

## Research Article

# Uptake and Dissipation of Carbofuran and Its Metabolite in Chinese Kale and Brinjal Cultivated under Humid Tropic Climate

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Carbofuran is an insecticide with a broad spectrum of activity and is relatively cheap. It is banned in many countries in the world; however, it remains widely used in Asia, Australia, and South America. Carbofuran is commonly used in vegetable farming in Malaysia and it is a legally registered pesticide. This study reports the uptake and dissipation of carbofuran and 3-ketocarbofuran in Chinese kale and brinjal under humid tropic field conditions. The residue profile in plants demonstrated an increase to a maximum, followed by a consistent reduction to a level below the limit of determination ( $<0.01$  mg/kg) over the experimental period. The maximum residue concentration was attained on Day 3 for kale (1.16 mg/kg fresh weight) and Day 7 for brinjal (0.06 mg/kg fresh weight) after carbofuran application. In order to comply with the maximum residue level (MRL) of 0.01 mg/kg, the preharvest interval for kale and brinjal were suggested at 23 and 28 days, respectively. The preharvest interval indicates that carbofuran is not recommended for Chinese kale but it is acceptable for brinjal. The average half-life of carbofuran in soil is 1.24 days, shorter than the literature values reported based on temperate condition, indicating accelerated dissipation under tropical climate. The estimated half-life of carbofuran in leaves was shorter than that in fruits with kale leaves reported at 2.54 days whilst brinjal leaves and fruits recorded at 3.22 and 10.33 days, respectively.

## 1. Introduction

The use of pesticides is an almost indispensable practice in vegetable farming in order to meet the continuous increase in demand and expectation. In 2016, Malaysia exported a total of 1,504,918 tonnes of vegetables, compared to 281,391 tonnes in 2011 [1, 2]. The consumer expectation of unblemished vegetables further intensifies the reliance of farmers on pesticides.

Carbofuran is an insecticide, acaricide, and nematicide that is widely used in vegetable farming in Malaysia. It has a broad spectrum of activity and is relatively cheap. In paddy and oil palm plantations, carbofuran is used for control of rhinoceros beetle and rodent [3]. The use of carbofuran has become an issue after several incidents of carbofuran detection in vegetables, higher than the Maximum Residue Level (MRL). These include a news report of 900 kg of vegetables tainted with carbofuran from Malaysia and Thailand [4] and The

European Commission has also reported a residue concentration of 0.33 mg/kg in fresh Chinese kale imported to Finland from Thailand [5]. The concern is further escalated with more claims of excessive use of carbofuran in durian and watermelon from Thailand, as pointed out by Wanwimolruk et al. [6].

As a matter of fact, carbofuran has been banned in Canada, the European Union, and United States due to numerous cases of bird poisoning [7]. According to the Royal Society for Protection of Birds [8], a total of 316 cases of bird poisoning involving carbofuran were reported in the UK in year 2002–2011. The secondary metabolites of carbofuran, specifically 3-ketocarbofuran and 3-hydroxycarbofuran, are also found lethal. In 2004, a total of 187 vultures and hyenas were killed after scavenging the bird carcasses containing carbofuran residue and its metabolites [9]. Despite that, carbofuran continues to be widely used in Asia, Australia, and South America; it is a legally registered pesticide in Malaysia. The next question to