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JSM Tropical Medicine and Research

Editorial

Biopesticide Production from Environmental Wastes

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Submitted: 12 Augsut 2016

Accepted: 12 August 2016

Published: 20 September 2016

EDITORIAL

Vector-borne diseases create a major element of communicable diseases (filariasis, malaria, dengue and Japanese encephalitis) in India and in other Asian countries. Yearly, about 300 million people are estimated to be affected by malaria, spreaded by *Anopheles* species of mosquitoes with about 1 million deaths [1, 2]. The world burden of lymphatic filariasis is approximately to be 250 million people infected primarily by filarial parasites (*Wuchereriabancrofti*, *Brugiamalayi* and *Brugiatimori*). Estimated 20 million people are infected every year by dengue viruses transmitted by *Aedes* species of mosquitoes with about 24,000 deaths [3]. Several strategies have been adopted to control the various diseases transmitted by mosquitoes. Chemical insecticides have been successfully used during the past several decades to control these dipteran pests and to diminish vector-borne diseases. But the utilize of chemical insecticides has become problematic because of a multiplicity of reasons including physiological resistance in the vectors, environmental pollution resulting in bio-amplification of food chain contamination and harmful effects on beneficial insects. Therefore, there has been an improved interest in recent years in the use of biological vector control agents. The finding of bacteria like *Bacillus sphaericus* (*Bs*) and *Bacillus thuringiensis* subsp. *israelensis* (*Bti*), highly toxic to dipteran larvae and possibility of the use of these biolarvicides in mosquito eradication operation [4]. Mosquito pathogenic bacilli have some advantages over synthetic insecticides in mosquito control operations, because, they have a wider host spectrum, are safer to non-target organisms (including humans) and are additional environment friendly. *Bti* synthesizes intracellular crystal inclusions during sporulation that contains multiple protein components of 134, 125, 67, and 27 kilo Daltons [5,6]. These proteins have been cloned independently and are toxic to mosquito larvae [7,8]. On the other side, *Bs* synthesizes proteins that assemble into crystals, which are composed of two main polypeptides, with molecular masses of 51 and 42 kilo Daltons. Though the high efficacy and specificity of Bs and *Bti* are useful in controlling mosquitoes, the cost to grow and generate *Bs* or *Bti* formulations, through a extremely refined laboratory bacterial culture medium, is exorbitant. The cost of *Bs/Bti* biopesticide production depends on many factors; however, the raw material cost is one of the most significant criteria, which comprises > 70 % of the overall production cost [9,10]. Hence, selection of growth medium or raw material is critical for commercial production of these biopesticides. In order to support the commercial production of biopesticides, utilization of less costly raw material is advisable [11,12]. Several raw materials (industrial and agricultural by-products) have been tested fruitfully in mosquito control program, as alternative culture media, for the production of *Bs/Bti* [13-15]. The authors of the present paper have also studied extensively on different biological waste materials on the production of biopesticides. Therefore, control of biopesticide production from environmental waste used as alternatives.

There are several cost-effective culture media were standardized by using different kinds of raw materials such as, coconut oil cake (COC), neem oil cake (NOC), groundnut oil cake (GOC), wheat bran (WB), chickpea husk (CPH), corncob (CC), chicken feather waste (CFW), slaughter house waste (SHW), coffee husk waste (CHW), clarified butter waste (CBW) and water melon fruit waste (WMW). These raw materials were used to yield superior level of bacterial production, than the conventional media (LB, NYSM). These new experimental media were found to have a higher yield, in terms of, biomass and toxin production. Biochemical analysis showed that, COC, NOC, GOC, WB, CPH, CC mosquitoes is an essential step towards the reduction of mosquito borne diseases. The comprised with rich fatty acids, and the CFW, SHW and WMFP comprised with rich carbohydrates which are the key components for efficient bacterial production. Thus, these materials can be utilized as a suitable substrate for the biopesticide production. The growth pattern of bacteria (Bs/*Bti* spore/crystals) and the mosquitocidal toxin production from culture medium prepared from clarified butter waste (CBW) collected from dairy industries was appreciable. Further, cost wise, the production of *Bti* from CBW is much more economical than conventional medium.

Every day, large quantity of clarified butter waste (CBW) is discarded, by dairy industries as a waste by-product, which is also an environmental menace. Many methods have been adopted to dispose CBW, like burning. The utilization the entire clarified butter waste (CBW), as an economical substrate, for

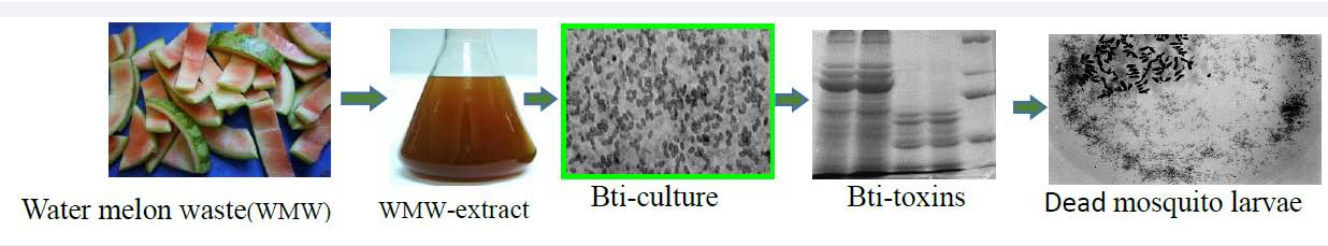

Figure 1 Wastes from water melon useful for bio-pesticide production.

biopesticide production. The underlining principle was based on the complete bio-degradation of nutrients from CBW, by the bacterial strains (*Bti* and *Bs*). As it is the by-product of milk industries, it does not need other nutrients for culturing the degrading bacteria. Figure 1 indicates the production of *Bti* from CBW. This fermentation technology facilitated the complete utilization of CBW, by avoiding any kind of resultant residual loss or wastage, resulting in an enhanced production of biopesticides and maintaining a cleaner environment. Thus, it upholds the dual benefits of complete utilization of clarified butter waste from the environment and enabling the production of mosquitocidal biopesticides.

Cost-effective analysis showed that the quantity of clarified butter waste required to prepare one liter of culture was only 30 gm/L, which is cost free, being a milk waste. On the contrary, preparation of one liter of NYSM involved a cost of US $ 3.6. This shows that CBW was cheaper than NYSM, nevertheless, the bacterial growth, toxin production and toxicity levels of test (CBW) and conventional (NYSM) media was similar. These results permit us to conclude that, the use of CBW, in the dried powder form, had manifold benefits, like complete degradation of feather waste, to avoid environmental contamination, increased shelf-life, easy preservation, transportation and convenience in handling and application. This method is highly economical, as it required comparatively lesser quantity of raw material (CBW) for culture media preparation, showing high efficacy of bacterial growth and toxicity, over vector mosquitoes.

Vector-borne diseases like, filariasis, malaria, dengue and Japanese encephalitis, remain a serious public health problem, all over the world. The control of these important mosquito borne diseases relies heavily on the extensive use of chemical insecticides, although, they are very expensive and toxic to non-target organisms. Owing to these constraints, biological control agents like, *Bacillus sphaericus* (*Bs*) and *B. thuringiensis*serovar*israelensis* (*Bti*) have been found to apply, widely and effectively, in mosquito control program. But, for operational purposes, there is an urgent need to produce these bacteria, utilizing cheap and commonly available biological waste materials, through simple fermentation biotechnology.

From that, the use of several biological waste materials, as an effective bacterial culture medium, is highly economical for the industrial production of these mosquito pathogenic bacilli, in terms of easy availability, cost-effectiveness, efficacy, environmental safety, and bio-waste remediation. The mosquitocidal spore/crystal toxins produced from the experimental culture medium (CBW) are higher than that of conventional medium (NYSM). The protein profiles of *Bs* and *Bti* spore/crystal toxins produced from CBW are similar to that of NYSM, by biochemical studies. The entomotoxicity studies with different mosquito species showed that the efficacy of *Bs* and *Bti* toxins produced from experimental and conventional media were comparable. The cost-effective analysis indicated that the use of CBW culture medium is highly economical for the industrial production of these mosquito pathogenic bacilli. Therefore, this study is important from the point of recycling environmental waste, as it possesses the dual benefits of effective utilization of environmental bio-organic waste and efficient production of mosquitocidal pathogenic bacilli.

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Cite this article

Poopathi S, Murugan K, Selvakumari J, Mani C, Bala P, et al. (2016) Biopesticide Production from Environmental Wastes. JSM Trop Med Res 1(2): 1008.