Micro-Review

IDENTIFICATION OF VARIOUS CHEMICAL CONSTITUENTS IN TOMATO SPECIES USING GC-MS TECHNIQUE

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ABSTRACT: GC-MS (Gas Chromatography Mass Spectrometry) is among those tools which are widely used to analyze and to profile very complicated mixtures of metabolites, like amino acids, organic acids, sugars and sugar alcohols, lipophilic compounds and phosphorylate intermediates. Advances in GC-MS technology have improved detection limits in complex samples. The ability to adjust the sensitivity requirements to match the analysis requirements makes the system useful for a wider range of applications. To study the profiles of natural and tissue cultured plants using GC-MS, is a unique idea which may lead to the production and identification of many novel bioactive compounds. Here is a review of some work done on Lycopersicon esculentum L. (tomato) a member of Solanaceae family using GC-MS technique.

Key words: GC-MS technique, Tomato, Chemical Constituents

1. INTRODUCTION

The composition of phenols from the plants namely *Solanum lycopersicon, Solanum nigrum*, *Teucrium polium, Origanum dictamnus*, *Lavandula vera* and *Lippia triphylla* was determined using GC-MS [1]. Several widely used vegetables such as; *Solanum lycopersicum*, *Solansum tuberosum*, *Capsicum annuum* and *Solanum melongena* when examined by GC-MS technique, a rich amount of vitamins and phenolic compounds were found [2]. GC-MS analysis has also been used to find the polysaccharides present in pericarp discs of tomato fruit [3]. This analysis also resulted in the detection of a wide variety of compounds in tomato. The process of metabolism of putrescine and spermidine was also examined in tomato using GC-MS [4-5].

2. BIOACTIVE COMPOUNDS IN TOMATO USING GC-MS

A GC-MS analysis was done by using D-[U-13C] glucose as a label to trace the density and to find the synthesis of polysaccharides present in pericarp discs of mature green fruit of *Lycopersicon esculentum* L. (tomato) [6]. Some specific changes were observed during biosynthesis of cell wall which includes great integration of mannosyl and xylosyl residues in the hemi-cellulosic parts of cell wall [3].

About one hundred and ninety volatile compounds were detected using GC-MS which includes aldehydes, ketones, esters, alcohols, hydrocarbons, ethers, nitrogen, oxygen, sulfur, phenols, free acids, heterocyclic compounds and lactones. Terpenes were also found present in tomato juice when analyzed using SPME (solid phase microextraction) [5].

GC-MS was used to identify and quantify the pesticide residues on various samples of tomatoes (Chart 1). Different compounds were detected such as; triadimenol, carbofuran, iprodione, chlorpyrifos, penconazole, pyrimethanil, captafol-metabolite, α and β-endosulfan and chlorfluazuron [7].

As Tomato functions the main economical food source with low-fat for obtaining energy, protein, high-quality fiber, pigments, vitamins, and also provides bioactive secondary metabolites, which either have harmful or helpful effects on diet. β-carotene, chlorophyll, lycopene, α-tomatine, dehydrotomatine tetrasaccharide, glycoalkaloids and the anti-cholinergic alkaloids, atropine are the volatile compounds found in tomato using GC-MS [8].

Methyl salicylate (Chart 2) is a plant-signaling substance, produced in response to any infection caused by viruses or herbivores to activate resistance against disease. Using GC-MS it was detected in tomato leaves as a defense response to TMV (tobacco mosaic virus) [9].

Resveratrol (Chart 2) is a stilbene phytoalexin found in wine, grape, peanut and considered as an essential food ingredient due to its chemo-preventative and anti-oxidant properties. During a GC-MS analysis, resveratrol, its *cis* isomers and 3-glucopyranoside piceid compounds were detected in the skin of tomato fruit and also it was observed that its concentration remains comparatively stable throughout fruit maturation then gradually increasing in the skin and finally not found in the flesh of tomato fruit [10].

Indole acetic acid (IAA, Chart 2) content was estimated in stamens and leaves of a normal and a stamenless-2 mutant of Tomato grown in three temperature regimes by using GC-MS-SIM (gas chromatography/mass spectrometry with selected ion monitoring) and by ELISA. By increasing temperature, the concentration of IAA was found increased in the mutant plants while had no influence in stamens and leaves of normal plants [11].

Different quantities of gibberellins (gibberellic acids) including GA_8, GA_1, GA_{19}, GA_{17}, GA_{29} and GA_{20} were detected using GC-MS from pericarp and immature seeds of tomato and higher contents were found in the seeds as compared to the pericarp and seeds contained GA_{24}, GA_{15}, GA_{44} and GA_{25} in addition [12].

Two analytical methods used from which, one was based on purge and trap and the other on SPME, both monitored by GC-MS and detected and quantify more than thirty-nine aroma compounds from fresh tomatoes. The fluoranthene metabolism in tomato cell cultures and the metabolites were detected by GC-MS [13-14].

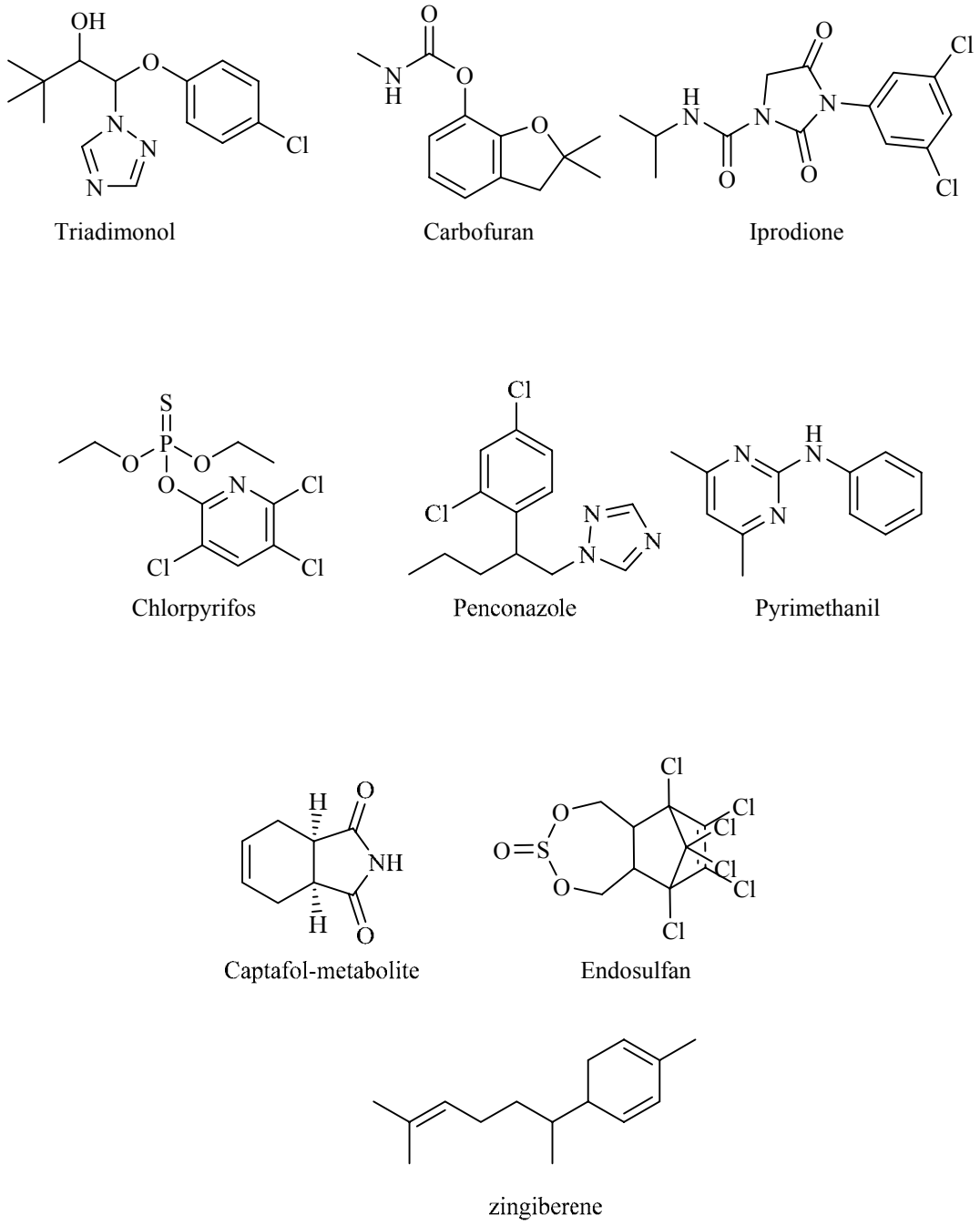

Chart 1: Identification of various pesticide residues in tomato using GC-MS.

During an experiment the volatile compounds of tomato were detected using GC-MS when inoculated with three bacterium species obtained from diseased tomatoes. A total of sixty-six volatile metabolites were found from which twenty-eight were obtained from healthy tomato fruits while fourteen were obtained on culturing with *Brevibacillus laterosporus* and *Listeria monocytogenes* whereas sixteen with *Bacillus megaterium*. Variations observed can be applied for the detection of pests in tomato [15].

By giving a heat-shock to the fruit pericarp of tomato the volatile metabolites related with chilling tolerance were obtained and identified using GC-MS. Total 363 metabolites were found from which 65 were already identified. It was concluded that on changing levels of metabolites the heat treatment not only gives protection from chilling but also affects the levels of fructose-6-phosphate, arabinose, shikimic acid and valine producing chilling tolerance [16].

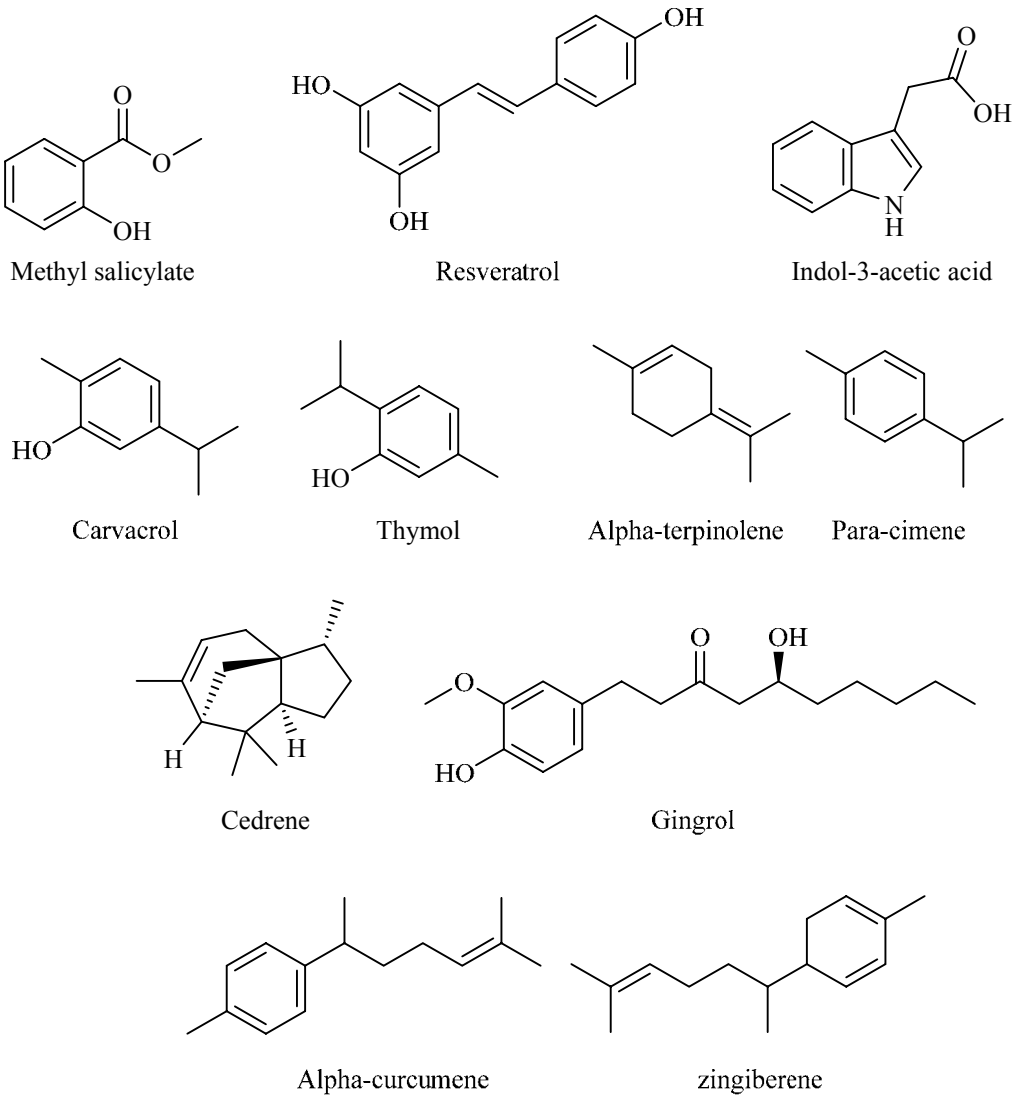

Chart 2: Chemical species identified in tomato using GC-MS.

The composition of fatty acids present in seed oil of tomato was evaluated using GC-MS. The sole constituents of seed oil of tomato involved linoleic acid (48%), palmitic acid (17%) and oleic acid (9%). So seed oil of tomato was found as the best source to get the most significant fatty acids like oleic acid and linoleic acid [17].

The activity of fungicides in five plant extracts was evaluated to check their anti-fungal effect of phytopathogenic fungi on tomato. *Pythium aphanidermatum, Fusarium oxysporum, and Rhizoctonia solani*, are the causative agents of damping-off disease in tomato. Three out of 5 extracts were found more efficient against these fungi. *Z. officinale* and *T. vulgaris* extracts were found effective and showed fungicidal activities against the fungi. GC-MS analysis of the plant extracts which were effective showed that T. *vulgaris* extract consists of 19% carvacrol, 38% thymol, 5% α-terpinolene and10% Para-cimene whereas *Z. officinale* consisted of 8% cedrene, 46% Gingerol, 7.32% α-curcumene and 7% zingiberene (Chart 2). These plant extracts might be involved in the development of effective and harmless alternative for environment to regulate tomato phytopathogenic fungi causing damping- off [18].

The quantity and quality of twelve organic and conventional tomato juice samples to determine the volatile compounds in tomato juices was done using GC-MS analysis. In organic samples, higher number of volatile compounds was found than that of conventional samples. Furthermore, faulty tomato samples were found to contain higher quantities of 3-methyl-1-butanol [19].

Recently a study was conducted to describe a validation process following document SANCO/12495/2011 and norm NTC-ISO/IEC 17025, multi-residue multi-class methods using the quick, easy, cheap, effective, rugged and safe (QuEChERS) sample preparation method and analysed the pesticides in tomatoes (*Solanum lycopersicum*), tamarillos (*Solanum betaceum*) and goldenberries (*Physalis peruviana*)

using GC-MS. The residues were validated over a range from 0.02 mg/kg to 0.20 mg/kg, with 24 analytes validated in tomatoes, 33 in tamarillos and 28 in goldenberries [20].

3. CONCLUSION

The current review summarizes that GC-MS is a beneficial technique which may be used in many ways such as; to trace the density and to find the synthesis of polysaccharides present in pericarp, to identify and quantify the pesticide residues, to detect gibberellins from pericarp and immature seeds of tomato, to produce a number of volatile compounds and bioactive primary and secondary metabolites etc. Further research is required to detect and produce specific volatile compounds which are useful in pharmaceuticals, pest control and other such purposes in future.

4. REFERENCES

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