Review articles & Short notes

Mustard oil bomb' in herbivory defense mechanism- A review

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Introduction

Mustard (*Brassica nigra* L.; Family: Brassicaceae) and rapeseed (*Sinapis spp*. L.; Family: Brassicaceae) plants are annual shrubs, grown in *rabi* season, belongs to order Cruciferae. Plants possess a wide range of morphological barriers (Trdan *et al*., 2009) and toxic biochemical substances (secondary metabolites) to protect themselves against harmful insect pests (Lucas-Barbosa *et al*., 2011). Secondary metabolites are inherited due to the evolutionary advantages they impart to the plant for defense from abiotic and biotic stress (Dong and Kahmann, 2009). The *Brassica* plants contain many phytochemicals that have medicinal value. The main phyto-chemicals present in *Brassica* species include polyphenols, phenolic acids, flavonoid, carotenoids (zeaxanthin, lutein, β carotene), tannins, alkaloids, saponins, anthocyanins, phytosterols, chlorophyll, glucosinolates, phytosteroids, terpenoids, glycosides, vitamin C, vitamin E and aliphatic and aromatic amines. Edible parts of Brassica plants show biological activities against different diseases and very effective in treating various diseases in humans like anti-microbial, anti-bacterial, anti-diabetic, anti-malarial, ant-aging, anti-ulcer, anti-hyperglycemic, anti-hyperlipidemic, anti-proliferative, neuro-protective, anti-genotoxin and anti-oxidant activities (Nawaz *et al*., 2018).

Glucosinolate is plant organic compound abundantly found in all Brassicaceae crops (Thinh-Nguyen *et al*., 2020). Glucosinolate derived from amino acids, which are glucosylated specialized metabolites (Blazevic *et al*., 2020) constituted of a β-thioglucose moiety, a sulfonated oxime moiety, and a structurally diverse side chain are categorized into aliphatic, indolic and benzenic glucosinolates (Agerbirk and Olsen, 2012). Glucosinolates have sulfur rich S-cells (Koroleva and Cramer, 2011), whereas the activating enzymes, myrosinases are present in protein enriched idioblasts called myrosin cells (Rask *et al*., 2000). Glucosinolates are present in plants in non-toxic and non-volatile form and are also known as 'mustard oil bomb' (Kissen *et al.*, 2009) in the event of herbivory by insects they are broken down by hydrolytic myrosinase to isothiocyanate or thiocynate or nitrite. About 130 glucosinolate structures have been discovered, sinigrin the most abundant aliphatic glucosinolates in Brassicaceae, directly controls

soil borne plant pests (Borek *et al*., 1994), indolic glucosinolate are involved in insect-deterring functions (Bednarek *et al*., 2009). Glucosinolate are important defense compounds in Brassicaceae against herbivores and pathogens. Glucosinolates contents and compositions vary depending on the *Brassica* species and insect damage (Tripathi and Mishra, 2007). It acts as an herbivory defense system deterrent herbivores and aiding parasitoids and predators (Hopkins *et al*., 2009).

Effect of glucosinolate on monophagous and polyphagous insect pests

Monophagous are those insects which feed on only a single species of plant or limited host range that is also known as specialist insect. Also define polyphagous and generalist. These specialists consume plants containing toxic compounds to detoxify or neutralize glucosinolate compound by enzymatic decomposition, excretion and sequestration, thereby converting into less toxic or non-toxic compounds (Poelman *et al*., 2008). Some specialists continuously feed the secondary metabolites, and develop a tolerance by depositing in their tissue to utilize for their defence (Fahey *et al*., 2001). Glucosinolate serve as attractant or stimulate (feeding and oviposition) for specialist insects (Wittstock *et al*., 2003). Some examples of specialists insects *Plutella xylostella*, has a sulfatase in its gut which cleaves the sulfate residue from the glucosinolate core structure and thus prevents its hydrolysis by myrosinase. The aphid *Brevicoryne brassicae* has been reported to possess its own myrosinase which produces isothiocyanates from sequestered glucosinolates when the aphid is damaged or killed. Interestingly, these isothiocyanates even serve as alarm signal to other members of the colony. Larvae of the *Pieris rapae* (cabbage white butterfly) form nitrite specific protein (NSP) in its gut to escape hydrolysis reaction by myrosinase. In brassicaceous plants, secondary chemicals, glucosinolates and their breakdown products effectively decrease performance of generalist herbivores (Agrawal and Kurashige, 2003). Glucosinolate products serve as defence compounds against generalist herbivores (ex. *Mamestra brassicae, Spodoptera eridania*) and it acts as biopesticides. Generalist herbivores are usually more sensitive to high levels of specific allelochemicals compared to specialists (Giamoustaris and Mithen 1995).

Conclusion

Many studies have been conducted worldwide regarding the study of glucosinolate as an active plant ingredient that regulates the population of monophagous and polyphagous pest. Myrosinase-glucosinolate system is present in plants of the Brassicaceae family. The enzyme myrosinase degrades glucosinolates into toxic products. This system is activated upon attack and is one of the defence barriers towards insect pests and pathogens. Sinigrin is the major glucosinolate present in *B. juncea* and gluconapin is the major glucosinolate in *B. napus* and the chemical defence mechanism (especially glucosinolates) is predominant in Brassicaceae (Bjorkman *et al*., 2011). According to Hopkins *et al*., (2009) high concentration of glucosinolates has an antibiotic

effect on both generalist and specialist pests. Schoonhoven *et al*., (2005) reported that some specialist herbivores even accumulate intact glucosinolates and use them for their own defence.

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