Revisiting Carica Papaya L. Latex Potentials May Resolve Agricultural Infestation Problems

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Abstract: Infestation problems are among the top concerns of many farmers worldwide. The use of synthetic pesticides as one of the pest control methods had been employed which caused many negative impacts both in the environment and human health. Effectivity of synthetic pesticides is only short-term which cannot compel for its undesirable impacts. Researches investigating plant potentials as an alternate pesticide for pest control were suggested as a promising solution without sacrificing the environment and its components. *Carica papaya L.* latex is known to contain a lot of phytochemicals including papain, a cysteine proteinase thought to effectively involved in plant defense against herviborous insects, mollusc, fungi and other farm pests. Hence, this review summarizes the *C. papaya L.* latex potentials as pesticide, molluscicide and fungicide in order to pave the way for an alternate pests control without damaging the components of the ecosystem and environment.

Keywords: Biopesticide, *Carica papaya L.,* cysteine proteinase, herviborous insects, latex laticifers, papain

Introduction

Food shortages and environmental degradation like pollution are two issues which should be given top priorities and need immediate attention since their impacts on the biosphere have reached to a serious level causing more complex problems to arise. The fast increase of human population is one of the main causes of food shortages of many countries. This has led to many individuals to engage in farming as one of the options to elevate agricultural production. Agriculture plays a very significant role in the economic stability of many nations. This is because it provides human beings with some of the basic needs including the food and raw materials. Though agriculture has significantly improved the economic condition of many countries, many challenges have been met. One of which is the problem on pest control. Farmers rely on synthetic pesticides to eradicate pest attack in the farms. However, the turn out of the pesticides as applied in many farms has never been beneficial to the environment specifically to the ecosystem. Pesticide application contributes to environmental degradation, a serious problem at times. Worldwide crop losses without the use of pesticides and other non-chemical control strategies is estimated to be about 70% of crop production, amounting to US$ 400 billion.

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The world wide pre-harvest losses due to insect pests, despite, the use of insecticides is 15% of total production representing over US$ 100 billion (Krattiger, 1997). The annual cost of insect control itself amounts to US$ 8 billion, thus warranting urgent economical control measures (Lawrence and Koundal, 2002). The use of synthetic pesticides as one of the well-known methods posed various side effects both in the environment and human health. The continuous and indiscriminate use of chemicals in agriculture posed the problem of acute and chronic toxicity to man (Kamel and Mangla, 1987). Likewise, the use of chemicals are of great concern to man; they can cause death through poisoning, accumulate in man, concentrate in food chains, because they are often not easily biodegradable, they cause resurgence and resistance in pathogens and pest populations, and destroy parasites, predators and flower pollinators (Taiga, et al., 2008). Chemicals pose hazards to ecosystem through induced resistance against target organisms and undue inundation of the environment with organic pollutants (Chukwuemeka and Anthonia, 2010). The exclusive use of use of chemical pesticides not only result in rapid build-up of resistance to such compounds, but their non- selectivity affects the balance between pests and natural predators, and is generally in favour of pests (Metcalf, 1986). Under these circumstances, provision of food to the rapidly expanding population has always been a challenge facing mankind. Today, much and serious endeavours are put on to give emphasis on plant-natural products as there is a need to look for long-lasting and reliable solutions that respect the requirements of man and environment (Taiga, et al., 2008). Biological control presents a better alternative with relative amount of cheapness, no side effects and reduced resistance (Okigbo, 2003; 2004; 2005; Okigbo and Ikediugwu, 2000; Okigbo and Nmeka, 2005). The use of pesticides of plant origin has been suggested by some workers as alternatives to synthetic chemicals, in order to counter the potential hazards and pollution problems associated with the use of synthetic chemicals (Amadioha, 2000; 2002).

Carica papaya L. essential features:

It is a fast growing tree-like herbaceous plant which belongs to the Family Caricaceae (Fig.1). It is called “pawpaw” or “papaw” or often known as “papaya” in many countries. It is likely that *C. papaya* originates from the lowlands of eastern

Central America, from Mexico to Panama (Nakasone and Paull, 1998). It was deliberately introduced to Australia more than a century ago as a horticultural crop for fruit production (Garrett, 1995). Its seeds were distributed to the Carribean and south-east Asia during Spanish exploration in the 16th Century, from where it spread rapidly to India, the Pacific and Africa (Villegas, 1997). The papaya tree (*Carica papaya*) is cultivated in many tropical areas under appropriate temperature range of 21–33^{o}C and mildly acid soil with pH range 6.0–6.5 (Nathalie, et al., 2010).

Figure 1. *Carica papaya L.* plant.

Carica papaya has a distinguishable characteristic based primarily on the color of its flesh; red and pink-fleshed cultivars are often known as 'papaya' while the yellow-fleshed fruits, known as 'paw paw', but both are refered to the same plant species. It is a soft-wooded perennial plant that lives for about 5-10 years (Chay-Prove, et al., 2000). Papayas normally grow as single-stemmed trees with a crown of large palmate leaves emerging from the apex of the trunk, but trees may become multi-stemmed when damaged (Villegas, 1997). It has a soft, hollow, cylindrical trunk ranges from 30 cm diameter at the base to about 5 cm diameter at the crown. Under optimal conditions, trees can reach 8-10 m in height but in cultivation, they are usually destroyed when they reach heights that make harvesting of fruit difficult. There are actually two distinct types of *C. papaya* plants: dioecious and gynodioecious. Dioecious papayas have male and female flowers (Fig. 2) on separate trees. Fruits (Fig.3) are ready to harvest from 5 to 6 months after flowering, which occurs from 5 to 8 months after seed germination (Chay-Prove, et al., 2000). The fruits range in size from 7 to 30 cm long and vary in mass from about 250 to 3000 g (OECD, 2003). Reports have shown that low temperatures could destroy fruit development. Temperatures below 12-14ºC strongly retard fruit maturation and adversely affect fruit production (Nakasone and Paull, 1998). Moreover, *Carica papaya* belongs to a group of plant species known as laticiferous plants

Figure 2. *C. papaya L.* flower.

Figure 3. *C. papaya L.* fruit with dripping latex on the aluminum tray.

which are thought to have contained specialized cells called laticifers and are dispersed throughout most plant tissues that secrete a substance known as 'latex'. All plant parts can contain latex. The commonly examined tissues of latex-bearing plants are stem and leaf tissue. Latex exudation from reproductive tissues (buds, flowers and fruits) is commonly observed, but like the root latex, is far less studied than the stem and leaf latex (Agrawal and Konno, 2009).

Scientific classification

Kingdom:	Plantae
(unranked):	Angiosperms
(unranked):	Eudicots
(unranked):	Rosids
Order:	Brassicales
Family:	Caricaceae
Genus:	*Carica*
Species:	*C. papaya*
Binomial name:	*Carica papaya* L.

Carica papaya L. latex potentials:

Latex is a complex mixture of chemical compounds with diverse chemical activities. It is a sticky emulsion that exudes upon damage from specialized canals in about 10% of flowering plant species. In many laticiferous plants, latex is stored under pressure which implies that it is abruptly expelled in response to cuts and bites by plant predators (El Moussaoui, et al., 2001). Collectively, these compounds are thought to be involved in defence of the plant against a wide range of pests and herbivores. Latex has no known primary metabolic function and has been strongly implicated in defense against herbivorous insects. Herbivores that feed on latex-bearing plants typically evade contact with latex by severing the laticifers or feeding intercellularly or may possess physiological adaptations (Agrawal and Konno, 2009). Experimental evidence has shown that latex contributes to plant protection against predators that could be achieved either mechanically or chemically (El Moussaoui, et al., 2001). For example, as a result of coagulation, latex droplets can eventually harden to the point of virtually muzzling predators (Dussourd and Eisner, 1987). In addition, toxic substances, when present in latex, have been shown to have a negative impact on both insect feeding rate and predator fitness (Malcolm and Zalucki, 1996). Moreover, *Carica papaya* belongs to a group of plant species known as laticiferous plants which are thought to have contained specialized cells called laticifers and are dispersed throughout most plant tissues that secrete a substance known as 'latex'. All plant parts can contain latex. The commonly examined tissues of latex-bearing plants are stem and leaf tissue. Latex exudation from reproductive tissues (buds, flowers and fruits) is commonly observed, but like the root latex, is far less studied than the stem and leaf latex (Agrawal and Konno, 2009). *Carica papaya L.* is the most important species within the Caricaceae, being cultivated widely for consumption as a fresh fruit and for use in drinks, jams candies and as dried and crystallized fruit (Villegas, 1997). Also, its green fruit, leaves and flowers are used as cooked vegetable (Watson, 1997). Biochemically, its leaves and fruit produce several proteins and alkaloids with important pharmaceutical and industrial applications (El Moussaoui, et al., 2001). *C. papaya* preparations are efficiently used in tissue burn, microbial/helmintic infection. It has antioxidant, immunomodulatory, hypoglycemic and hypolipidemic effects and it has insecticidal/molluscicidal activity against various pests (Singh, et al., 2010). Aqueous extracts of *C. papaya* latex contain some cysteine proteinases (Brocklehurst, et al., 1981). One of these is papain, a thiol protease with many industrial applications in the food and pharmaceutical industry as meat tenderizer, digestive aid, clarifying agent in breweries, contact lens cleaner or bloodstain remover in detergents (Leipner and Saller, 2000). Considering that, cysteine proteinases may constitute as much as 80% of the enzyme fraction in papaya latex (El Moussaoui, et al., 2001). Potential roles in defence against pathogenic microorganisms or against herbivory are likely for most of the enzymes isolated from papaya latex to date.

Future Perspectives:

First, more researches on the significant potentials of *C. papaya L.* latex applications on pests. Studies on *C. papaya L.* could focuss on the responses of herviborous insects, mollusks, fungi and other pests damaging agricultural farms but not limited to plant responses as well. Second, the role of latex proteins specifically papain as one of cysteine proteinases constituting 80% of the enzyme fraction in papaya latex must be supported with research-based answers in order to clear out the contradicting opinion that proteinase inhibitors (PIs) actively contribute to plant defence mechanisms. Moreover, the mechanisms of protease toxicity towards pests must be made known and explored in the benefit of pest management.

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