The Pharma Innovation Journal 2021; SP-10(11): 2959-2962

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(11): 2959-2962

www.thepharmajournal.com
Received: 11-09-2021
Accepted: 18-10-2021

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A review vermiwash: A plant growth booster and a disease supressor

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Abstract
Vermiwash is a liquid extract produced from vermicompost in a medium where earthworms are richly populated. It comprises a massive decomposer bacteria count, mucus, vitamins, different bioavailable minerals, hormones, enzymes, different antimicrobial peptides, etc. This paper aimed to assess how these natural products in vermiwash enhances plant growth. Earthworms establish symbiotic relationship with microbes, produce an essential product that supports the growth of plants, and suppress plant's root disease. It is recommended that earthworm should be inoculated in an agricultural field, or prepare and apply its vermiwash as a spray or as additive bio-fertilizer in the soil to enhance the productivity of the crops.

Keywords: drillosphere, vermi technology, ammonification, nitrogen fixation

1. Introduction
Vermiwash is a watery liquid of pale yellowish colour that is collected after the passage of water through a column of living earthworms in action. In other words it is a collection of excretory products and mucus secretion of earthworm along with micronutrients from the soil organic molecules from the medium. Today vermitechnology is successfully utilized for converting organic wastes into useful products through the action of living earthworms. The worm worked soils have burrows formed by the earthworms and bacteria richly inhabit these burrows termed as drillospheres. The water passing through these passages washes the nutrients from these burrows and is collected as vermiwash rich in nutrients which has a wide range of applications and beneficial for growth and development of plant and stimulate the yield and productivity of crops.

Many studies showed that vermiwash applied as a liquid bio-fertilizer as well as a spray (Shafique *et al*., 2021) [13]. By using growth parameter, effect of vermiwash had been evaluated on different crops, such as *Linum usitatissimum* L. (Makkar *et al*., 2019) [7], *Pennisetum glaucum* (Naroila and Poonia, 2011) [13], *Trigonella foenum* (Tadayyon *et al*., 2018) [1], *Solanum melongena* (Sundararasu and Jeyasankar, 2014) [20]. reported vermiwash was rich source of micro and macronutrients, enzymes, and growth regulator, which improved the growth and productivity of plants and reduced biotic stress. The vermiwash application is compatible with environmental protection. Thus, we have reviewed the importance of vermiwash in disease control, mechanism of disease suppression, components of vermiwash that are applied in disease suppression, and pest control in order to use these scientific facts in agriculture to enhance crop productivity.

Soil born microflora is essential for growth of plants because organic nitrogenous compounds and phosphorous are decomposed and mineralized by different enzymes produced by nitrogen fixing and phosphate solublizing bacteria. Vermiwash microflora contains Azotobactor, Agrobacterium, Rhizobium, phosphate sollublizing and urease producing microbes. Presence of these microbes makes available inorganic nitrogen, amino acids, and inorganic phosphates to plants through aminofication and nitrification processes. It also increases the number of micro-organisms in the soil which helps in decomposing soil organic matter (Tripathi *et al*. 2005) [16]. Likewise Prabhu (2006) [11] reported presence of large number of beneficial microorganisms that help in plant growth and protects it from a number of infestations. It was also reported that vermiwash improves the germination percentage of the seeds and seedling vigour of seeds such as cowpea and paddy crops.

2. Methodology

The manuscript was reviewed from data of well reputed articles using Google Scholar search engine. All the articles were read thoroughly, important concepts of data squeezed out, constructed then rewritten in a meaning full manner. Most of the data of the manuscript obtained from Scopus indexed and non-Scopus articles were used due to lack of published data in Scopus indexed journals on the desired subjects.

2.1 Preparation of vermiwash

Big earthen pot/ plastic drum with capacity of 200 liters (provided with tap in the bottom) was placed in shade. Five cm each of concrete and red sand was laid in the bottom of the drum for effective drainage. Old kitchen wastes (30-40cm)/ one-week-old dung was filled in the drum. 200-300 earth worms were released in the waste/dung. An earthen pot with minute hole in the bottom from where water poured drop wise was hanged over the drum after one week of earthworm's inoculation. After 2-3 days, extract is collected from the tap placed at the bottom of drum is called as 'Vermiwash' (Fig 1), Pathak and Ram (2013) [9].

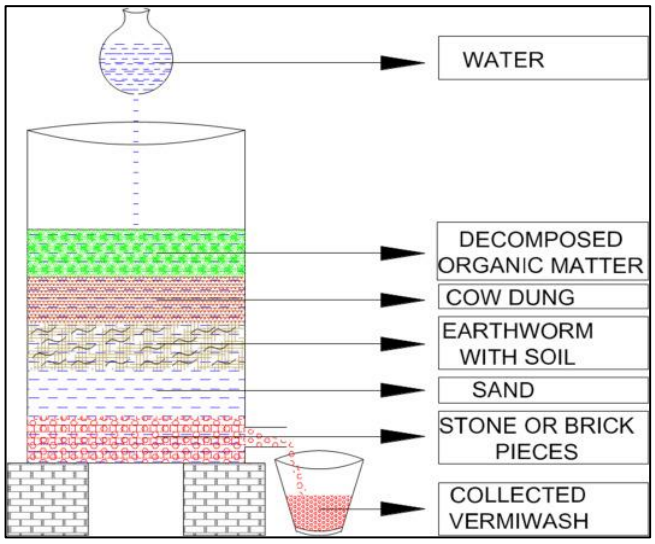

Fig 1: Preparation of vermiwash. It showed a basic means of vermiwash preparation. The bottom layer contains stone or brick pieces in coarse grain. The next layer contains sand, which helps to drain water through it to maintain moderate moisture. In the third layer earthworms inoculated with organic soil, in the fourth layer cow dung, or any organic waste which used as a main raw material. On the top layer the decomposed organic matter such as leaf litter, straw, etc an additional raw material that mainly prevents direct exposure from sunlight. The periodic sprinkling of water should be done to prevent desiccation and facilitate the comminution of organic matter. Finally, pure vermiwash harvested for application.

2.2 Vermiwash and its composition

Vermiwash is a honey brown coloured worm coelomic fluid extract containing several enzymes, plant growth hormones (IAA, Cytokinin, G A3), Vitamins, along with excretory substances and mucus secretion of earthworms (Ansari and Sukhraj, 2010) [2], humic acid from soil and organic waste materials which can be easily absorbed by plant tissues (Sundaravadivelu *et al*., 2011) [16]; Nath and Singh, 2012) [8]. It contains total solids (2448 mg/L), volatile solids (738 mg/L), silica (8 mg/L), auxin (0.98 µg/L) and cytokinin (0.68 µg/L) (Patil *et al*., 2007) [10]. Dead earthworm's tissue releases nitrogen in form of nitrates-25%, ammonia 45%, organic soluble compound 3% and uncalculated material 27% which improves the nutrient quality of vermiwash. Nitrogen in vermiwash is present in the form of muscus, enzymes, nitrogenous excretory substances of worms and plant growth hormones (Tripathi and Bhardwaj, 2004) [20]. Vermiwash is rich in various enzymes cocktail of protease, amylase, urease and phosphatase. Vermiwash formed from municipal solid wastes is composed of organic matter, plant nutrient and soluble salt which increases soil nutrient and moisture content (Sayyad, 2017) [12].

2.3 Role of vermiwash to improve productivity and Rhizobial nodulation of legumes

Vermiwash is rich in dissolved nutrients and amino acids which are easily available for plants. It is also a toxic free and ecofriendly compound, which cease the bacterial growth and forms a protective layer for their survival and growth.

As a foliar spray, it was reported to initiate flowering and long lasting inflorescence. It can also be used as a liquid fertilizer applied to the rhizosphere. No pathogen can survive in this fluid, thereby protecting the earthworms from the diseases caused by pathogens. It acts as a plant tonic and thus helps in reducing many plant pathogenic fungi. It increases the rate of photo synthesis in crops/plants. The vegetative parameters viz., carotenoid, leaf weight, chlorophyll, the height of Phaseolus vulgaris. L bean reported by Belmeskine *et al*. (2020) [3] to increase significantly. Plants treated with pure vermiwash during their growth could be productive. It provided copious amount of bioavailable macro and micronutrients for synthesis of their biomass.

Soya bean, a leguminous plant, harnesses nitrogen-fixing bacteria in their nodules and contain healthy protein. In an experiment, Mahendra and Narendra (2012) [7] observed enhancement of higher nodule counts and root biomass in a soya bean field treated with vermiwash, which may prove to be a boon for improving productivity of agricultural crops. As the number of nodules per plant increases, the fixation rate of nitrogen increases resulting in higher biomass, leaf size, pod and seed size. Vermiwash contains higher concentration of available nitrogen improving Rhizobial colonization of nodules. Sufficient availability of soluble nitrogen enhances plant growth and increases productivity.

2.4 Effect of vermiwash on various crops

Seedling of Vigna munga, Vigna radiate, Sesamum indicum, resulted in increase of growth parameters like the root length, shoot length, number of twigs and leaves and total biomass of the plant after spraying the vermiwash of Perionyx excavate. Vermiwash exhibited growth promoting effects on the exomorphological characters such as plant height, length and diameter of the internode, number of leaves, leaf surface area, root length, wet and dry weight of the shoot and root of Abelmoschus esculentus. Among the various foliar treatments used in the study, 15% vermiwash showed growth enhancing effects followed by 10% vermiwash, Gibberelic acid (100 g/ml) and Naphthalene acetic acid (100 g/ml). Maximum root length and plant biomass was recorded in 15% vermiwash. These results clearly indicate that vermiwash can be exploited as a potent biofertiliser and foliar spray.

Effect of vermiwash on the growth and development of leaves and stem of tomato plants was studied22. Vermiwash when mixed with vermicompost increased the shoot length to 19.61±0.18cm as compared to control 17.92±0.21 cm, when vermiwash was directly sprayed on the plants of tomato the

length of shoot was recorded to be 19.72±0.30 cm which was higher as compared to control group17.92±0.21 cm. It can be concluded that the growth of tomato plants showed much positive results when grown in vermicompost. However the results were apparent when the plants were treated with vermiwash. Hence, vermiwash proves to be an effective fertilizer which contributes the growth of plants when sprayed directly as well as mixed with a definite ratio of vermicompost.

A study in 2014 to evaluate the effect of vermiwash on growth and productivity of brinjal plants was conducted. Physicochemical properties of the soil in both control and experimental plots were studied and interrupted with results. The results revealed that vermiwash spray enhanced the growth parameters like height of the plant, number of leaves, Flowering and fruiting ratio was significantly increased in experimental plots. From the results it is seen that extracts from earthworms offer a valuable resource which could be effectively exploited for increasing the production of brinjal.

A study was carried out on effect of vermiwash on growth of Capsicum frutescens results showed that Vermiwash treated Capsicum frutescens showed increased root, shoot length and number of leaves after 30 days than the vermiwash untreated plants (Varghese and Prabha, 2014) [17]. Vermiwash along with gibberellic acid was used to bring about seed germination and seedling growth in Hibiscus sabdariffa and Phaseolus vulgaris (Fathima and Malathy, 2014) [4].

2.5 Effect of vermiwash on soil property

Organic formulations could be a potent source to move forward soil fertility (Verma *et al*., 2017) [18]. Combination of vermicompost and vermiwash [VW+VC] recorded a significant influence on the biochemical characteristics of the soil with marked improvement in soil micronutrients and better qualitative improvement in the physical and chemical properties of the soil (Ansari and Sukhraj, 2010) [2]. Tharmaraj *et al*., (2011) [15] reported that soil treated with mixture of vermicompost and vermiwash had significantly improve soil physico-chemical properties comparison to unamended soil.

2.6 Vermiwash as disease suppresser

Vermiwash appeared to have an inherent quality, which acted as liquid organic fertilizer as well as mild biocide, and tended to utilize it a powerful contribution to organic agriculture, soil wellbeing, disease control and sustainable crop production (Das *et al*., 2014 [5]; Tripathi *et al*., 2005) [16]. Vermiwash at 5–10 percent dilution inhibited mycelial growth of pathogenic fungi. It also had capacity to encounter worms, thereby save crops and enhance productivity. As a foliar spray, it initiated flowering and enduring inflorescence. Likewise, it could be utilized as a liquid fertilizer applied to the rhizosphere (Das *et al*., 2014; Khan *et al*., 2015) [5, 9]. No pathogens could survive in vermicompost, thereby protect earthworms from diseases. It acted as a plant tonic and thus helped in reducing many plant's pathogenic fungi (Das *et al*., 2014; Tripathi *et al*., 2005) [5, 16].

vermiwash is proven to be able to control disease powdery mildew at 75.14% rate when applied. On the other hand, combination of vermicompost, vermiwash and 10% cow urine which said to be able to control disease at 73.37% rate. (v9). Earthworms secrete coelomic fluid through their dorsal pores as a defense mechanism against stress. The coelomic fluid contains immunity components, which effectively controls protozoan parasite monocystis (Field *et al*., 2004) [5].

3. Conclusion

Vermiwash is the by-product of vermicompost applied as fertilizer by directly adding it into soil and as a liquid spray overall part of the plant body to prevent fungal, bacterial pathogen, and pests. Bioactive macro molecules found in the coelomic fluid, mucus, and skin secretion of earthworms are very important to act against pathogenic soil microbe and pests. As earthworm survives in soil, full of pathogenic microorganisms, and evolves cellular and humoral defense mechanisms protecting them from infection. Their cellular defense mechanism fight against pathogen by phagocytosis. Other metabolites such as hormones, enzymes, vitamins, proteins, different macro and micronutrients, and a massive amount of microbes facilitate a conducive environment for the growth of a plant by reducing stress conditions and create unfavorable condition for pathogenic soil microbes and pests. Furthermore, the exponential multiplication of soil microbes around earthworm in vermiwash competed and defended the disease-causing. Therefore, application of vermiwash as spraying on the surface of plants significantly suppress a pathogen and pest.

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