



## EVALUATION OF TURMERIC WATER AND SALT WATER IN REDUCING IMIDACLOPRID RESIDUE IN *CAPSICUM ANNUUM*

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### INTRODUCTION

In today's world, exposure to toxins—especially pesticides—has become inevitable due to rapid industrialization, urbanization, and increased agricultural demand. According to the World Health Organization, about 3,000,000 cases of pesticide poisoning and 220,000 deaths are reported annually in developing countries.<sup>[1]</sup> Human beings, especially infants and children, are more vulnerable to the deleterious effects of pesticides due to their non-specific nature and inadequate application.<sup>[2]</sup> Pesticide exposure may result in chronic or acute poisoning. Synthetic pesticides like Imidacloprid, a neonicotinoid, are widely used for crop protection but accumulate in plant tissues, including commonly consumed vegetables such as *Capsicum annuum*. Imidacloprid breakdown products—for instance, desnitro-imidacloprid—have a high affinity for mammalian nAChRs and are known to be highly

toxic to mice.<sup>[3]</sup> These metabolites can be formed either in a mammal's body during metabolism or in the environment.<sup>[4]</sup> Imidacloprid has a strong potential to persist in the environment, breaking down into various compounds and accumulating in water, soil, air, and plant residues, making it one of the most concerning pesticides for ecological and human health. Chronic exposure to such residues can lead to cumulative toxicity in humans, resembling long-term nicotine poisoning.

*Capsicum annuum*—commonly known as chilli, green chilli, or pepper—is one of the most widely used spices in households, and thus human exposure is nearly universal. Its high

demand ensures intensive agricultural production, during which Imidacloprid is frequently employed to reduce pest-related losses. It is applied at various stages of cultivation—seed treatment, sapling growth, transplantation, pre-flowering, and pre-harvest—leading to multiple exposures and increased deposition of residues within plant tissues. As this spice is consumed daily, constant and consistent exposure to Imidacloprid occurs, facilitating its accumulation in the human body and contributing to cumulative or chronic toxic effects. Ayurveda recognizes this gradual toxic accumulation Dooshivisha<sup>[5]</sup> and offers detoxifying approaches. Hence, finding simple, economical methods to reduce pesticide residues in daily foods is essential to minimize health risks and enhance public safety. This study focuses on such an approach.

In Ayurveda, Acharya Charaka has described a group of ten herbs known as *Vishagna Dashemani*, beneficial in managing toxic conditions.<sup>[6]</sup> Among them, Turmeric (*Curcuma longa*) is widely available and commonly used in Indian households for its diverse pharmacological properties, including antiseptic antidiabetic and anti cancerous effects. Recognizing its potential, this study explores the efficacy of turmeric water in reducing pesticide residues from *Capsicum annuum*, a frequently consumed spice.

## MATERIALS AND METHODS

Fresh *Capsicum annuum* samples were collected from local farmers in the Hassan region to ensure authenticity and minimal external contamination. Organic Turmeric (*Curcuma longa*) rhizomes were procured, cleaned, and pounded into powder for preparation of Turmeric Water in two concentrations: 12 g/L and 24 g/L. Imidacloprid standard suitable for GC-MS analysis was sourced from Sigma Aldrich for quantification purposes. Six test groups were analyzed: the imidacloprid standard, untreated *Capsicum annuum*, samples washed with potable water, samples treated with Turmeric Water in two concentrations, and those washed with salt water (12 g/L), a common household practice.

For residue extraction, 10 grams of homogenized sample was mixed with 50 mL water and sonicated for 15 minutes. The homogenate was filtered using Whatman No. 1 filter paper. From the filtrate, 25 mL was partitioned three times with 5 mL chloroform in a separating funnel. The chloroform layer was collected, dried over anhydrous sodium sulfate, evaporated under reduced pressure, and reconstituted in 1 mL chloroform for analysis.

Gas Chromatography-Mass Spectrometry (GC-MS) was conducted using a Thermo Scientific TSQ 9000 instrument with a TG-5MS column (30 m × 0.25 mm, 0.25 µm). The injection was done in splitless mode at 200°C with a volume of 2 µL. The oven temperature was programmed to start at 76°C (held for 1 minute), increase at 20°C/min to 270°C, and hold for 3 minutes. The mass spectrometer was operated in Selected Ion Monitoring (SIM) mode, with an interface temperature of 300°C and electron multiplier voltage ranging from 1750 to 2100 V. The selected ions used for quantification were m/z 211 and 99. The imidacloprid residue was calculated using the formula: (Sample Area / Standard Area) × Standard Concentration × Dilution Factor.

## RESULTS

All six experimental groups in the study were analyzed using GC-MS, and the following results were obtained. The first sample is of the Sigma standard of the Imidacloprid which is in its pure form provided the concentration of 10 µg/ml which is used to identify the compound for further analysis of the samples. Second sample is of the Capsicum annum which is collected from the farmer and subjected to the analysis of residue level of pesticide in the sample which showed the results as 5.79 µg/ml which is exorbitantly high when compared to the WHO standard of acceptable daily limit of 1 µg /kg. Third sample is of the Capsicum annum after washing with the potable water it showed some reduction in the residue level of 17.61% which brought the residue to the 4.77 µg/ml. Fourth sample analysed in the GCMS is of the Capsicum annum washed with 1.2 % Turmeric Water which showed the reduction upto 35.23 % which reduced the residue to 3.75 µg/ml. Fifth sample is of the Capsicum annum washed with 2.4% Turmeric Water which reduced the residue by 63.90% which brought down the residue to 2.09 µg/ml. Sixth sample is tested with the Capsicum annum washed with 1.2% salt water solution which showed the highest result in the reduction of the pesticide by 86.70 % which brought down the residual value to 0.77 µg/ml.

**Table I: Pesticide reduction values.**

| Sample                | Retention time(min) | Area    | Imidaclopride conc(µg/ml) | Percentage of reduction |
|-----------------------|---------------------|---------|---------------------------|-------------------------|
| Imidacloprid Standard | 9.67                | 5596675 | 10.00                     |                         |
| Non treated           | 9.684               | 810226  | 5.79                      |                         |
| Normal water          | 9.684               | 666832  | 4.77                      | 17.61%                  |
| 1.2% Turmeric Water   | 9.69                | 525176  | 3.75                      | 35.23%                  |
| 2.4% Turmeric Water   | 9.687               | 292883  | 2.09                      | 63.90%                  |
| 1.2% NaCl solution    | 9.682               | 107710  | 0.77                      | 86.70%                  |

## DISCUSSION

The present study demonstrates that household washing methods can significantly reduce imidacloprid residues in *Capsicum annuum*. The untreated sample contained residues (5.79 µg/mL) far exceeding the WHO-recommended acceptable daily intake of 1 µg/kg, underscoring the urgent need for effective decontamination strategies before consumption.<sup>[7]</sup>

Washing with potable water resulted in only a modest reduction (17.61%), which is consistent with previous studies showing limited removal of systemic pesticides by plain water rinsing due to their physicochemical properties and penetration into the plant cuticle<sup>[8]</sup> In contrast, turmeric water exhibited concentration-dependent efficacy, with 2.4% turmeric solution reducing residues by nearly 64%. This effect may be attributed to the bioactive constituents of turmeric, particularly curcuminoids, which possess surfactant-like and chelating properties that can facilitate solubilization and dislodgement of pesticide residues. Similar findings have been reported where plant-based washes showed potential in reducing organophosphate and neonicotinoid residues.<sup>[9]</sup>

The most effective intervention in the present study was saline washing, where 1.2% salt water reduced residues by 86.7%, lowering concentrations to 0.77 µg/mL. The mechanism likely involves increased ionic strength and osmotic pressure, which can disrupt adherence of pesticide residues on the vegetable surface<sup>[9]</sup> Prior studies have also confirmed the superior efficacy of saline and alkaline washes in removing surface-bound pesticide residues compared to water alone.<sup>[10]</sup>

Taken together, these findings suggest that readily available, low-cost household interventions—particularly saline washing—are effective in substantially reducing pesticide contamination in vegetables. While turmeric water demonstrated moderate efficacy, further studies are warranted to explore optimal concentrations, contact times, and possible synergistic effects with other natural agents. Additionally, although GC–MS analysis provided reliable quantification of imidacloprid residues, the scope of this study was limited to a single neonicotinoid pesticide and a single vegetable matrix. Broader investigations across different pesticides, crop types, and washing practices would enhance the generalizability of these results.

## CONCLUSION

The present study demonstrates that simple household washing methods can substantially reduce imidacloprid residues in *Capsicum annuum*. Among the tested treatments, potable water achieved only minimal reduction, while turmeric water showed concentration-dependent efficacy. The highest residue reduction was observed with 1.2% saline washing, which lowered imidacloprid levels by nearly 87% and brought the residues closer to the WHO safety threshold. These findings highlight the practicality and effectiveness of low-cost, accessible interventions such as saline washing for minimizing dietary exposure to pesticide residues. Further research is warranted to evaluate these approaches across a broader range of pesticides, food matrices, and household conditions to strengthen their applicability as public health recommendations.

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