylazine in olive oil by liquid chromatography/ion-trap mass spectrometry and time-of-flight mass spectrometry. Huanjing Huaxue 2005;24:735–8.

[12] Shen Zhonglan, Cai Jibao, Gao Yun, Zhu Xiaolan, Su Qingde. A new matrix solid phase dispersion–accelerate solvent extraction–gas chromatographic method for determination of organochlorine pesticides residues in soil. Fenxi Huaxue 2005;33:1318–20.

[13] Li Jianke, Hu Qiuhui, Wu Rina, Zhang Haibin, Wu Jingjing. Matrix solid-phase dispersion and gas chromatography determination of 5 organophosphorous pesticide residues in concentrated apple juice. Nanjing Nongye Daxue Xuebao 2005;28:111–5.

[14] Grujic Svetlana, Radisic Marina, Vasiljevic Tatjana, Lausevic Mila. Determination of carbendazim residues in fruit juices by liquid chromatography–tandem mass spectrometry. Food Addit Contam 2005;22: 1132–7.

[15] Hu Yan-Yun, Zheng Ping, He You-Zhao, Sheng Guo-Ping. Response surface optimization for determination of pesticide multiresidues by matrix solid-phase dispersion and gas chromatography. J Chromatogr A 2005;1098:188–93.

[16] Tang Feng, Yue Yongde, Hua Rimao, Cao Haiqun. Matrix solid-phase dispersion microextraction and determination of pesticide residues in medicinal herbs by gas chromatography with a nitrogen–phosphorus detector. J AOAC Int 2006;89:498–502.

[17] Barker Steven A. Use of matrix solid-phase dispersion for determining pesticides in fish and foods. Methods Biotechnol 2006;19:285–96.

[18] Cai Jibao, Gao Yun, Zhu Xiaolan, Su Qingde. Matrix solid phase dispersion— Soxhlet simultaneous extraction clean-up for determination of organochlorine pesticide residues in tobacco. Anal Bioanal Chem 2005;383:869–74.

[19] Furusawa N. Determination of DDT in animal fats after matrix solid-phase dispersion extraction using an activated carbon fiber. Chromatographia 2005;62:315–8.

[20] Choma Irena, Komaniecka Iwona. Matrix solid-phase dispersion combined with thin-layer chromatography— direct bioautography for determination of enrofloxacin and ciprofloxacin residues in milk. J Liq Chromatogr Relat Technol 2005;28:2467–78.

[21] Garcia de Llasera MP, Gomez-Almaraz L, Vera-Avila LE, Pena-Alvarez A. Matrix solid-phase dispersion extraction and determination by high-performance liquid chromatography with fluorescence detection of residues of glyphosate and aminomethylphosphonic acid in tomato fruit. J Chromatogr A 2005;1093:139–46.

[22] Grynbaum Marc David, Hentschel Petra, Putzbach Karsten, Rehbein Jens, Krucker Manfred, Nicholson Graeme, et al. Unambiguous detection of astaxanthin and astaxanthin fatty acid esters in krill (*Euphausia superba Dana*). J Sep Sci 2005;28:1685–93.

[23] Zou Qiong-Hui, Liu Yuan, Xie Meng-Xia, Han Jie, Zhang Lei. A rapid method for determination and confirmation of the thyreostats in milk and urine by matrix solid-phase dispersion and gas chromatography–mass spectrometry. Anal Chim Acta 2005;551:184–91.

[24] Shao Bing, Gao Ying-xin, Han Hao, Zhao Rong, Meng Juan, Qu Guohua. Determination of alkylphenol and bisphenol A in milk and eggs by matrix solid-phase dispersion extraction–liquid chromatography–mass spectrometry. Huanjing Huaxue 2005;24:483–4.

[25] Putzbach Karsten, Krucker Manfred, Grynbaum Marc David, Hentschel Petra, Webb Andrew G, Albert Klaus. Hyphenation of capillary high-performance liquid chromatography to microcoil magnetic resonance spectroscopy— determination of various carotenoids in a small-sized spinach sample. J Pharm Biomed Anal 2005;38:910–7.

[26] Soler Carla, Manes Jordi, Pico Yolanda. Routine application using single quadrupole liquid chromatography-mass spectrometry to pesticides analysis in citrus fruits. J Chromatogr A 2005;1088:224–33.

[27] Bogialli Sara, Bruno Milena, Curini Roberta, Di Corcia Antonio, Lagana Aldo, Mari Barbara. Simple assay for analyzing five microcystins and nodularin in fish muscle tissue: hot water extraction followed by liquid chromatography–tandem mass spectrometry. J Agric Food Chem 2005;53:6586–92.

[28] Majors Ronaldo E. New technologies for the sample preparation of organic compounds. Abstracts, 37th middle atlantic regional meeting of the American Chemical Society, New Brunswick, NJ, United States, May 22–25, 2005; 2005. GENE-449.

[29] Pensado L, Casais MC, Mejuto MC, Cela R. Application of matrix solid-phase dispersion in the analysis of priority polycyclic aromatic hydrocarbons in fish samples. J Chromatogr A 2005;1077:103–9.

[30] Feng Xia-ping, Zhang Liang, Zhang Zhuo-heng, Chen Wei-gou. Determination of chloramphenicol in animal food by MSPD and GC/MS using PTV large volume injection. Zhongshan Daxue Xuebao. Ziran Kexueban 2005;44:65–8.

[31] Yang Rong, Zhai Tongyu, Zhou Yaxuan, Liu Haiyan, Zang Xiaohuan. Matrix solid-phase dispersion and high performance liquid chromatographic determination of trace isoprocarb and deltamethrin in food. Shipin Kexue (Beijing, China) 2004;25:158–60.

[32] Zhang Lei, Liu Yuan, Xie Meng-Xia, Qiu Yue-Ming. Simultaneous determination of thyreostatic residues in animal tissues by matrix solid-phase dispersion and gas chromatography–mass spectrometry. J Chromatogr A 2005;1074:1–7.

[33] Dawidowicz Aandrzej L, Wianowska Dorota. PLE in the analysis of plant compounds. J Pharm Biomed Anal 2005;37:1155–9.

[34] Ruiz Maria Jose, Camean Ana Maria, Moreno Isabel Maria, Pico Yolanda. Determination of microcystins in biological samples by matrix solid-phase dispersion and liquid chromatography–mass spectrometry. J Chromatogr A 2005;1073:257–62.
[35] Calbiani F, Careri M, Elviri L, Mangia A, Pistara L, Zagnoni I. Rapid assay for analyzing biogenic amines in cheese: matrix solid-phase dispersion followed by liquid chromatography–electrospray-tandem mass spectrometry. J Agric Food Chem 2005;53:3779–83.
[36] Martinez A, Ramil M, Montes R, Hernanz D, Rubi E, Rodriguez I, et al. Development of a matrix solid-phase dispersion method for the screening of polybrominated diphenyl ethers and polychlorinated biphenyls in biota samples using gas chromatography with electron-capture detection. J Chromatogr A 2005;1072:83–91.
[37] Carro AM, Lorenzo RA, Fernandez F, Rodil R, Cela R. Multi-residue screening of chlorinated and brominated compounds from aquaculture samples using matrix solid-phase dispersion— gas chromatography–mass spectrometry. J Chromatogr A 2005;1071:93–8.
[38] Lehotay Steven J, Mastovska Katerina, Yun Seon Jong. Evaluation of two fast and easy methods for pesticide residue analysis in fatty food matrixes. J AOAC Int 2005;88:630–8.
[39] Yang, Rong, Ma, Jing-jun, Song, Shiang-ju. Matrix solid-phase dispersion (MSPD) and high performance liquid chromatographic determination of trace isoprocarb in rice. Zhongguo Weisheng Jianyan Zazhi (2005), 15 (1), 48, 123.
[40] Feng Xiaping, Chen Weiguo, Wang Zhiyuan, Chen Jie, Cai Jingying. A rapid and simple method for determination of organochlorine multi-pesticides in fruits and vegetables. Zhongguo Weisheng Jianyan Zazhi 2004;14:701–2.
[41] Langowska Barbara. Sorbents in MSPD technique for determination of pesticide residues in plant material. Prog Plant Prot 2003;43:224–30.
[42] Giza Irena, Sztwiertnia Urszula. Determination of tebufenpyrad in greenhouse vegetables by gas chromatography. Prog Plant Prot 2004;44:686–8.
[43] Tadeo JL, Sanchez-Brunete C, Perez RA. Herbicide residues. Food Science and Technology (New York, NY, United States) (2004), 138 (Handbook of Food Analysis, Volume 2), 1269–1295.
[44] Ferrer Carmen, Gomez M Jose, Garcia-Reyes Juan F, Ferrer Imma, Thurman E Michael, Fernandez-Alba Amadeo R. Determination of pesticide residues in olives and olive oil by matrix solid-phase dispersion followed by gas chromatography/mass spectrometry and liquid chromatography/tandem mass spectrometry. J Chromatogr A 2005;1069: 183–94.
[45] Bogialli Sara, Curini Roberta, Di Corcia Antonio, Lagana Aldo, Mele Monica, Nazzari Manuela. Simple confirmatory assay for analyzing residues of aminoglycoside antibiotics in bovine milk: hot water extraction followed by liquid chromatography-tandem mass spectrometry. J Chromatogr A 2005;1067:93–100.
[46] Borkovcova I, Janouskova E, Rehurkova I, Ruprich J. Determination of n-methylcarbamates in foods. Cent Eur J Public Health 2004;12:220–3.
[47] Putzbach Karsten, Krucker Manfred, Albert Klaus, Grusak Michael A, Tang Guangwen, Dolnikowski Gregory G. Structure determination of partially deuterated carotenoids from intrinsically labeled vegetables by HPLC-MS and 1H NMR. J Agric Food Chem 2005;53:671–7.
[48] Chu Xiang-Gang, Hu Xiao-Zhong, Yao Hui-Yuan. Determination of 266 pesticide residues in apple juice by matrix solid-phase dispersion and gas chromatography–mass selective detection. J Chromatogr A 2005;1063: 201–10.
[49] Teixeira D Martins, Teixeira da Costa C. Novel methods to extract flavanones and xanthones from the root bark of *Maclura pomifera*. J Chromatogr A 2005;1062:175–81.
[50] Su Shu-Chu, Chou Hsiao-Hui, Chang Pi-Chiou, Liu Chao-Hong, Chou Shin-Shou. Simultaneous determination of febantel, fenbendazole, oxfendazole and oxfendazole sulfone in livestock by matrix solid phase dispersion extraction technique and HPLC. Yaowu Shipin Fenxi 2004;12:244–53.
[51] Dorea Haroldo Silveira, Lopes Waneidi Gomez. Application of the matrix solid phase dispersion (MSPD) technique in the analysis of pesticides in okra by GC–MS. Quim Nova 2004;27:892–6.
[52] Andreu Vicente, Pico Yolanda. Determination of pesticides and their degradation products in soil: critical review and comparison of methods. Trends Anal Chem 2004;23:772–89.
[53] Lagana Aldo, Faberi Angelo, Fago Giovanna, Marino Aldo, Pastorini Elisabetta, Samperi Roberto. Application of an innovative matrix solid-phase dispersion–solid-phase extraction–liquid chromatography–tandem mass spectrometry analytical methodology to the study of the metabolism of the estrogenic mycotoxin zearalenone in rainbow trout liver and muscle tissue. Int J Environ Anal Chem 2004;84:1009–16.
[54] Dorea Haroldo S, Lima Sobrinho Ledjane. Analysis of pesticide residues in rice using matrix solid-phase dispersion (MSPD). J Braz Chem Soc 2004;15:690–4.
[55] Ramil Criado M, Hernanz Fernandez D, Rodriguez Pereiro I, Cela Torrijos R. Application of matrix solid-phase dispersion to the determination of polychlorinated biphenyls in fat by gas chromatography with electron-capture and mass spectrometric detection. J Chromatogr A 2004;1056:187–94.
[56] Camean Ana, Moreno Isabel M, Ruiz Maria J, Pico Yolanda. Determination of microcystins in natural blooms and cyanobacterial strain cultures by matrix solid-phase dispersion and liquid chromatography–mass spectrometry. Anal Bioanal Chem 2004;380:537–44.
[57] Bogialli Sara, Curini Roberta, Di Corcia Antonio, Lagana Aldo, Nazzari Manuela, Tonci Michela. Simple and rapid assay for analyzing residues of carbamate insecticides in bovine milk: hot water extraction followed by liquid chromatography–mass spectrometry. J Chromatogr A 2004;1054: 351–7.
[58] de Rijke Eva, de Kanter Frans, Ariese Freek, Brinkman Udo A Th, Gooijer Cees. Liquid chromatography coupled to nuclear magnetic resonance spectroscopy for the identification of isoflavone glucoside malonates in T. pratense L. leaves. J Sep Sci 2004;27:1061–70.
[59] Sandra P, David F, Tienpont B. From CGC–MS to MS-based analytical decision makers. Chromatographia 2004;60(Suppl 1):S299–302.
[60] Chase Jr G William, Lin Ye, Stoakes Vicky C, Eitenmiller Ronald R, Long Austin R. An interlaboratory-verified method for the determination of vitamins A and E in milk- and soy-based infant formula by liquid chromatography with matrix solid-phase dispersion extraction. J AOAC Int 2004;87:1173–8.
[61] Gaillard Maria, Juillet Cedrik, Cezilly Frank, Perrot-Minnot Marie-Jeanne. Carotenoids of two freshwater amphipod species (*Gammarus pulex* and *G. roeseli*) and their common acanthocephalan parasite Polymorphus minutus. Biochem Physiol B Biochem Mol Biol 2004;139B: 129–36.
[62] Karasova G, Lehotay J. MSPD extraction of phenolic compounds from fruit-green tea using various non-polar sorbents. J Liq Chromatogr Relat Technol 2004;27:2837–45.
[63] Soler Carla, Manes Jordi, Pico Yolanda. Liquid chromatography–electrospray quadrupole ion-trap mass spectrometry of nine pesticides in fruits. J Chromatogr A 2004;1048:41–9.
[64] Perret Daniela, Gentili Alessandra, Marchese Stefano, Sergi Manuel, Caporossi Lidia. Determination of free fatty acids in chocolate by liquid chromatography with tandem mass spectrometry. Rapid Commun Mass Spectrom 2004;18:1989–94.
[65] Kristenson EM, Shahmiri S, Slooten CJ, Vreuls RJJ, Brinkman UATh. Matrix solid-phase dispersion micro-extraction of pesticides from single insects with subsequent GC–MS analysis. Chromatographia 2004;59:315–20.
[66] Cardosa Maria Helena WM, Bastos Liucia Helena P, Neves Tatiane S, Abrantes Shirley. Implementation of matrix solid phase dispersion (MSPD) technique for the determination of pesticide residues in oranges. Cienc Tecnol Aliment (Campinas, Brazil) 2004;24:298–302.
[67] Choma Irena, Pilorz Karol. A novel application of matrix solid-phase dispersion for determination of doxycycline and flumequine residues in milk. J Liq Chromatogr Relat Technol 2004;27:2143–51.
[68] Hu Xiaozhong, Yu Jianxin, Yan Zhigang, Ni Lansun, Lin Yanfei, Wang Peng, et al. Determination of multiclass pesticide residues in apple juice by gas chromatography–mass selective detection after extraction by matrix solid-phase dispersion. J AOAC Int 2004;87:972–85.
[69] Albero Beatriz, Sanchez-Brunete Consuelo, Tadeo Jose L. Determination of thiabendazole in orange juice and rind by liquid chromatography with

fluorescence detection and confirmation by gas chromatography/mass spectrometry after extraction by matrix solid-phase dispersion. J AOAC Int 2004;87:664–70.
[70] Albero B, Sanchez-Brunete C, Donoso A, Tadeo JL. Determination of herbicide residues in juice by matrix solid-phase dispersion and gas chromatography–mass spectrometry. J Chromatogr A 2004;1043: 127–33.
[71] Tseng Su-Hsiang, Lin Yu-Ju, Chang Pi-Chiou, Chou Shin-Shou, Chang Hung-Min. Determination of simazine residue in sugarcane by application of matrix solid phase dispersion (MSPD) extraction technique. Yaowu Shipin Fenxi 2004;12:74–8.
[72] Garcinuno RM, Ramos L, Fernandez-Hernando P, Camara C. Optimization of a matrix solid-phase dispersion method with subsequent clean-up for the determination of ethylene bisdithiocarbamate residues in almond samples. J Chromatogr A 2004;1041:35–41.
[73] Sassine Andre, Moura Sergio, Leo Viviane Morais, Bustillos Oscar Vega. Cypermethrin residues determination in the milk of a lactating dairy cow by gas chromatography–ion trap mass spectrometry. J Anal Toxicol 2004;28:238–41.
[74] Bogialli Sara, Capitolino Vittorio, Curini Roberta, Di Corcia Antonio, Nazzari Manuela, Sergi Manuel. Simple and rapid liquid chromatography–tandem mass spectrometry confirmatory assay for determining amoxicillin and ampicillin in bovine tissues and milk. J Agric Food Chem 2004;52:3286–91.
[75] Ding Lan, Xie Mengxia, Liu Yuan, Shan Jihao, Yang Qingfeng, Liu Suying. Determination of furazolidone residue in eggs by high performance liquid chromatography. Fenxi Huaxue 2004;32:139–42.
[76] Karasova Gabriela, Brandsteterova Eva, Lachova Miroslava. Matrix solid phase dispersion as an effective preparation method for food samples and plants before HPLC analysis. Czech J Food Sci 2003;21:219–34.
[77] Furusawa N. A toxic reagent-free method for normal-phase matrix solid-phase dispersion extraction and reversed-phase liquid chromatographic determination of aldrin, dieldrin, and DDTs in animal fats. Anal Bioanal Chem 2004;378:2004–7.
[78] Lopes Waneide Gomes, Dorea Haroldo Silveira. Determination of pesticides in beans by matrix solid-phase dispersion (MSPD). Pesticidas 2003;13:73–82.
[79] Xiao HB, Krucker M, Albert K, Liang XM. Determination and identification of isoflavonoids in Radix astragali by matrix solid-phase dispersion extraction and high-performance liquid chromatography with photodiode array and mass spectrometric detection. J Chromatogr A 2004;1032:117–24.
[80] Yang Rong, Liu Haiyan, Lu Xiaofang. Matrix solid-phase dispersion (MSPD) and high performance liquid chromatographic determination of trace pirimicarb and amitraz in fruit and vegetable. Hebei Nongye Daxue Xuebao 2003;26:114–7.
[81] Blesa J, Soriano JM, Molto JC, Manes J. Limited survey for the presence of aflatoxins in foods from local markets and supermarkets in Valencia, Spain. Food Addit Contam 2004;21:165–71.
[82] Blasco C, Font G, Pico Y. Determination of dithiocarbamates and metabolites in plants by liquid chromatography–mass spectrometry. J Chromatogr A 2004;1028:267–76.
[83] Bogialli Sara, Curini Roberta, Di Corcia Antonio, Nazzari Manuela, Tamburro Davide. A simple and rapid assay for analyzing residues of carbamate insecticides in vegetables and fruits: hot water extraction followed by liquid chromatography–mass spectrometry. J Agric Food Chem 2004;52:665–71.
[84] Bogusz Maciej J, El Hajj Samir Abu, Ehaideb Zeyad, Hassan Huda, Al-Tufail Mohammad. Rapid determination of benzo[a]pyrene in olive oil samples with solid-phase extraction and low-pressure, wide-bore gas chromatography–mass spectrometry and fast liquid chromatography with fluorescence detection. J Chromatogr A 2004;1026:1–7.
[85] Michel Monika, Buszewski Boguslaw. Optimization of a matrix solid-phase dispersion method for the determination analysis of carbendazim residue in plant material. J Chromatogr B Anal Technol Biomed Life Sci 2004;800:309–14.
[86] Ding Yayun, Xu Xiaoyun, Xie Mengxia, Yang Qingfeng, Liu Suying. Matrix solid-phase dispersion coupled with gas chromatography–mass spectrometry for the analysis of trace residue of diethylstilbestrol in animal tissue. Fenxi Huaxue 2003;31:1356–9.
[87] Albero Beatriz, Sanchez-Brunete Consuelo, Tadeo Jose L. Determination of organophosphorus pesticides in fruit juices by matrix solid-phase dispersion and gas chromatography. J Agric Food Chem 2003;51: 6915–21.
[88] Michel Monika, Buszewski Boguslaw. Isolation and determination of carbendazim residue from wheat grain by matrix solid-phase dispersion and HPLC. J Sep Sci 2003;26:1269–72.
[89] Yang Rong. Matrix solid-phase dispersion and high performance liquid chromatographic determination of trace carbofuran in wheat. Hebei Daxue Xuebao Ziran Kexueban 2003;23:269–71.
[90] Kishida Kunihiro, Furusawa Naoto. Toxic/harmful solvents-free technique for HPLC determination of six sulfonamides in meat. J Liq Chromatogr Relat Technol 2003;26:2931–9.
[91] de Voogt Pim, Saez Monica, Gonzalez-Mazo Eduardo. Sample handling for the determination of surfactants in biota. Compr Anal Chem 2003;40:429–41.
[92] Lagana Aldo, Bacaloni Alessandro, Castellano Maryanna, Curini Roberta, De Leva Ilaria, Faberi Angelo, et al. Sample preparation for determination of macrocyclic lactone mycotoxins in fish tissue, based on on-line matrix solid-phase dispersion and solid-phase extraction cleanup followed by liquid chromatography/tandem mass spectrometry. J AOAC Int 2003;86:729–36.
[93] Giza I, Sztwiertnia U. Gas chromatographic determination of azoxystrobin and trifloxystrobin residues in apples. Acta Chromatogr 2003;13:226–9.
[94] Husain SW, Kiarostami V, Morrovati M, Tagebakhsh MR. Multiresidue determination of diazinon and ethion in pistachio nuts by use of matrix solid phase dispersion with a lanthanum silicate co-column and gas chromatography. Acta Chromatogr 2003;13:208–14.
[95] Kastelan-Macan Marija, Babic Sandra. Pesticides. Chromatographic science series, vol. 89. Handbook of Thin-Layer Chromatography, 3rd edition; 2003. p. 767–805.
[96] Blesa J, Soriano JM, Molto JC, Marin R, Manes J. Determination of aflatoxins in peanuts by matrix solid-phase dispersion and liquid chromatography. J Chromatogr A 2003;1011:49–54.
[97] Hines Murray E, Styer Eloise L. Preliminary characterization of chemically generated Mycobacterium avium subsp. paratuberculosis cell wall-deficient forms (spheroplasts). Vet Microbiol 2003;95:247–58.
[98] Morzycka Bozena, Matrix solid phase dispersion— new prospects in analysis of pesticide residues. Pestycydy (Warsaw) (2003), Volume Date 2002, (1–4), 61–69.
[99] Li Zhao-yang, Zhang Zhi-chao, Zhou Qi-lin, Zhu Chang-shou, Wang Qing-min, Wang Qin-sun. Matrix solid-phase dispersion method for determination of fenpropathrin in soil. Fenxi Shiyanshi 2003;22:13–5.
[100] Albero B, Sanchez-Brunete C, Tadeo JL. Determination of endosulfan isomers and endosulfan sulfate in tomato juice by matrix solid-phase dispersion and gas chromatography. J Chromatogr A 2003;1007: 137–43.
[101] Tadeo JL, Sanchez-Brunete C. Analysis of pesticide residues in fruit juices by matrix-solid phase dispersion and gas chromatographic determination. Chromatographia 2003;57:793–8.
[102] Zuin Vania G, Yariwake Janete H, Lancas Fernando M. Analysis of pesticide residues in Brazilian medicinal plants: matrix solid phase dispersion versus conventional (European pharmacopoeia) methods. J Braz Chem Soc 2003;14:304–9.
[103] Albero Beatriz, Sanchez-Brunete Consuelo, Tadeo Jose L. Determination of polycyclic aromatic hydrocarbons in honey by matrix solid-phase dispersion and gas chromatography/mass spectrometry. J AOAC Int 2003;86:576–82.
[104] Li Zhao-Yang, Zhang Zhi-Chao, Zhou Qi-Lin, Wang Qing-Min, Gao Ru-Yu, Wang Qin-Sun. Stereo- and enantioselective determination of pesticides in soil by using achiral and chiral liquid chromatography in combination with matrix solid-phase dispersion. J AOAC Int 2003;86: 521–8.
[105] Yang Rong. Determination of trace carbofuran in rice with matrix solid phase dispersion (MSPD)-high performance liquid chromatography. Sepu 2003;21:295.
[106] Bogialli Sara, Curini Roberta, DiCorcia Antonio, Nazzari Manuela, Polci Maria Letizia. Rapid confirmatory assay for determining 12 sulfonamide

antimicrobials in milk and eggs by matrix solid-phase dispersion and liquid chromatography–mass spectrometry. J Agric Food Chem 2003;51: 4225–32.
[107] Bogialli Sara, Curini Roberta, Di Corcia Antonio, Nazzari Manuela, Sergi Manuel. Confirmatory analysis of sulfonamide antibacterials in bovine liver and kidney: extraction with hot water and liquid chromatography coupled to a single- or triple-quadrupole mass spectrometer. Rapid Commun Mass Spectrom 2003;17:1146–56.
[108] Glaser T, Lienau A, Zeeb D, Krucker M, Dachtler M, Albert K. Qualitative and quantitative determination of carotenoid stereoisomers in a variety of spinach samples by use of MSPD before HPLC-UV, HPLC-APCI-MS, and HPLC-NMR on-line coupling. Chromatographia 2003;57: S/19–25.
[109] Li Zhao-Yang, Zhang Zhi-Chao, Liu Yi-Shan, Zhou Qi-Lin, Gao Ru-Yu, Wang Qin-Sun. Determination of uniconazole in soil with an enantio-selective way. Gaodeng Xuexiao Huaxue Xuebao 2003;24:840–2.
[110] Blaszczyk Alfred, Jasiczak Jan. Rapid and economical methods for extraction of pesticides from food products. Wiad Chem 2002;56: 1035–52.
[111] Morzycka Bozena. Determination of organophosphorus pesticides in fruits and vegetables by matrix solid-phase dispersion method. J Plant Prot Res 2002;42:17–22.
[112] Sanvoss Martin. Application of LC-NMR and LC-NMR-MS hyphenation to natural products analysis. On-line LC-NMR and related techniques; 2002. p. 111–28.
[113] Bogialli Sara, Curini Roberta, Di Corcia Antonio, Nazzari Manuela, Samperi Roberto. A liquid chromatography-mass spectrometry assay for analyzing sulfonamide antibacterials in cattle and fish muscle tissues. Anal Chem 2003;75:1798–804.
[114] Fernandez M, Pico Y, Manes J. Rapid screening of organophosphorus pesticides in honey and bees by liquid chromatography–mass spectrometry. Chromatographia 2002;56:577–83.
[115] Zhao Meiping, Li Yuanzong, Chang Wenhao. Analysis of phenolic environmental estrogens. Fenxi Huaxue 2003;31:103–9.
[116] Bazulic D, Sapunar-Postruznik Jasenka, Drincic Helena Kubala, Grubelic Mirela, Oraic D. Determination of hexachlorobenzene (HCB) in the perirenal and dorsal fatty tissues of pigs. Acta Vet Hung 2002;50:111–5.
[117] Kubala-Drincic Helena, Bazulic Davorin, Sapunar-Postruznik Jasenka, Grubelic Mirela, Stuhne Goran. Matrix solid-phase dispersion extraction and gas chromatographic determination of chloramphenicol in muscle tissue. J Agric Food Chem 2003;51:871–5.
[118] Ziakova Alica, Brandsteterova Eva, Blahova Eva. Matrix solid-phase dispersion for the liquid chromatographic determination of phenolic acids in Melissa officinalis. J Chromatogr A 2003;983:271–5.
[119] Walles Markus, Borlak Juergen, Levsen Karsten. Application of restricted access material (RAM) with precolumn-switching and matrix solid-phase dispersion (MSPD) to the study of the metabolism and pharmacokinetics of Verapamil. Anal Bioanal Chem 2002;374:1179–86.
[120] Tolls Johannes, Samperi Roberto, Di Corcia Antonio. Bioaccumulation of LAS in Feral Fish Studied by a Novel LC-MS/MS Method. Environ Sci Technol 2003;37:314–20.
[121] Morzycka Bozena. Simple method for the determination of trace levels of pesticides in honeybees using matrix solid-phase dispersion and gas chromatography. J Chromatogr A 2002;982:267–73.
[122] van Bennekom EO, Brouwer L, Laurant EHM, Hooijerink H, Nielen MWF. Confirmatory analysis method for zeranol, its metabolites and related mycotoxins in urine by liquid chromatography-negative ion electrospray tandem mass spectrometry. Anal Chim Acta 2002;473: 151–60.
[123] Li Zhao-Yang, Zhang Zhi-Chao, Zhou Qi-Lin, Gao Ru-Yu, Wang Qin-Sun. Fast and precise determination of phenthoate and its enantiomeric ratio in soil by the matrix solid-phase dispersion method and liquid chromatography. J Chromatogr A 2002;977:17–25.
[124] Michel Monika, Buszewski Boguslaw. HPLC determination of pesticide residue isolated from food matrices. J Liq Chromatogr Relat Technol 2002;25:2293–306.
[125] Blasco C, Font G, Pico Y. Comparison of microextraction procedures to determine pesticides in oranges by liquid chromatography-mass spectrometry. J Chromatogr A 2002;970:201–12.
[126] Lienau Annette, Glaser Tobias, Krucker Manfred, Zeeb Daniel, Ley Fritz, Curro Frederick, et al. Qualitative and quantitative analysis of tocopherols in toothpastes and gingival tissue employing HPLC NMR and HPLC MS coupling. Anal Chem 2002;74:5192–8.
[127] Morzycka Bozena. Multiresidue matrix solid-phase dispersion method for the determination of fungicides in fruits and vegetables. Chem Anal (Warsaw, Poland) 2002;47:571–83.
[128] Navarro M, Pico Y, Marin R, Manes J. Application of matrix solid-phase dispersion to the determination of a new generation of fungicides in fruits and vegetables. J Chromatogr A 2002;968:201–9.
[129] Feng Xiuqiong, Tang Qingyong. Multiresidue determination of organo-phosphorus pesticides in Chinese medicinal herbs. Nongyao Kexue Yu Guanli 2002;23:17–20.
[130] Perret Daniela, Gentili Alessandra, Marchese Stefano, Sergi Manuel, D'Ascenzo Giuseppe. Validation of a method for the determination of multiclass pesticide residues in fruit juices by liquid chromatography/tandem mass spectrometry after extraction by matrix solid-phase dispersion. J AOAC Int 2002;85:724–30.
[131] Blasco Cristina, Pico Yolanda, Font Guillermina. Monitoring of five postharvest fungicides in fruit and vegetables by matrix solid-phase dispersion and liquid chromatography/mass spectrometry. J AOAC Int 2002;85:704–11.
[132] Sandra Pat, David Frank. High-throughput capillary gas chromatography for the determination of polychlorinated biphenyls and fatty acid methyl esters in food samples. J Chromatogr Sci 2002;40:248–53.
[133] Jing Legang. New development in determination of food pesticide residues. Shipin Kexue (Beijing, China) 2002;23:148–51.
[134] Curren Meredith SS, King Jerry W. New sample preparation technique for the determination of avoparcin in pressurized hot water extracts from kidney samples. J Chromatogr A 2002;954:41–9.
[135] Nowak Ronald M, Lehmann Robert G, Lange Gary M, Karpovich David S. Accumulation of DDT in fish from the Pine River in Michigan: comparison with other sites worldwide. Abstracts of papers, 223rd ACS National Meeting, Orlando, FL, United States, April 7–11, 2002; 2002. CHED-432.
[136] Sanchez-Brunete Consuelo, Albero Beatriz, Miguel Ester, Tadeo Jose Luis. Determination of insecticides in honey by matrix solid-phase dispersion and gas chromatography with nitrogen–phosphorus detection and mass spectrometric confirmation. J AOAC Int 2002;85:128–33.
[137] Blasco C, Pico Y, Manes J, Font G. Determination of fungicide residues in fruits and vegetables by liquid chromatography–atmospheric pressure chemical ionization mass spectrometry. J Chromatogr A 2002;947: 227–35.
[138] Gomez-Ariza JL, Bujalance M, Giraldez I, Velasco A, Morales E. Determination of polychlorinated biphenyls in biota samples using simultaneous pressurized liquid extraction and purification. J Chromatogr A 2002;946:209–19.
[139] Ahmed Farid E. Analyses of pesticides and their metabolites in foods and drinks. Trends Anal Chem 2001;20:649–61.
[140] Kishida Kunihiro, Furusawa Naoto. Matrix solid-phase dispersion extraction and high-performance liquid chromatographic determination of residual sulfonamides in chicken. J Chromatogr A 2001;937:49–55.
[141] Fernandez-Alba AR, Lopez Martinez MD, Contreras M. Evaluation of the relationship between carotenoids and colour measures by chromatographic and colorimetric based procedures: application to fruits and vegetables. Special publication— Royal Society of Chemistry, 269 (Biologically-Active Phytochemicals in Food); 2001. p. 280–2.
[142] Yague Cristina, Bayarri Susana, Lazaro Regina, Conchello Pilar, Arino Agustin, Herrera Antonio. Multiresidue determination of organochlorine pesticides and polychlorinated biphenyls in milk by gas chromatography with electron-capture detection after extraction by matrix solid-phase dispersion. J AOAC Int 2001;84:1561–8.
[143] Loveland PM, Reddy AP, Pereira CB, Field JA, Bailey GS. Application of matrix solid-phase dispersion in the determination of dibenzo[a,l] pyrene content of experimental animal diets used in a large-scale tumor study. J Chromatogr A 2001;932:33–41.
[144] Pous Ximo, Ruiz M Jose, Pico Yolanda, Font Guillermina. Determination of imidacloprid, metalaxyl, myclobutanil, propham, and thiabendazole in

fruits and vegetables by liquid chromatography-atmospheric pressure chemical ionization-mass spectrometry. Fresenius' J Anal Chem 2001;371:182–9.
[145] Albero Beatriz, Sanchez-Brunete Consuelo, Tadeo Jose L. Multiresidue determination of pesticides in honey by matrix solid-phase dispersion and gas chromatography with electron-capture detection. J AOAC Int 2001;84:1165–71.
[146] Berrueta LA, Fernandez-Armentia M, Bakkali A, Gonzalo A, Lucero ML, Orjales A. Matrix solid-phase dispersion technique for the determination of a new antiallergic drug, bilastine, in rat faeces. J Chromatogr B Biomed Sci Appl 2001;760:185–90.
[147] Valenzuela Ana I, Pico Yolanda, Font Guillermina. Determination of five pesticide residues in oranges by matrix solid-phase dispersion and liquid chromatography to estimate daily intake of consumers. J AOAC Int 2001;84:901–9.
[148] Valenzuela AI, Popa DS, Redondo MJ, Manes J. Comparison of various liquid chromatographic methods for the analysis of avermectin residues in citrus fruits. J Chromatogr A 2001;918:59–65.
[149] Kristenson EM, Haverkate EGJ, Slooten CJ, Ramos L, Vreuls RJJ, Brinkman UAT. Miniaturized automated matrix solid-phase dispersion extraction of pesticides in fruit followed by gas chromatographic–mass spectrometric analysis. J Chromatogr A 2001;917:277–86.
[150] Sandvoss M, Weltring A, Preiss A, Levsen K, Wuensch G. Combination of matrix solid-phase dispersion extraction and direct on-line liquid chromatography–nuclear magnetic resonance spectroscopy–tandem mass spectrometry as a new efficient approach for the rapid screening of natural products: application to the total asterosaponin fraction of the starfish Asterias rubens. J Chromatogr A 2001;917:75–86.
[151] Curren Meredith SS, King Jerry W. Ethanol-modified subcritical water extraction combined with solid-phase microextraction for determining atrazine in beef kidney. J Agric Food Chem 2001;49:2175–80.
[152] Crescenzi C, Bayoudh S, Cormack PAG, Klein T, Ensing K. Determination of clenbuterol in bovine liver by combining matrix solid-phase dispersion and molecularly imprinted solid-phase extraction followed by liquid chromatography/electrospray ion trap multiple-stage mass spectrometry. Anal Chem 2001;73:2171–7.
[153] Zhang Su-xia, Li Jun-suo, Qian Chuan-fan. MSPD clean-up and HPLC determination of benzimidazoles in beef muscle. Zhongguo Shouyi Xuebao 2000;20:569–71.
[154] Dachtler Markus, Glaser Tobias, Kohler Konrad, Albert Klaus. Combined HPLC-MS and HPLC-NMR on-line coupling for the separation and determination of lutein and zeaxanthin stereoisomers in spinach and in retina. Anal Chem 2001;73:667–74.
[155] Rakoczy Ilona, Kovacs Aniko. Matrix solid-phase dispersion isolation and liquid-chromatographic determination of methomyl in biological tissues. Z Zag Nauk Sadow 2000;43:217–21.
[156] Chase Jr G William, Eitenmiller RR, Long AR. Liquid chromatographic analysis of vitamin K1 in medical foods using matrix solid-phase dispersion. J Food Compos Anal 2000;13:765–71.
[157] Zhong Weike, Hao Jian, Fan Yaobo, Wang Minjian. Development in pesticide residue analysis of food. Fenxi Huaxue 2000;28:904–10.
[158] Gaunt Patricia, Barker Steven A. Matrix solid phase dispersion extraction of triazines from catfish tissues; examination of the effects of temperature and dissolved oxygen on the toxicity of atrazine. Int J Environ Pollut 2000;13: 284–312.
[159] Barker SA. Matrix solid-phase dispersion. J Chromatogr A 2000;885: 115–27.
[160] dos Ramos FJ. Beta-2-agonist extraction procedures for chromatographic analysis. J Chromatogr A 2000;880:69–83.
[161] Barker SA. Applications of matrix solid-phase dispersion in food analysis. J Chromatogr A 2000;880:63–8.
[162] Chase Jr G William, Eitenmiller Ronald R, Long Austin R. Liquid chromatographic analysis of vitamin K1 in milk-based infant formula with matrix solid-phase dispersion. J AOAC Int 1999;82:1140–5.
[163] Barker Steven A. Sorbent technologies principles and applications. Residue analysis in food; 2000. p. 37–71.
[164] Chase Jr G William, Thompson Brian. Accelerated solvent extraction of vitamin K1 in medical foods in conjunction with matrix solid-phase dispersion. J AOAC Int 2000;83:407–10.
[165] Valenzuela AI, Pico Y, Font G. Liquid chromatography/atmospheric pressure chemical ionization-mass spectrometric analysis of benzoylurea insecticides in citrus fruits. Rapid Commun Mass Spectrom 2000;14: 572–7.
[166] Valenzuela AI, Redondo MJ, Pico Y, Font G. Determination of abamectin in citrus fruits by liquid chromatography-electrospray ionization mass spectrometry. J Chromatogr A 2000;871:57–65.
[167] Fernandez M, Pico Y, Manes J. Determination of carbamate residues in fruits and vegetables by matrix solid-phase dispersion and liquid chromatography-mass spectrometry. J Chromatogr A 2000;71:43–56.
[168] Chase Jr G William, Eitenmiller RR, Long AR. The liquid chromatographic analysis of vitamin K1 in soy based infant formula using matrix solid phase dispersion. J Liq Chromatogr Relat Technol 2000;23:423–32.
[169] Ramos L, Eljarrat E, Hernandez LM, Rivera J, Gonzalez MJ. Levels of polychlorinated biphenyls, polychlorinated dibenzo-p-dioxins and dibenzofurans in commercial yoghurt samples in Spain. Comparison with different dairy products. Anal Chim Acta 1999;402:241–52.
[170] Tolls Johannes, Haller Manuela, Sijm Dick THM. Extraction and isolation of linear alkylbenzenesulfonate and its sulfophenylcarboxylic acid metabolites from fish samples. Anal Chem 1999;71:5242–7.
[171] Glaser Tobias, Dachtler Markus, Albert Klaus. Study of carotenoid stereoisomers in spinach and in the retina by HPLC-NMR and HPLC-MS coupling. GIT Labor-Fachz 1999;43:904–9.
[172] Chase Jr G William, Eitenmiller Ronald R, Long Austin R. Analysis of beta-carotene in medical food by liquid chromatography with matrix solid-phase dispersion. J AOAC Int 1999;82:663–8.
[173] Batulic Davorin, Sapunar-Postruznik Jasenka, Bilic Sara. Significance of the quality of florisil in organochlorine pesticide analysis. Arh Hig Rada Toksikol 1998;49:319–25.
[174] Chase Jr G William, Eitenmiller Ronald R, Long Austin R. A liquid chromatographic method for the analysis of retinyl acetate in soy based infant formula using matrix solid phase dispersion. J Liq Chromatogr Relat Technol 1999;22:1205–12.
[175] Tolls Johannes, Haller Manuela, Sijm Dick THM. Extraction and isolation of linear alcohol ethoxylates from fish. J Chromatogr A 1999;839:109–17.
[176] Valenzuela AI, Lorenzini R, Redondo MJ, Font G. Matrix solid-phase dispersion microextraction and determination by high-performance liquid chromatography with UV detection of pesticide residues in citrus fruit. J Chromatogr A 1999;839:101–7.
[177] Dorea Haroldo Silveira, Fernando Mauro Lancas. Matrix solid-phase dispersion extraction of organophosphorus and synthetic pyrethroid pesticides in cashew nut and passion fruit. J Microcolumn Sep 1999;11: 367–75.
[178] Zhao M, van der Wielen F, de Voogt P. Optimization of a matrix solid-phase dispersion method with sequential clean-up for the determination of alkylphenol ethoxylates in biological tissues. J Chromatogr A 1999;837:129–38.
[179] Chase Jr G William, Eitenmiller Ronald R, Long Austin R. A liquid chromatographic method for analysis of all-rac-alpha-tocopheryl acetate and retinyl palmitate in medical food using matrix solid-phase dispersion in conjunction with a zero reference material as a method development tool. J AOAC Int 1999;82:107–11.
[180] Kinoshita Masayasu. Analysis of synthetic antibacterials in cultured marine products with matrix solid-phase dispersion. Shokuhin Eisei Kenkyu 1998;48:91–7.
[181] McGrane Marie, O'Keeffe Michael, Smyth Malcolm R. Multi-residue analysis of penicillin residues in porcine tissue using matrix solid phase dispersion. Analyst (Cambridge, United Kingdom) 1998;123:2779–83.
[182] Horne Elizabeth, O'Keeffe Michael, Desbrow Claire, Howells Anne. A novel sorbent for the determination of clenbuterol in bovine liver. Analyst (Cambridge, United Kingdom) 1998;123:2517–20.
[183] Chase Jr G William, Eitenmiller Ronald R, Long Austin R. Liquid chromatographic method for the analysis of all-rac-alpha-tocopheryl acetate and retinyl palmitate in soy-based infant formula using matrix solid phase dispersion. J Liq Chromatogr Relat Technol 1998;21:2853–61.
[184] Matos Lino Celeste, Ferreira Azzolini Clara B, Valente Nunes Domingos S, Rocha Silva Jose M, Noronha da Silveira M Irene. Methods for the

determination of organochlorine pesticide residues in human serum. J Chromatogr B Biomed Sci Appl 1998;716:147–52.
[185] Wu Shuguang, Hofmann Charles K. Matrix solid phase dispersion (MSPD): a new isolation technique for the analysis of pesticide residues in natural products. Book of abstracts, 216th ACS National Meeting, Boston, August 23–27; 1998. ANYL-111.
[186] Chase Jr G William, Long Austin R. Liquid chromatographic method for analysis of all-rac-alpha-tocopheryl acetate and retinyl palmitate in milk-based infant formula using matrix solid-phase dispersion. J AOAC Int 1998;81:582–6.
[187] Torres Carmen M, Pico Yolanda, Marin Rosa, Manes Jordi. Evaluation of organophosphorus pesticide residues in citrus fruits from the Valencian Community (Spain). J AOAC Int 1997;80:1122–8.
[188] Brandsteterova Eva, Kubalec Pavel, Bovanova Ludmila, Simko Peter, Bednarikova Alena, Machackova Lubomira. SPE and MSPD as pre-separation techniques for HPLC of tetracyclines in meat, milk, and cheese. Z Lebensm Unters Forsch A Eur Food Res Technol 1997;205: 311–5.
[189] Torres CM, Pico Y, Manes J. Comparison of octadecylsilica and graphitized carbon black as materials for solid-phase extraction of fungicide and insecticide residues from fruit and vegetables. J Chromatogr A 1997;778: 127–37.
[190] Crouch Michael D, Barker Steven A. Analysis of toxic wastes in tissues from aquatic species. Applications of matrix solid-phase dispersion. J Chromatogr A 1997;774:287–309.
[191] Le Boulaire Stephanie, Bauduret Jean-Claude, Andre Francois. Veterinary drug residues survey in meat: an HPLC method with a Matrix Solid Phase Dispersion Extraction. J Agric Food Chem 1997;45:2134–42.
[192] Yago Lane S. Matrix solid phase dispersion: the next step in solid phase extraction for food samples? An overview of the technology. Semin Food Anal 1996;1:45–54.
[193] Kappel LC, Barker SA. Fenbendazole-related drug residues in milk from treated dairy cows. J Vet Pharmacol Ther 1996;19:416–22.
[194] Viana E, Molt JC, Font G. Optimization of a matrix solid-phase dispersion method for the analysis of pesticide residues in vegetables. J Chromatogr A 1996;754:437–44.
[195] Tekel Jozef, Hatrik Stefan. Pesticide residue analyses in plant material by chromatographic methods: clean-up procedures and selective detectors. J Chromatogr A 1996;754:397–410.
[196] Alvinerie M, Sutra JF, Capela D, Galtier P, Fernandez-Saurez A, Horne E. Matrix solid-phase dispersion technique for the determination of moxidectin in bovine tissues. Analyst (Cambridge, United Kingdom) 1996;121:1469–72.
[197] Kai Shigemi, Nikkawa Takayasu, Takahashi Atsuko, Koizumi Akiko, Hyoudou Yukio, Suzuki Sumiko. Preparation of sample solution for determination of acid coal-tar dyes in confectionery by the matrix solid-phase dispersion method. Shokuhin Eiseigaku Zasshi 1996;37:146–50.
[198] Daun Robert J, Ryan David L. Magnitude of residues of methomyl in edible tissues and milk of dairy cows. Book of abstracts, 212th ACS National Meeting, Orlando, FL, August 25–29; 1996. AGRO-045.
[199] Barker Steven A, Floyd Z Elizabeth. Matrix solid phase dispersion (MSPD): implications for the design and use of new bonded surface chemistries. Special publication— Royal Society of Chemistry, 173 (Chemically Modified Surfaces: Recent Developments); 1996. p. 66–71.
[200] Obana Hirotaka, Hori Shinjiro. Latest analytical methods for the residual pesticides in foods. Jpn J Toxicol Environ Health 1996;42:1–16.
[201] Castilho MC, Ramos F, Silveira EMA. Chloramphenicol: review of its analytical methodology in food products. Rev Port Farm 1995;45:100–9.
[202] Torres CM, Pico Y, Manes J. Analysis of pesticide residues in fruit and vegetables by matrix solid phase dispersion (MSPD) and different gas chromatography element-selective detectors. Chromatographia 1995;41:685–92.
[203] Torres CM, Pico Y, Redondo MJ, Manes J. Matrix solid-phase dispersion extraction procedure for multiresidue pesticide analysis in oranges. J Chromatogr A 1996;719:95–103.
[204] Johnston JJ, Petty EE. A comparison of solvent extraction, solid phase extraction and matrix solid phase dispersion for the quantification of organochlorine pesticide residues in biological matrixes. Book of Abstracts, 210th ACS National Meeting, Chicago, IL, August 20–24, Pt. 1; 1995. AGRO-005.
[205] Boyd D, O'Keeffe M, Smyth MR. Matrix solid phase dispersion linked to solid phase extraction for beta-agonists in liver samples: an update. Anal Proc 1995;32:301–3.
[206] Schenck Frank J, Wagner Roberta. Screening procedure for organochlorine and organophosphorus pesticide residues in milk using matrix solid phase dispersion (MSPD) extraction and gas chromatographic determination. Food Addit Contam 1995;12:535–41.
[207] Ling Y-C, Huang I-P. Multiresidue-matrix solid-phase dispersion method for determining 16 organochlorine pesticides and polychlorinated biphenyls in fish. Chromatographia 1995;40:259–66.
[208] Yang Rong, Fu Chengguany. Matrix solid-phase dispersion and high performance liquid chromatographic determination of trace Pirimicarb and Amitraz in fruits and vegetables. Hebei Daxue Xuebao Ziran Kexueban 1994;14:29–33.
[209] Ling Y-C, Huang I-P. Multi-residue matrix solid-phase dispersion method for the determination of six synthetic pyrethroids in vegetables followed by gas chromatography with electron capture detection. J Chromatogr A 1995;695:75–82.
[210] Schenck Frank J. Isolation and quantification of ivermectin in bovine milk by matrix solid phase dispersion (MSPD) extraction and liquid chromatographic determination. J Liq Chromatogr 1995;18:349–62.
[211] Yang Rong, Fu Chengguang. Matrix solid-phase dispersion and high performance liquid chromatographic determination of trace carbofuran in corn. Fenxi Ceshi Xuebao 1994;13:72–5.
[212] Shearan Paula, O'Keeffe Michael. Novel approach to the 'on-site' testing for sulfamethazine in pork carcasses. Analyst (Cambridge, United Kingdom) 1994;119:2761–4.
[213] Rosen Johan, Hellenaes Karl-Erik, Toernqvist Paulina, Shearan Paula. Automated extraction of acetylgestagens from kidney fat by matrix solid phase dispersion. Analyst (Cambridge, United Kingdom) 1994;119: 2635–7.
[214] Walker Calvin C, Barker Steven A. Extraction and liquid chromatographic analysis of sulfadimethoxine and 4-N-acetylsulfadimethoxine residues in channel catfish (*Ictalurus punctatus*) muscle and plasma. J AOAC Int 1994;77:1460–6.
[215] Pico Yolanda, Molto Juan C, Manes Jordi, Font Guillermina. Solid phase techniques in the extraction of pesticides and related compounds from foods and soils. J Microcolumn Sep 1994;6:331–59.
[216] Iosifidou Eleni, Shearan Paula, O'Keefe Michael. Application of the matrix solid phase dispersion technique for the determination of ivermectin residues in fish muscle tissue. Analyst (Cambridge, United Kingdom) 1994;119:2227–9.
[217] Tamura Hiroshi, Yotoriyama Mamoru, Kurosaki Kanako, Shinohara Nobukatu. High performance liquid chromatographic analysis of sulfonamides in livestock products using matrix solid-phase dispersion (MSPD) method with silica gel. Shokuhin Eiseigaku Zasshi 1994;35: 271–5.
[218] Barker Steven A, Kappel Leonard C, Short Charles R. Tissue distribution and clearance of the cephalosporin cefquinome in the bovine. Residues Vet. Drugs Food, Proc. 2nd. EuroResidue Conf., vol. 1; 1993. p. 165–9.
[219] Boyd Damien, O'Keeffe Michael, Smyth Malcolm R. Matrix solid-phase dispersion as a multiresidue extraction technique for beta-agonists in bovine liver tissue. Analyst (Cambridge, United Kingdom) 1994;119: 1467–70.
[220] Fukushima Shigehiko, Taguchi Shuzo, Nishimune Takahiro, Sueki Kenji. Determination of five sulfa drugs, furazolidone and clopidol in chicken tissues by matrix solid-phase dispersion isolation method. Osaka-Furitsu Koshu Eisei Kenkyusho Kenkyu Hokoku, Shokuhin Eisei-Hen 1993;24:19–24.
[221] Walker Calvin C, Barker Steven A. Extraction and enzyme immunoassay of sulfadimethoxine residues in channel catfish (*Ictalurus punctatus*) muscle. J AOAC Int 1994;77:908–16.
[222] Barker Steven A, Long Austin R. Preparation of milk samples for immunoassay and liquid chromatographic screening using matrix solid-phase dispersion. J AOAC Int 1994;77:848–54.
[223] McLaughlin Lee G, Henion Jack D, Kijak Philip J. Multiresidue confirmation of aminoglycoside antibiotics in bovine kidney by ion spray

high-performance liquid chromatography/tandem mass spectrometry. Biol Mass Spectrom 1994;23:417–29.
[224] Ling Y-C, Chang M-Y, Huang I-P. Matrix solid-phase dispersion extraction and gas chromatographic screening of polychlorinated biphenyls in fish. J Chromatogr A 1994;669:119–24.
[225] Shearan Paula, O'Keeffe Michael, Smyth Malcolm R. Comparison of matrix solid phase dispersion (MSPD) with a standard solvent extraction method for sulfamethazine in pork muscle using high-performance liquid and thin-layer chromatography. Food Addit Contam 1994;11:7–15.
[226] Barker Steven A, Long Austin R, Isolation of drugs or drug metabolites from biological specimens via matrix solid phase dispersion. U.S. (1993), 10 pp. Cont. of U.S. Ser. No. 893,903, abandoned.
[227] Lott Heidi M, Barker Steven A. Comparison of a matrix solid phase dispersion and a classical extraction method for the determination of chlorinated pesticides in fish muscle. Environ Monit Assess 1993;28:109–16.
[228] Walker Calvin C, Lott Heidi M, Barker Steven A. Matrix solid-phase dispersion extraction and the analysis of drugs and environmental pollutants in aquatic species. J Chromatogr 1993;642:225–42.
[229] Lott Heidi M, Barker Steven A. Extraction and gas chromatographic screening of 14 chlorinated pesticides in crayfish (*Procambarus clarkii*) hepatopancreas. J AOAC Int 1993;76:663–8.
[230] Shaikh Badar, Moats William A. Liquid chromatographic analysis of antibacterial drug residues in food products of animal origin. J Chromatogr 1993;643:369–78.
[231] Barker Steven A. How to analyze those messy biological samples. Chemtech 1993;23:42–5.
[232] Boyd Damien, Shearan Paula, Hopkins JP, O'Keeffe Michael, Smyth Malcolm R. Matrix solid-phase dispersion linked to immunoassay techniques for the determination of clenbuterol in bovine liver samples. Anal Proc 1993;30:156–7.
[233] Boyd D, Shearan P, Hopkins JP, O'Keeffe M, Smyth MR. Application of matrix solid phase dispersion for the determination of clenbuterol in liver samples. Anal Chim Acta 1993;275:221–6.
[234] Renson C, Degand G, Maghuin-Rogister G, Delahaut Ph. Determination of sulfamethazine in animal tissues by enzyme immunoassay. Anal Chim Acta 1993;275:323–8.
[235] Hines II Murray E, Frazier Ken S. Differentiation of mycobacteria on the basis of chemotype profiles by using matrix solid-phase dispersion and thin-layer chromatography. J Clin Microbiol 1993;31:610–4.
[236] Barker Steven, Hawley Rex. Efficient biological analysis using MSPD. Am Lab 1992;24:42–3.
[237] Barker Steven A, Long Austin R, Hines II Murray E. Disruption and fractionation of biological materials by matrix solid-phase dispersion. J Chromatogr 1993;629:23–34.
[238] Lott Heidi M, Barker Steven A. Matrix solid-phase dispersion extraction and gas chromatographic screening of 14 chlorinated pesticides in oysters (*Crassostrea virginica*). J AOAC Int 1993;76:67–72.
[239] Hines II Murray E, Jaynes Jesse M, Barker Steven A, Newton Joseph C, Enright Frederick M, Snider III Theron G. Isolation and partial characterization of glycolipid fractions from Mycobacteriuum avium serovar 2 (Mycobacterium paratuberculosis 18) that inhibit activated macrophages. Infect Immun 1993;61:1–7.
[240] Schenck Frank J, Wagner Roberta, Bargot William. Determination of clorsulon residues in milk using a solid-phase extraction cleanup and liquid chromatographic determination. J Liq Chromatogr 1993;16: 513–20.
[241] Reimer Gerry J, Suarz Agripina. Liquid chromatographic confirmatory method for five sulfonamides in salmon muscle tissue by matrix solid-phase dispersion. J AOAC Int 1992;75:979–81.
[242] Agarwal Vipin K. High-performance liquid chromatographic methods for the determination of sulfonamides in tissue, milk and eggs. J Chromatogr 1992;624:411–23.
[243] Schenck Frank J, Barker Steven A, Long Austin R. Matrix solid-phase dispersion extraction and liquid chromatographic determination of nicarbazin in chicken tissue. J AOAC Int 1992;75:659–62.
[244] Schenck Frank J, Barker Steven A, Long Austin R. Matrix solid-phase dispersion extraction and liquid chromatographic determination of ivermectin in bovine liver tissue. J AOAC Int 1992;75:655–8.
[245] Barker Steven A, Long Austin R. The application of matrix solid phase dispersion (MSPD) to the extraction and subsequent analysis of drug residues in animal tissues. Anal. Antibiot./Drug residues Food Prod. Anim. Origin, [Proc. Am. Chem. Soc. Agric. Food Chem. Div. Symp.; 1992. p. 119–32. Meeting Date 1991.
[246] Barker Steven A, Long Austin R. Tissue drug residue extraction and monitoring by matrix solid phase dispersion (MSPD)-HPLC analysis. J Liq Chromatogr 1992;15:2071–89.
[247] Jarboe Herman H, Kleinow Kevin M. Matrix solid-phase dispersion isolation and liquid chromatographic determination of oxolinic acid in channel catfish (*Ictalurus punctatus*) muscle tissue. J AOAC Int 1992;75:428–32.
[248] Stafford Steven C, Lin Willy. Determination of oxamyl and methomyl by high-performance liquid chromatography using a single-stage postcolumn derivatization reaction and fluorescence detection. J Agric Food Chem 1992;40:1026–9.
[249] McLaughlin Lee G, Henion Jack D. Determination of aminoglycoside antibiotics by reversed-phase ion-pair high-performance liquid chromatography coupled with pulsed amperometry and ion spray mass spectrometry. J Chromatogr 1992;591:195–206.
[250] Hines II ME, Long AR, Snider III TG, Barker SA. Lysis and fractionation of *Mycobacterium paratuberculosis* and *Escherichia coli* by matrix solid-phase dispersion. Anal Biochem 1991;195:197–206.
[251] Haagsma Nel. Analytical aspects of veterinary drug residues. Mikrochim Acta 1991;2:63–70.
[252] Schenck Frank J, Barker Steven A, Long Austin R. Matrix solid phase dispersion (MSPD) isolation and liquid chromatographic determination of clorsulon in milk. J Liq Chromatogr 1991;14:2827–34.
[253] Van Poucke LSG, Depourcq GCI, Van Peteghem CH. A quantitative method for the detection of sulfonamide residues in meat and milk samples with a high-performance thin-layer chromatographic method. J Chromatogr Sci 1991;29:423–7.
[254] Reimer Gerry J, Suarez Agripina. Development of a screening method for five sulfonamides in salmon muscle tissue using thin-layer chromatography. J Chromatogr 1991;555:315–20.
[255] Long Austin R, Crouch Michael D, Barker Steven A. Multiresidue matrix solid phase dispersion (MSPD) extraction and gas chromatographic screening of nine chlorinated pesticides in catfish (*Ictalurus punctatus*) muscle tissue. J AOAC 1991;74:667–70.
[256] Long Austin R, Soliman Maher M, Barker Steven A. Matrix solid phase dispersion (MSPD) extraction and gas chromatographic screening of nine chlorinated pesticides in beef fat. J AOAC 1991;74:493–6.
[257] Long Austin R, Hsieh Lily C, Malbrough Marsha S, Short Charles R, Barker Steven A. Matrix solid phase dispersion (MSPD) extraction and liquid chromatographic determination of five benzimidazole anthelmintics in pork muscle tissue. J Food Compos Anal 1990;3:20–6.
[258] Long Austin R, Hsieh Lily C, Malbrough Marsha S, Short Charles R, Barker Steven A. Matrix solid-phase dispersion (MSPD) isolation and liquid chromatographic determination of furazolidone in pork muscle tissue. J AOAC 1991;74:292–4.
[259] Long Austin R, Hsieh Lily C, Malbrough Marsha S, Short Charles R, Barker Steven A. Matrix solid phase dispersion isolation and liquid chromatographic determination of sulfadimethoxine in catfish (*Ictalurus punctatus*) muscle tissue. J AOAC 1990;73:868–71.
[260] Long Austin R, Hsieh Lily C, Malbrough Marsha S, Short Charles R, Barker Steven A. Matrix solid phase dispersion isolation and liquid chromatographic determination of oxytetracycline in catfish (*Ictalurus punctatus*) muscle tissue. J AOAC 1990;73:864–7.
[261] Long Austin R, Malbrough Marsha S, Hsieh Lily C, Short Charles R, Barker Steven A. Matrix solid phase dispersion isolation and liquid chromatographic determination of five benzimidazole anthelmintics in fortified beef liver. J AOAC 1990;73:860–3.
[262] Long Austin R, Hsieh Lily C, Malbrough Marsha S, Short Charles R, Barker Steven A. Matrix solid-phase dispersion (MSPD) isolation and liquid chromatographic determination of oxytetracycline, tetracycline, and chlortetracycline in milk. J AOAC 1990;73:379–84.