Application News

GCMS-TQ™8040 and LCMS™-8050

# Multiresidue pesticides analysis in Curcumin color additive powder using GCMS-TQ8040 NX and LCMS-8050

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## User Benefits

- The method involves study of LOQ on both GC-MS/MS and LC-MS/MS, based on validation parameters like linearity, recovery, repeatability and within-laboratory reproducibility.
- A modified QuEChERS extraction procedure has been employed for quantifying the pesticides at trace levels from complex matrix like Curcumin powder using Ultra-Fast technologies of LCMS-8050 and GCMS-TQ8040 NX.
- LCMS Method Package for residual pesticide Ver.3 and GCMS Smart Pesticides Database™ Ver.2 from Shimadzu Corporation enables ease of optimizing instrumental method.

## 1. Introduction

Color additives are dyes, pigments, or other substances that can impart color when added or applied to a food, drug, cosmetic, or the human body. They can be found in a range of consumer products—from cough syrup and eyeliner to contact lenses and cereal.

The food color curcumin (turmeric yellow) is obtained by solvent extraction of turmeric, i.e., the ground rhizomes of *Curcuma longa* L., with purification of the resultant extract by crystallization. In India, it has been used as a food preservative and as a spice in curry dishes. Hence, considering the heavy use of pesticides in their cultivation, it is important to analyze these plant-based color additives for the presence of residual pesticides.

This application news shows validation data of the Multi-residue analysis method in complex matrix such as curcumin powder. The analysis was performed using modified QuEChERS[1] and triple quadrupole gas chromatography (GC-MS/MS) and liquid chromatography (LC-MS/MS) system.

Fig. 1 Curcumin color additive powder

## 2. Materials and Methods

The customized reference standards for 72 pesticides under study were procured from Restek Corporation.

CS-27517-1; CS-27517-2; CS-27517-3; CS-27517-4; CS-27517-5; CS-27517-6.

The curcumin powder procured from local market was used to prepare matrix-matched calibration standards and fortified samples. The calibration standards were analyzed in the range of 0.5 to 200 µg/L and 0.1 to 20 µg/L for GC-MS/MS and LC-MS/MS, respectively. Fortified samples were prepared in six replicates of each 5, 10 and 20 µg/kg. Shimadzu GCMS-TQ8040 NX (Fig. 2) and LCMS-8050 with Nexera™ X2 a front-end HPLC (Fig. 3), manufactured by Shimadzu Corporation Japan, were used as analytical tool to quantify residual pesticides in matrix.

Shimadzu's Smart Pesticides Database Ver.2 for GC-MS/MS and Method Package for residual pesticides Ver.3 for LC-MS/MS enabled quick instrumental method optimization for higher throughput. For most of the compounds, 1 target and 2 reference MRM transitions were used in the method.

Shimadzu's data processing software 'LabSolutions Insight™' was used for data processing, which helped in evaluating validation parameters with ease.

## 2.1. Sample preparation

This study uses single extraction procedure for GC-MS/MS and LC-MS/MS. For extraction, modified QuEChERS method approach was adopted. AR grade salts like sodium chloride, anhydrous magnesium sulphate ($MgSO_4$), trisodium citrate dihydrate and disodium hydrogen citrate sesquihydrate were used in optimised proportion to get maximum recoveries of pesticides. Acetonitrile was used as extraction solvent.

After extraction, clean up was performed using optimum combination of C-18, GCB (Graphitized carbon black), PSA (Primary secondary amine), zirconium and anhydrous $MgSO_4$ to minimise matrix interference, reduce instrument contamination and achieve lower LOQs.

After clean up, the aliquot of acetonitrile was divided in two parts. For GC-MS/MS, one part was reconstituted in ethyl acetate. For LC-MS/MS, the remaining aliquot was diluted using methanol and filtered through 0.22µm nylon filter.

All samples were analysed as per conditions shown in Table 1 and 2 for GC-MS/MS and LC-MS/MS, respectively.

Fig. 2 Shimadzu GCMS-TQ8040 NX

## 2.2. Analytical Conditions

Table 1 Instrument configuration and Analytical Conditions: GC-MS/MS

| System Configuration | |
|---|---|
| GC-MS/MS | : GCMS-TQ8040 NX |
| Auto-injector | : AOC™-20i + s |
| Column | : SH-Rxi-5Sil MS (30 m × 0.25 mm I.D., df = 0.25 µm) |
| Liner | : Topaz Liner, Splitless Single Taper w/Wool |
| **GC** | |
| Injector temp. | : 250 °C |
| Column oven temp | : 80 °C (2 min), 20 °C/min to 180 °C, 5 °C/min to 300 °C (3 min) |
| Run time | : 34 min |
| Injection mode | : Splitless (High pressure at 250kPa) |
| Injection volume | : 2 µL |
| Carrier gas | : He |
| Linear Velocity | : 40.4 cm/sec (Constant mode) |
| **MS** | |
| Ionization mode | : EI |
| Ion source temp. | : 230 °C |
| Interface temp. | : 280 °C |
| Solvent cut time | : 5 min |
| Loop Time | : 0.3 sec |
| Resolution | : Unit (Q1) – Unit (Q3) |

Fig. 3 Shimadzu LCMS™-8050

Table 2 Instrument configuration and Analytical Conditions: LC-MS/MS

| System Configuration | |
|---|---|
| LC-MS/MS | : LCMS-8050 |
| Auto-sampler | : Nexera X2 SIL-30AC |
| Column | : Shim-pack™ Scepter C18 (100 mm × 4.6 mmI.D., 5 µm) (P/N: 227-31020-04) |
| **LC** | |
| Flow rate | : 0.6 mL/min |
| Mobile phase A | : 2 mM Ammonium formate in water + 0.02% Formic acid |
| Mobile phase B | : 2 mM Ammonium formate in methanol + 0.02% Formic acid |
| Gradient program | : B Concentration 5-10%B (0.0 min to 1.0 min) →55% (3.00 min) → 75% (5.00 min) →90% (9.00 min) →100% (11.0-14.00 min) →10% (14.25min) →5% (14.75-18.0min) |
| Run time | : 18 min |
| Injection volume | : 5 x 5 µL (Sandwich injection with water) |
| Column oven temp | : 40 °C |
| **MS** | |
| Ionization | : ESI |
| Nebulizing gas flow | : 3 L/min |
| Heating gas flow | : 8 L/min |
| Drying gas flow | : 8 L/min |
| Interface temp. | : 300 °C |
| DL temp. | : 150 °C |
| Heating block temp. | : 400 °C |
| Resolution | : Unit (Q1) – Unit (Q3) |

## 3. Result and Discussion

Validation parameters like linearity, recovery and precision were studied against criteria set by Standard Method Performance Requirement (SMPR) (Refer Table 3). Results obtained on GC-MS/MS and LC-MS/MS are shown in Table 4 and 5, respectively.

Table3 SMPR

| Analytical range | LOQ to 100 times LOQ |
|---|---|
| Recovery % | 60-120 |
| $RSD_R$ % | ≤30 |
| $RSD_r$ % | ≤20 |

### 3.1. Linearity study

In this modified QuEChERS method, samples were diluted five times for GC-MS/MS and fifty times for LC-MS/MS analysis. Hence the matrix matched calibration standards were analyzed from much lower concentration levels i.e., 0.5 to 200 µg/L and 0.1 to 20 µg/L for GC-MS/MS and LC-MS/MS, respectively.

Accuracies of calibration curves were evaluated according to SANTE/12682/2019.[2] Representative calibration curves of compounds are shown in Figure 4 and 5. Most of the compounds showed accuracy within 80-120%. Accuracies obtained at LOQ levels, and their correlation coefficients ($R^2$) are displayed in Table 4 and 5.

### 3.2. Recovery study

Six fortified samples of each 5, 10 and 20 µg/kg were analyzed, and their mean recovery was evaluated against SMPR. All compounds showed good recovery within the range of 60 to 120% at LOQ levels. (Refer to Tables 4 and 5) As mentioned previously, fortified samples were diluted five times for GC-MS/MS and fifty times for LC-MS/MS, respectively.

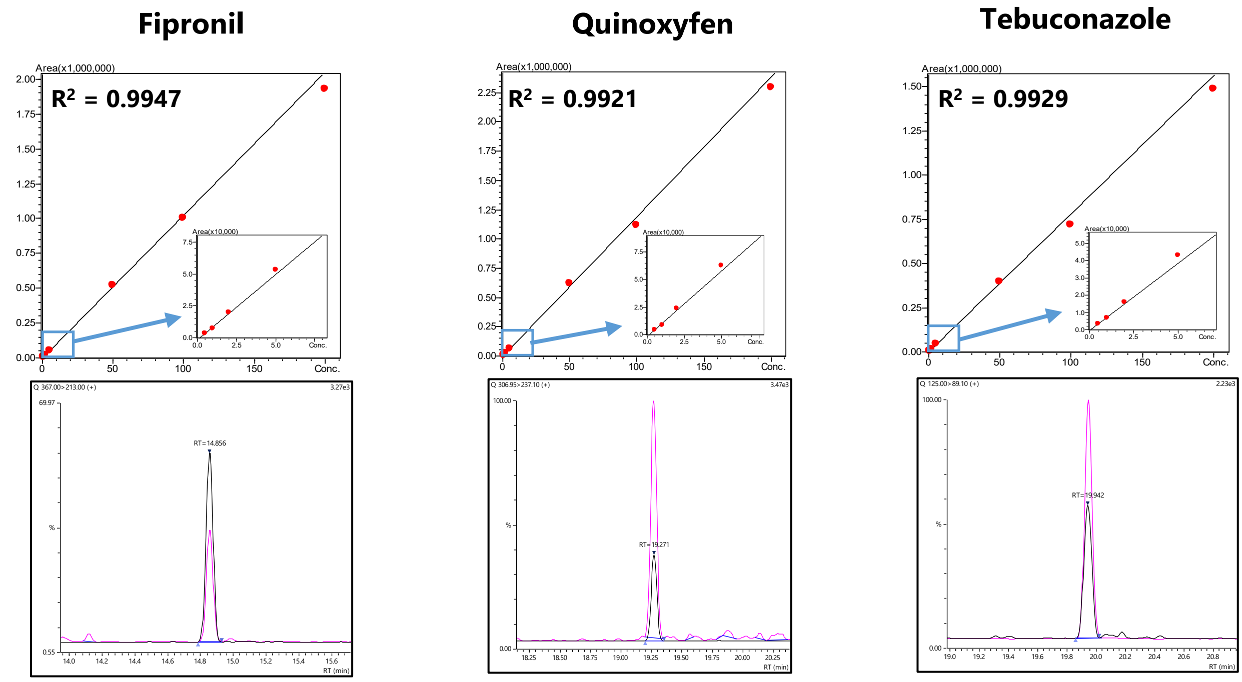


Fig. 4  Representative linearity graphs and chromatograms at LOQ level for GC-MS/MS compounds

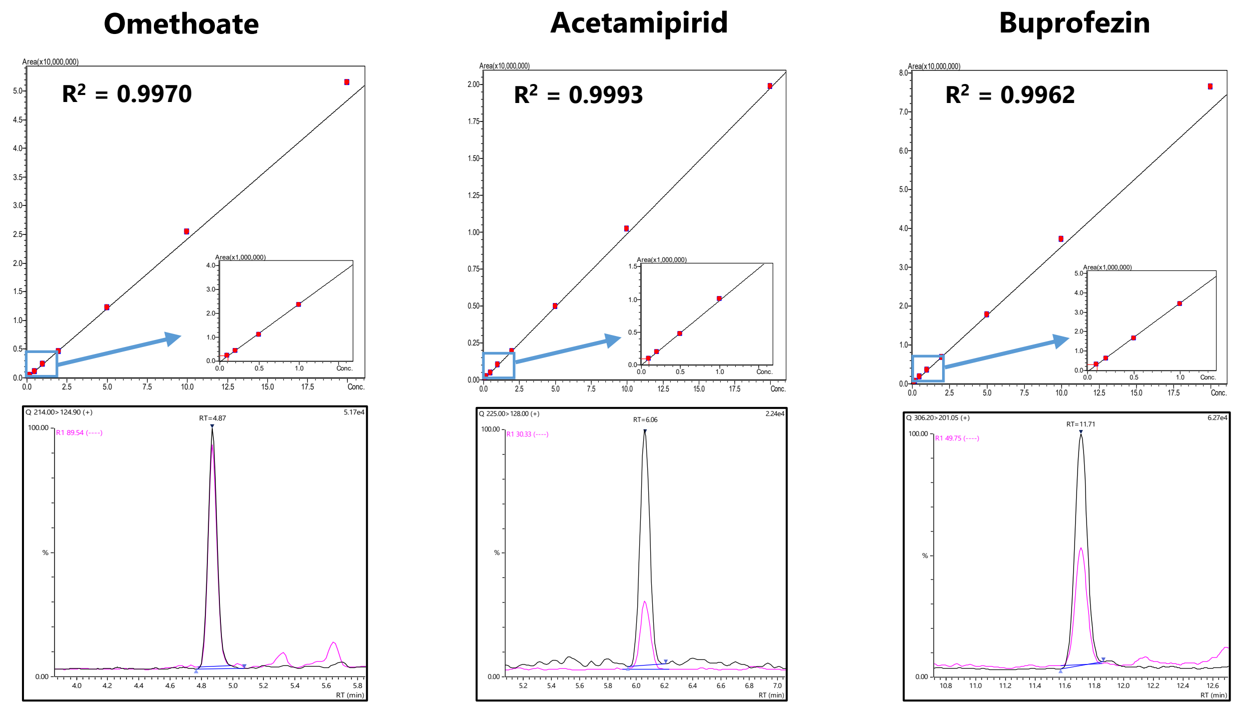


Fig. 5  Representative linearity graphs and chromatograms at LOQ level for LC-MS/MS compounds

### 3.3. Precision study

For precision, repeatability and within-laboratory reproducibility studies were carried out.

**Repeatability ($RSD_r$):** Repeatability experiment was performed by injecting six replicates at 5, 10 and 20µg/L concentration levels. The % RSD for repeatability of six injections at their respective LOQ levels were found to be less than 20%. (Refer to Tables 4 and 5)

**Reproducibility ($RSD_R$):** Reproducibility experiment for recoveries was performed on six different spiked samples at 5, 10 and 20 µg/L concentration levels. The % RSD for recovery of six spiked samples at their respective LOQ levels were found to be less than 30%. (Refer to Tables 4 and 5)

Trend graphs for recovery and precision data obtained on GC-MS/MS and LC-MS/MS are shown in Figure 6 and 7, respectively.

Out of 72 compounds analyzed, LOQs of five compounds were found to be higher than the recovery levels analyzed in this study. Among these, Cyfluthrin, Cypermethrin and Spinetoram were having less than 60% recoveries in the spiked samples whereas Linuron and Methoxyfenozide showed poor response.

This method successfully achieved 5µg/kg LOQs on GC-MS/MS and LC-MS/MS for 61 compounds. Whereas 3 compounds showed 20µg/kg LOQ on GC-MS/MS and other 3 showed LOQ at 10µg/kg on LC-MS/MS. Refer to summary Tables 4 and 5. Representative chromatograms of a few compounds at their LOQ levels are shown in Figure 4 and 5.

Table 4 Summary results of GC-MS/MS analysis

| ID | Compound Name | Ret. Time (min) | Target MRM (m/z) | CE | Matrix match linearity ($R^2$) | % Accuracy at LOQ | LOQ mg/kg | Recovery at LOQ (%) | Precision % $RSD_R$ (n=6) | Precision % $RSD_r$ (n=6) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Tetrahydrophthalimide (THPI) as Captan deg. | 8.150 | 151.10>79.00 | 18 | 0.9752 | 105.25 | 0.02 | 66.65 | 18.42 | 6.22 |
| 2 | Diazinone | 11.152 | 304.10>179.20 | 19 | 0.9919 | 90.65 | 0.005 | 87.07 | 19.04 | 12.05 |
| 3 | Pyrimethanil | 11.313 | 198.10>118.10 | 30 | 0.9855 | 93.18 | 0.005 | 73.45 | 11.59 | 9.15 |
| 4 | Metalaxyl | 12.787 | 234.10>146.20 | 20 | 0.9884 | 87.67 | 0.005 | 70.94 | 15.52 | 13.99 |
| 5 | Malathion | 13.481 | 157.95>125.00 | 9 | 0.9901 | 87.80 | 0.005 | 68.29 | 22.44 | 9.85 |
| 6 | Chlorpyrifos | 13.703 | 313.95>257.90 | 17 | 0.9828 | 77.30 | 0.005 | 63.30 | 30.85 | 20.37 |
| 7 | Cyprodinil | 14.717 | 224.15>222.10 | 24 | 0.9895 | 103.57 | 0.005 | 85.01 | 10.94 | 7.80 |
| 8 | Fipronil | 14.840 | 367.00>213.00 | 29 | 0.9947 | 90.09 | 0.005 | 81.33 | 6.83 | 12.28 |
| 9 | Triflumizole | 15.388 | 278.05>73.10 | 8 | 0.9961 | 101.48 | 0.005 | 70.96 | 12.44 | 9.78 |
| 10 | Flutriafol | 16.253 | 219.10>123.10 | 21 | 0.9875 | 89.16 | 0.005 | 78.96 | 18.01 | 13.11 |
| 11 | Fludioxonil | 16.518 | 248.05>127.10 | 27 | 0.9889 | 100.16 | 0.005 | 76.47 | 11.55 | 4.15 |
| 12 | Myclobutanil | 16.951 | 179.05>125.00 | 18 | 0.9869 | 89.74 | 0.005 | 72.99 | 14.50 | 8.23 |
| 13 | Buprofezin | 17.074 | 172.10>57.10 | 21 | 0.9843 | 110.61 | 0.005 | 83.96 | 11.51 | 10.07 |
| 14 | Chlorfenapyr | 17.373 | 247.00>227.00 | 14 | 0.9591 | 76.81 | 0.005 | 73.97 | 11.80 | 16.00 |
| 15 | Propiconazole-1 | 19.239 | 172.95>109.00 | 25 | 0.9905 | 105.33 | 0.005 | 68.88 | 25.18 | 15.40 |
| 16 | Trifloxystrobin | 19.242 | 222.05>190.10 | 5 | 0.9841 | 105.57 | 0.005 | 90.11 | 10.36 | 2.84 |
| 17 | Quinoxyfen | 19.257 | 306.95>237.10 | 24 | 0.9921 | 87.77 | 0.005 | 77.89 | 9.82 | 13.49 |
| 18 | Fenhexamid | 19.444 | 177.00>113.00 | 17 | 0.9824 | 89.93 | 0.005 | 68.68 | 11.65 | 18.51 |
| 19 | Propiconazole-2 | 19.458 | 172.95>109.00 | 25 | 0.9948 | 97.86 | 0.005 | 73.89 | 9.86 | 13.31 |
| 20 | Fluopicolide | 19.555 | 209.00>182.00 | 19 | 0.9788 | 99.78 | 0.005 | 84.60 | 18.63 | 6.83 |
| 21 | Tebuconazole | 19.936 | 125.00>89.10 | 21 | 0.9929 | 92.40 | 0.005 | 65.68 | 23.45 | 14.03 |
| 22 | Piperonyl butoxide | 20.285 | 176.05>131.10 | 13 | 0.9898 | 97.47 | 0.005 | 73.64 | 14.91 | 7.87 |
| 23 | Fluxapyroxad | 21.104 | 381.10>159.10 | 16 | 0.9813 | 94.57 | 0.005 | 90.86 | 12.88 | 7.23 |
| 24 | Iprodione | 20.864 | 187.00>124.00 | 24 | 0.9946 | 100.17 | 0.02 | 73.73 | 10.52 | 12.14 |
| 25 | Chlorantraniliprole | 21.327 | 278.00>249.00 | 20 | 0.9699 | 86.69 | 0.005 | 67.99 | 22.17 | 5.94 |
| 26 | Bifenthrin | 21.217 | 181.05>165.10 | 22 | 0.9735 | 96.84 | 0.005 | 74.80 | 12.05 | 5.60 |
| 27 | Bifenazate | 21.358 | 300.10>258.10 | 9 | 0.9701 | 89.79 | 0.005 | 68.16 | 14.04 | 11.50 |
| 28 | Etoxazole | 21.490 | 359.15>187.20 | 21 | 0.9848 | 99.68 | 0.02 | 60.16 | 4.94 | 12.22 |
| 29 | Fenpropathrin | 21.530 | 265.05>210.10 | 12 | 0.9895 | 100.05 | 0.005 | 72.25 | 16.15 | 7.18 |
| 30 | Lambda-Cyhalothrin | 23.107 | 208.05>181.10 | 9 | 0.9642 | 103.38 | 0.005 | 74.67 | 13.23 | 12.53 |
| 31 | Pyridaben | 24.826 | 147.15>117.10 | 24 | 0.9897 | 100.77 | 0.005 | 65.76 | 10.91 | 9.90 |
| 32 | Boscalid | 26.285 | 140.10>112.10 | 12 | 0.9635 | 94.48 | 0.005 | 66.44 | 11.98 | 14.77 |

Table 5 Summary results of LC-MS/MS analysis

| ID | Compound Name | Ret. Time (min) | Target MRM (m/z) | CE | Matrix match linearity ($R^2$) | % Accuracy at LOQ | LOQ mg/kg | Recovery at LOQ (%) | Precision % $RSD_R$ (n=7) | Precision % $RSD_r$ (n=6) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Methamidophos | 4.416 | 142.00>94.05 | -15 | 0.9971 | 103.8 | 0.005 | 89.87 | 2.78 | 1.16 |
| 2 | Acephate | 4.706 | 183.90>143.00 | -10 | 0.9983 | 102.6 | 0.005 | 99.99 | 3.92 | 4.5 |
| 3 | Propamocarb | 4.833 | 189.10>102.15 | -17 | 0.9984 | 103.7 | 0.005 | 64.35 | 3.02 | 3.99 |
| 4 | Omethoate | 4.882 | 214.00>124.90 | -22 | 0.9970 | 103.3 | 0.005 | 101.5 | 4.98 | 1.87 |
| 5 | Dinotefuran | 4.993 | 203.05>87.00 | -15 | 0.9990 | 101 | 0.005 | 106.83 | 3.63 | 3.9 |
| 6 | Methomyl | 5.465 | 163.00>88.00 | -9 | 0.9966 | 103.2 | 0.005 | 107.76 | 5.55 | 2.69 |
| 7 | Thiamethoxam | 5.426 | 292.00>211.00 | -12 | 0.9948 | 106.7 | 0.005 | 106.24 | 3.8 | 2.82 |
| 8 | Imidacloprid | 5.793 | 256.00>175.05 | -19 | 0.9980 | 102 | 0.005 | 110.32 | 17.39 | 4.72 |
| 9 | Clothianidin | 5.908 | 250.00>169.00 | -13 | 0.9955 | 105.7 | 0.005 | 103.54 | 6.5 | 7.62 |
| 10 | Flupyradifurone | 6.015 | 288.95>125.95 | -20 | 0.9991 | 101.8 | 0.005 | 115.31 | 3.81 | 2.45 |
| 11 | Acetamiprid | 6.082 | 225.00>128.00 | -20 | 0.9993 | 99.9 | 0.005 | 100.87 | 6.54 | 5.27 |
| 12 | Carbendazim | 6.102 | 192.00>160.05 | -18 | 0.9962 | 103.6 | 0.005 | 104.71 | 7.51 | 2.74 |
| 13 | Sulfoxaflor | 6.21 | 277.95>174.10 | -8 | 0.9964 | 104.2 | 0.005 | 103.79 | 9.44 | 4.56 |
| 14 | Dimethoate | 6.196 | 230.00>198.90 | -10 | 0.9972 | 104.5 | 0.005 | 107.07 | 2.88 | 2.79 |
| 15 | Thiacloprid | 6.342 | 253.00>126.05 | -20 | 0.9948 | 104.6 | 0.005 | 112.16 | 2.01 | 2.96 |
| 16 | Thiabendazole | 6.673 | 202.00>175.00 | -25 | 0.9964 | 104.2 | 0.005 | 91.54 | 3.71 | 1.57 |
| 17 | Carbaryl (NAC) | 7.533 | 202.00>145.00 | -11 | 0.9982 | 100.1 | 0.005 | 104.4 | 15.24 | 6.58 |
| 18 | Imazalil | 7.683 | 297.00>158.95 | -21 | 0.9984 | 101.2 | 0.005 | 80.08 | 5.49 | 7.89 |
| 19 | Flutriafol | 7.75 | 302.10>70.05 | -17 | 0.9980 | 103.2 | 0.005 | 118.62 | 6.32 | 5.18 |
| 20 | Metalaxyl | 8.03 | 280.10>220.10 | -14 | 0.9959 | 104.4 | 0.005 | 116.74 | 6.41 | 2.22 |
| 21 | Azoxystrobin | 8.333 | 404.00>371.95 | -15 | 0.9955 | 103.6 | 0.005 | 114.99 | 3.67 | 4.8 |
| 22 | Mandipropamid | 8.568 | 412.00>328.00 | -15 | 0.9914 | 108.6 | 0.005 | 112.51 | 9.27 | 6.29 |
| 23 | Dimethomorph | 8.831 | 388.00>301.00 | -21 | 0.9974 | 96.95 | 0.01 | 111.76 | 7.19 | 5.12 |
| 24 | Bifenazate | 9.109 | 301.10>198.10 | -10 | 0.9982 | 103.1 | 0.005 | 94.62 | 9.51 | 7.18 |
| 25 | Fluopyram | 9.097 | 396.90>207.90 | -21 | 0.9983 | 101.5 | 0.005 | 97.33 | 8.42 | 13.99 |
| 26 | Pyrimethanil | 9.188 | 200.10>107.10 | -25 | 0.9932 | 99.5 | 0.005 | 99.59 | 11.42 | 9.86 |
| 27 | Spirotetramat | 9.152 | 374.10>216.00 | -33 | 0.9975 | 103.8 | 0.005 | 112.96 | 5.37 | 7.35 |
| 28 | Pyriproxyfen | 9.393 | 338.95>69.95 | -22 | 0.9899 | 109 | 0.01 | 87.25 | 16.87 | 12.45 |
| 29 | Fenbuconazole | 9.376 | 337.00>124.95 | -28 | 0.9953 | 95.4 | 0.005 | 112.44 | 19.5 | 10.04 |
| 30 | Cyazofamid | 9.466 | 325.00>107.90 | -16 | 0.9988 | 101.3 | 0.005 | 102.44 | 10.7 | 17.23 |
| 31 | Diflubenzuron | 9.714 | 311.00>158.10 | -14 | 0.9936 | 100.7 | 0.005 | 97.9 | 11.21 | 11.09 |
| 32 | Tebuconazole | 10.009 | 308.10>69.95 | -24 | 0.9965 | 103.8 | 0.005 | 103.75 | 7.36 | 5.29 |
| 33 | Propiconazole | 10.256 | 342.00>158.90 | -27 | 0.9923 | 108.4 | 0.005 | 102.58 | 14.09 | 19.18 |
| 34 | Pyraclostrobin | 10.475 | 388.00>194.00 | -13 | 0.9934 | 103.1 | 0.005 | 112.16 | 7.06 | 3.15 |
| 35 | Diazinone | 10.472 | 305.00>169.10 | -21 | 0.9979 | 103 | 0.005 | 111.97 | 5.22 | 3.69 |
| 36 | Cyprodinil | 10.582 | 226.10>93.10 | -37 | 0.9988 | 99.4 | 0.005 | 103.42 | 11.75 | 8.62 |
| 37 | Indoxacarb | 10.611 | 528.00>202.90 | -40 | 0.9977 | 108.65 | 0.01 | 112.9 | 13.35 | 13.95 |
| 38 | Difenoconazole | 10.695 | 406.00>250.90 | -26 | 0.9962 | 104.7 | 0.005 | 115.8 | 8.06 | 4.07 |
| 39 | Trifloxystrobin | 10.904 | 409.00>186.00 | -20 | 0.9966 | 103 | 0.005 | 113.88 | 3.81 | 0.94 |
| 40 | Triflumizole | 11.013 | 346.10>278.00 | -10 | 0.9965 | 104.5 | 0.005 | 110.02 | 4.76 | 2.65 |
| 41 | Profenofos | 11.482 | 372.80>302.80 | -19 | 0.9965 | 104.5 | 0.005 | 76.64 | 11.81 | 12.69 |
| 42 | Buprofezin | 11.694 | 306.20>201.05 | -13 | 0.9962 | 104.7 | 0.005 | 109.5 | 4.34 | 2.63 |
| 43 | Piperonyl-butoxide | 11.969 | 356.10>177.00 | -20 | 0.9965 | 103.5 | 0.005 | 114.68 | 4.17 | 1.82 |
| 44 | Spirodiclofen | 12.542 | 411.10>313.05 | -14 | 0.9982 | 103 | 0.005 | 118.38 | 11.78 | 13.65 |
| 45 | Pyridaben | 12.989 | 365.20>147.20 | -25 | 0.9971 | 103.8 | 0.005 | 101.67 | 9.11 | 11.94 |
| 46 | Flonicamid | 5.466 | 227.95>81.00 | 8 | 0.9962 | 102.3 | 0.005 | 111.04 | 5.55 | 7.32 |
| 47 | Fludioxonil | 8.796 | 247.10>180.15 | 28 | 0.9863 | 102 | 0.005 | 106.77 | 2.98 | 2.8 |
| 48 | Fipronil | 9.42 | 434.90>330.00 | 16 | 0.9970 | 104.5 | 0.005 | 100.93 | 6.98 | 2.8 |
| 49 | Flubendiamide | 9.46 | 680.90>254.10 | 27 | 0.9947 | 106.7 | 0.005 | 105.94 | 5.4 | 3.02 |
| 50 | Novaluron | 10.797 | 491.00>470.90 | 13 | 0.9997 | 101.1 | 0.005 | 114.12 | 9.02 | 10.05 |

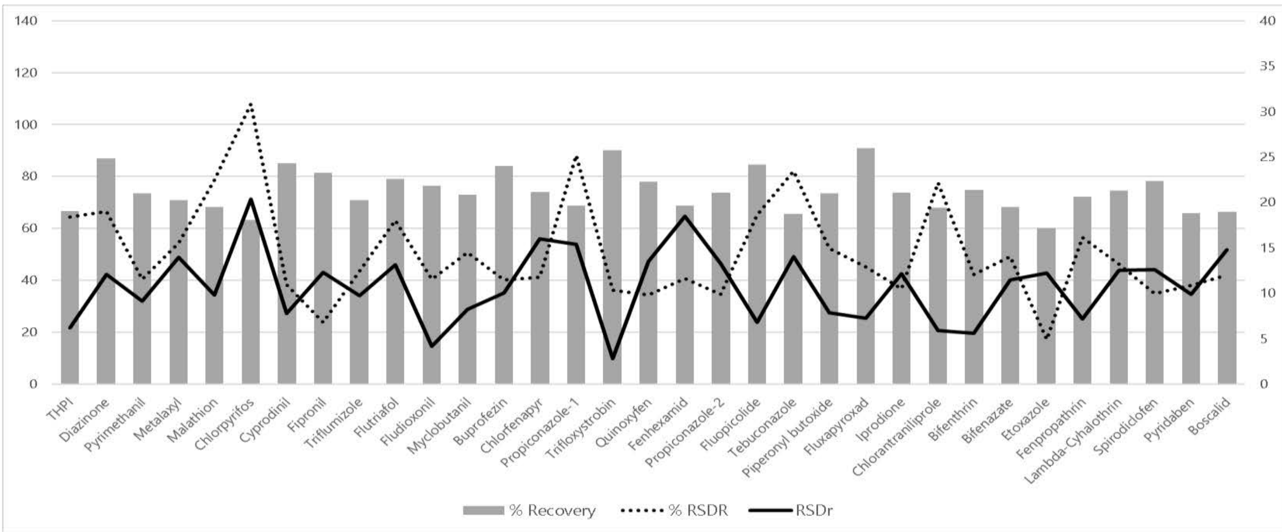


Fig. 6 Trend graph of summary results on GC-MS/MS

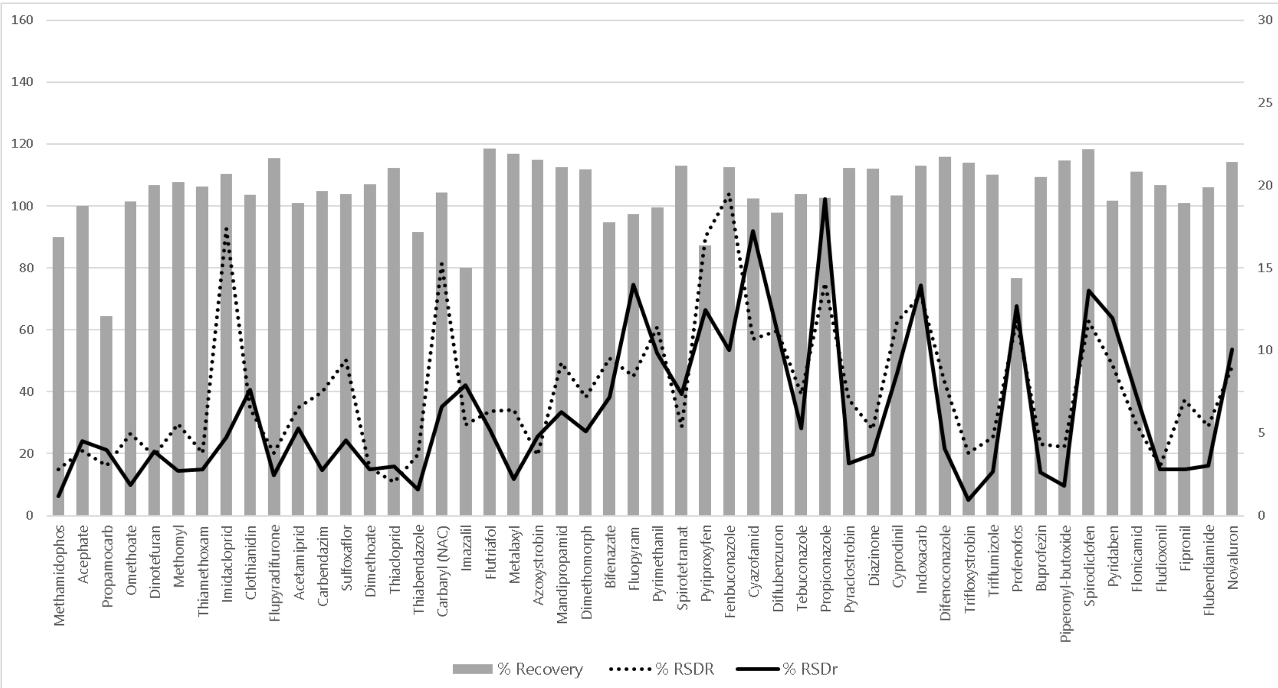


Fig. 7 Trend graph of summary results on LC-MS/MS

## 4. Conclusion

This study shows that the modified QuEChERS method combined with GC-MS/MS and LC-MS/MS achieved consistent pesticides monitoring in curcumin color additive sample.

Although it is a complex and difficult matrix, the modified QuEChERS method, suppressed interference from matrix.

The GC-MS/MS and LC-MS/MS detected trace levels of pesticides even though the sample was diluted.

As this method involves both the techniques, based on LOQ requirement, best suitable analytical tool can be selected.

## 5. References

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06-SAIP-F-01-EN First Edition: Aug. 2021

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