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Kiran Jadhav

Research Scholar, Department of Aquaculture College of Fisheries, MPUAT, Udaipur (Rajasthan)-India.

V.P. Saini

Professor, Aquaculture Research & Seed Unit Directorate of Research, MPUAT, Udaipur (Rajasthan)-India.

O.P. Sharma

Professor, Department of Aquaculture College of Fisheries, MPUAT, Udaipur (Rajasthan)-India.

M. L. Ojha

Asstt Professor, Department of Aquaculture College of Fisheries, MPUAT, Udaipur (Rajasthan)-India.

H.K.Jain

Professor, Department of Statistics, Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan)-India.

Correspondence:

V.P. Saini

Professor, Aquaculture Research & Seed Unit Directorate of Research, MPUAT, Udaipur (Rajasthan)-India.

Efficacy of vermiwash in the production of live fish food organisms

Kiran Jadhav, V.P. Saini, O.P. Sharma, M.L.Ojha, H.K.Jain

Abstract

In the present investigation, the efficacy of vermiwash was assessed for the production of live fish food organisms (zooplankton). For this purpose, studies were conducted in 56 liter static water holding using five concentration (0, 6, 8, 10 and 12%) of vermiwash. The application of vermiwash had significant effect on water quality. As such the values of dissolved oxygen and pH slightly reduced just after the application of vermiwash. However, a subsequent increase in pH and dissolved oxygen levels were seen from 7th day onwards. On the other hand, the levels of nitrate nitrogen, orthophosphate and total bacterial population increased after the treatment and subsequently decreased in all the treatments. In general the levels of different water quality parameters remained congenial for the growth and multiplication of zooplankton.

The production rate of zooplankton in vermiwash treated waters was significantly high than control. Still the highest mean production (1336 Nos/l) was recorded with 10% concentration of vermiwash. The statistical analysis of variance (ANOVA) on mean zooplankton production showed that the treatments were significantly different as compared to control. Further, the Duncan's multiple range test showed that the plankton production was significantly ($p \leq 0.01$) different in treatments except T₁&T₂ and T₃&T₄. On the basis of results of zooplankton production, a dose of 10% vermiwash is recommended.

Keywords: Earthworm, Vermiwash, Live food, Aquaculture, Zooplankton

1. Introduction

As the abundance of fish food organisms largely depends upon available nutrients in the pond water, the application of common pond fertilizer and multi micro nutrients gains importance. However, many traditional and commercial organic fertilizers are available for pond use but prior to their recommendation it requires to conduct preliminary evaluation trial. In the present research work, one such organic fertilizers "Vermiwash" has been tested for the production of live fish food organisms.

Vermiwash is an indispensable part of vermicompost, which is a watery extract of earthworms. It is basically a combination of secretion and wash of earthworms, present in the medium, honey brown in colour. It is a nutrient rich liquid produced by earthworms, feeding on organic waste material and plants residues. It is also nontoxic and ecofriendly, which arrests bacterial growth and forms as a protective layer for their survival and growth. Vermiwash contains N, P, K, Ca and hormones such as auxin, cytokinins, some other secretions and many useful microbes like heterotrophic bacteria, fungi etc. [1]. The quality of vermiwash produced by earthworms depends on the vermicompost that is used. Worm worked soils have burrows formed by the earthworms, bacteria richly inhabit these burrows, also called as the drilospheres. Water passing through these passages, washes the nutrients from these burrows to the roots to be absorbed by the plants. This principal is applied in the preparation of vermiwash.

In natural system, earthworms along with soil microorganisms degrade organic waste material of soil and thus maintain nutrient flux and act as excellent biological agents for recovery of vermiwash and vermiprotein for wide use in agro-ecosystem, aquaculture and poultry. The coelomic fluid of earthworm is called as vermiwash. Recently vermiwash production has drawn the attention of commercial vermiculturists, because of its rich organic composition. Long tubular body of earthworm contains coelomic fluid secreted by the body itself that always keeps the body wet and facilitates the body functions. Concentration of nutrients like, auxins, cytokinins, bacteria, fungi calcium, phosphorus, potassium etc. present in vermiwash, depends on the raw material which is used in the production of vermicompost.

The process of converting organic waste by earthworms, into nutrient filled humus is called vermicomposting. Thus vermicomposting process mineralizes the complex substances, releasing the nutrients readily available to the plants as fertilizer. Vermiwash plays an important role in the plant growth and development; contribute to initiation of rooting, root growth, plant development, promotion of growth rate and improvement in crop production increasing the soil organic matter and increase in nutrient content which are readily available for the plants, resulting in good crop yield. Looking the permissively result of vermiwash in agriculture crops and its rich nutrient content (N-0.62, P-0.68, K-0.66 & Conductivity-1.14 μS) etc.), it has been decided to test the potentialities of vermiwash in aqua production.

2. Material and Methods

The experiments was conducted at the college of Fisheries, Udaipur, Rajasthan, (India). Vermiwash was collected from Organic Agriculture Unit of Directorate of Research, MPUAT, Udaipur. It contained pH 7.3, Conductivity 1.14 μS Phosphorous 0.68, Potassium 0.66 and Nitrogen 0.62 %. The vermiwash was dilute 100(control), 94(T₁), 92(T₂), 90(T₃) and 88(T₄) % by adding freshwater (temperature 24.2 pH 7.2, dissolve oxygen 6.78 mg l⁻¹, alkalinity 158 mg l⁻¹, hardness 220 mg l⁻¹, total dissolve solid 933.50 mg l⁻¹, electrical conductivity 1.07 μS , nitrate-nitrogen 0.26 mg l⁻¹ and orthophosphate 0.7 mg l⁻¹) to make test mediums. The vermiwash treated water were inoculated with zooplankton culture (app 200 Nos per tank) for their growth and multiplication. These zooplankton were collected from natural ponds and their culture was maintained in the laboratory.

The population of zooplankton was counted in each of the experimental and control tanks at 7, 14, 21 and 28 days. The quantitative analyses of zooplankton were done with a Sedgwick Rafter Cell [2]. The water qualities of the experimental mediums was examined first after fertilization with vermiwash and subsequently at 7 days intervals over a period of 28 days. The temperature and Dissolved Oxygen (DO) were measured using HACH (HQ10) DO meter. pH was measured with a mini electronic pH meter. Alkalinity, hardness, electrical conductivity (EC), total dissolve solid (TDS), nitrate-nitrogen and orthophosphate were analyzed following standard methods of APHA [3]. The total bacterial population (SPC) was also observed in each of aquaria tanks at 7 day intervals following method [3]. The analysis of variance and Duncan's multiple range were performed using standard technique of Steel and Torrie [4].

3. Results

The results pertaining to physico- chemical water qualities parameters are presented in Table 1 and 2. In the experimental waters, dissolved oxygen concentration was initially low in treated waters, but increased subsequently in all the treatments. The pH of experimental water oscillated between 7.2 and 8.3. (Table 1). The lowest and highest pH values were recorded in T₃ and control respectively. Further, it would be seen from Table 2 that the highest (7.86±0.37) and lowest (7.81±0.36) average values of pH were in T₁ and T₄ respectively.

In the vermiwash treated waters the concentration of dissolve oxygen was initially low (i.e. up to 7th day) in treated waters which increased subsequently in all the treatments (Table 1). The lowest value (5.20 mg l⁻¹) of the dissolved oxygen was recorded in T₄, while the highest (7.89 mg l⁻¹) was in T₂.

However the lowest (6.44 mg l⁻¹) and highest (6.78 mg l⁻¹) mean values of DO were in T₂ & T₃ respectively (Table 2).

In experimental waters, the values of total alkalinity ranged from 158 to 438 mg l⁻¹. The lowest (158 mg l⁻¹) was noticed in control on 21st day. Whereas, the highest (438 mg l⁻¹) was observed in T₄ on 14th days (Table 1). Further, the respective highest (348.8 mg l⁻¹) and lowest (258.8 mg l⁻¹) mean values of total alkalinity were in T₄ and control.

The values of water hardness in vermiwash treated waters ranged between 220.00 to 483.00 mg l⁻¹. The lowest (220.00 mg l⁻¹) concentration was observed in T₂, while highest (483.00 mg l⁻¹) was in T₄. The lowest (315.60±92.72 mg l⁻¹) and higher (389.00±85.89 mg l⁻¹) average value of hardness were recorded in T₂ and T₄ respectively (Table 2).

Total dissolve solid in vermiwash treated waters ranged from 933.50 to 1398.50 mg l⁻¹. The lowest (933.50 mg l⁻¹) was observed in control on 14th day, while the highest (1398.50 mg l⁻¹) was in T₃ on 21th day (Table 1). The respectively lowest and highest average value of TDS were 969.90±21.29 and 1285.40±168.27 mg l⁻¹ in control and T₃ (Table 2).

Electrical conductivity of vermiwash treated waters ranged between 1.07 to 3.92 μS . The lowest value (1.07 μS) of electrical conductivity was observed in control on 28th day, while highest value (3.92 μS) was in T₄ (Table 1). The respective lowest and highest average value of electrical conductivity were 1.67±0.39 and 2.90±0.74 μS in control and T₄ (Table 2).

Nitrate-nitrogen concentration ranged between 0.21 to 0.76 mg l⁻¹. The lowest value (0.21 mg l⁻¹) was noticed on initial days in T₁. Whereas, the highest value (0.76 mg l⁻¹) was again noticed in T₁ on 14th day. The values of NO₃-N were higher in treated water as compared to control (Table 1). The lowest (0.45±0.16 mg l⁻¹) and (0.58±0.21 mg l⁻¹) average values of nitrate-nitrogen were observed in T₃ and T₄ respectively (Table 2).

Orthophosphate concentration in vermiwash treated waters ranged from 0.01 to 0.67 mg l⁻¹. The lowest (0.01 mg l⁻¹) concentration was observed in control, while the highest 0.67 mg l⁻¹ was in T₄ on 28th day (Table 1). The lowest (0.01±0.01 mg l⁻¹) and highest (0.24±0.25 mg l⁻¹) average value of orthophosphate were in control and T₄ respectively (Table 2).

The application of vermiwash significantly boosted the plankton production in treated waters. During initial phase of experiment (i.e. up to 7th day) the plankton production rate was high in lower doses than higher doses. Subsequently, this trends was found revert as the rate of plankton production showed increasing trends in higher doses (T₃ & T₄) towards the end of experiment, as compared to lower doses (T₁ & T₂).

It is evident from the results that among various groups of zooplankters, rotifers was more dominant in fertilized water. Where the population of cladocerans, nauplii & cyclops ranked IInd, IIIrd & IVth respectively. The total zooplankton population in water fertilized with varying level of vermiwash was significantly higher than control. While comparing the counts of different zooplankton groups in relation to vermiwash application, it was noticed that Cladocerans & rotifers had particularly higher standing biomass than cyclops. From the result of total zooplankton production, it is noticed that a dose of 10% is more suitable for achieving higher zooplankton production. In case of fertilized waters, highest zooplankton population of 1909 Nos/l was noticed in treatment T₃ on 28th day. However, the lowest population of 480 Nos/l were noticed in control on 7th day (Table 4). The highest average.

Table 1: Weekly variations in selective water quality parameters in vermiwash treated waters

Treatments	Day of Observation	Water Temp. (°C)	pH	DO (mg l ⁻¹)	Alkalinity (mg l ⁻¹)	Hardness (mg l ⁻¹)	TDS (mg l ⁻¹)	EC (µS)	Nitrate-N (mg l ⁻¹)	Ortho-P (mg l ⁻¹)
Control	0	27.40	7.75	6.50	314.00	295.00	987.50	1.96	0.39	0.01
	7	25.45	8.31	6.43	330.00	290.00	978.00	1.95	0.56	0.01
	14	24.35	7.70	7.05	246.00	240.00	933.50	1.86	0.53	0.01
	21	28.70	7.40	6.60	158.00	373.00	980.50	1.50	0.51	0.02
	28	30.65	8.15	6.95	246.00	391.00	970.00	1.07	0.47	0.02
T ₁	0	27.20	7.75	6.00	331.00	280.00	987.00	1.96	0.21	0.03
	7	25.30	8.30	5.84	374.00	312.00	986.00	2.26	0.23	0.17
	14	24.50	7.65	7.80	404.00	307.00	1007.00	2.43	0.76	0.15
	21	28.60	7.35	6.60	253.00	403.00	1135.00	2.61	0.60	0.16
	28	30.00	8.00	6.69	160.00	412.00	1205.50	3.13	0.75	0.05
T ₂	0	27.30	7.80	5.60	316.00	220.00	986.50	1.96	0.26	0.25
	7	25.25	8.30	5.71	384.00	240.00	1193.00	2.36	0.35	0.03
	14	24.45	7.70	7.89	430.00	292.00	1272.50	2.51	0.59	0.15
	21	28.60	7.35	6.60	268.00	413.00	1269.00	2.83	0.63	0.06
	28	30.15	8.10	6.40	203.00	413.00	1356.50	3.42	0.64	0.28
T ₃	0	27.15	7.80	5.45	376.00	300.00	986.00	1.96	0.21	0.18
	7	25.30	8.30	6.05	331.00	292.00	1288.00	2.54	0.37	0.01
	14	24.20	7.75	7.84	411.00	296.00	1362.00	2.68	0.53	0.07
	21	28.45	7.20	7.25	263.00	462.00	1398.50	2.60	0.64	0.07
	28	30.05	8.20	6.30	240.00	462.00	1392.50	3.68	0.50	0.39
T ₄	0	27.20	7.85	5.20	322.00	325.00	987.50	1.96	0.24	0.21
	7	25.35	8.30	6.16	426.00	322.00	1323.50	2.61	0.55	0.02
	14	24.45	7.80	7.25	438.00	332.00	1346.50	2.74	0.74	0.15
	21	28.45	7.30	7.15	284.00	483.00	1377.50	3.27	0.75	0.18
	28	30.35	8.05	6.40	274.00	483.00	1389.53	3.92	0.60	0.67

Table 2: Range and mean values of selected water quality parameters in vermiwash treated waters

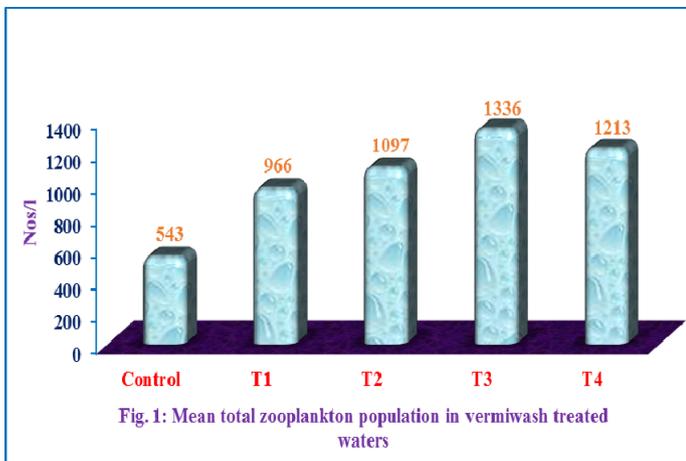
Treatments	Particulars	Water Temp. (°C)	pH	DO (mg l ⁻¹)	Alkalinity (mg l ⁻¹)	Hardness (mg l ⁻¹)	TDS (mg l ⁻¹)	EC (µS)	Nitrate-N (mg l ⁻¹)	Ortho-P (mg l ⁻¹)
Control	Min	24.35	7.40	5.43	158.00	240.00	933.50	1.07	0.39	0.01
	Max	30.65	8.31	8.05	330.00	391.00	987.50	1.96	0.56	0.02
	Mean	27.31	7.86	6.50	258.80	317.80	969.90	1.67	0.49	0.01
	SD±	2.52	0.36	1.09	68.20	62.75	21.29	0.39	0.07	0.01
T ₁	Min	24.50	7.35	5.84	160.00	280.00	986.00	1.96	0.21	0.03
	Max	30.00	8.30	7.80	404.00	412.00	1205.50	3.13	0.76	0.17
	Mean	27.12	7.81	6.58	304.40	342.80	1064.10	2.48	0.51	0.11
	SD±	2.27	0.36	0.77	98.70	60.39	100.41	0.44	0.27	0.07
T ₂	Min	24.45	7.35	5.60	203.00	220.00	986.50	1.96	0.26	0.03
	Max	30.15	8.30	7.89	430.00	413.00	1356.50	3.42	0.64	0.28
	Mean	27.15	7.85	6.44	320.20	315.60	1215.50	2.61	0.49	0.15
	SD±	2.35	0.37	0.92	90.28	92.72	140.48	0.55	0.18	0.11
T ₃	Min	24.20	7.20	6.05	240.00	292.00	986.00	1.96	0.21	0.01
	Max	30.05	8.30	7.84	411.00	462.00	1398.50	3.68	0.64	0.39
	Mean	27.03	7.85	6.78	324.20	362.40	1285.40	2.69	0.45	0.14
	SD±	2.35	0.44	0.74	72.63	90.97	173.04	0.62	0.16	0.15
T ₄	Min	24.45	7.30	6.16	274.00	322.00	987.50	1.96	0.24	0.02
	Max	30.35	8.30	7.25	438.00	483.00	1389.53	3.92	0.75	0.67
	Mean	27.16	7.86	6.63	348.80	389.00	1284.91	2.90	0.58	0.24
	SD±	2.37	0.37	0.53	78.15	85.89	168.27	0.74	0.21	0.25

zooplankton population of (1336±592 Nos/l) in T₃ and lowest (543±51 Nos/l) was in control (Figure 1). Statistical analysis on average total zooplankton population data shows the treatment were highly significant at 1 % ($p \leq 0.01$) level of probability. Similarly, Duncan's multiple range test showed that various treatment were significantly different from each other at 1% ($p \leq 0.01$) level of significance except T₁ & T₂ and T₃ & T₄.

It would be seen from these results that higher SPC counts corresponds to higher doses of vermiwash application. The SPC values were however, lower in control throughout the study period as compared to treated waters. The highest (5.06 No. /ml $\times 10^5$) of total bacterial population (SPC) was observed in T₄ on 14th day of the study period. Whereas, the lowest (0.95 No. /ml $\times 10^5$) population was in the control (Fig 2).

Table 3: Zooplankton population (Nos/l) in vermiwash treated water

Treatments	Days of observation	Cladocerans	Cyclops	Rotifers	Nauplii	Total Zooplankton
Control	7	123	93	204	60	480
	14	147	108	105	164	523
	21	165	111	108	193	577
	28	174	213	103	102	592
T ₁	7	257	97	182	190	725
	14	230	144	202	312	887
	21	349	150	292	326	1116
	28	416	232	304	161	1113
T ₂	7	476	92	205	189	961
	14	230	122	330	313	995
	21	229	179	405	347	1160
	28	351	288	430	202	1271
T ₃	7	197	121	114	183	614
	14	240	138	406	336	1119
	21	470	295	514	453	1731
	28	575	335	548	452	1909
T ₄	7	184	102	281	205	770
	14	309	114	266	347	1035
	21	564	202	319	421	1505
	28	403	290	400	423	1515



4. Discussion

In the present study, use of vermiwash as an organic fertilizer has been studied for the production of zooplankton. The application of vermiwash was found suitable for the culture of zooplankton as their numbers increased significantly in all the treated waters. The zooplankton were able to utilize the nutrients available in vermiwash through a food chain where nutrients were utilized by unicellular planktonic life that were then preyed upon by zooplankton [5, 6]. From the water quality parameters, it is well documented that opportunities for higher biological production were available in the treated waters. Therefore, the treated waters maintained high populations of bacteria as well as zooplankton.

The results of the present investigation (Tables 1) have revealed the significant impact of vermiwash on various physico-chemical and biological water quality parameters. On comparing the initial (soon after fertilization) and final day (day 28) values of different water quality parameters (Table 1), obviously the levels of dissolved oxygen and pH were found to increase. On the other hand, NO₃-N, orthophosphate, and total bacterial population decreased in all the experimental waters, which is a clear indication of nutrient utilization for biomass production. Nitrogen in the form of nitrate has reflected notably higher levels in vermiwash treated waters than in the controls (Table 1). The higher levels of nitrate nitrogen in treated waters were probably due to the decomposition of

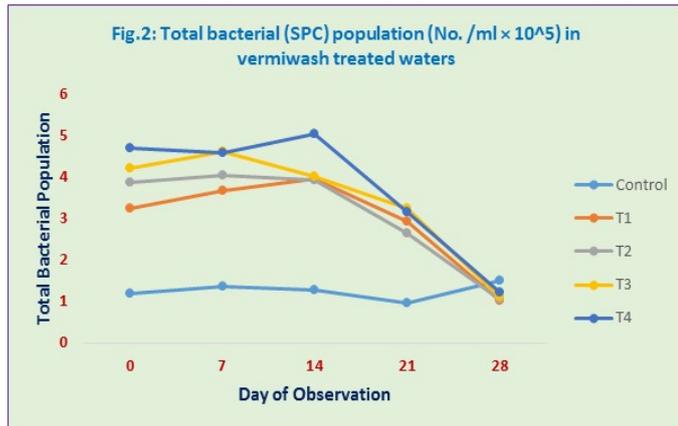
organic matter in vermiwash used for the experimental purpose.

Nitrate nitrogen showed a definite pattern in all the treatments, being high initially in the treated waters as compared to the controls. Subsequently, the reductions in NO₃-N were greater in the treated waters. This may be explained by notably higher biological productivity (i.e., bacterial flora and zooplankton) which extracted NO₃-N from the water media [7, 8]. Moreover, the fairly alkaline pH of the experimental waters has also played a significant role in the removal of NO₃ in the form of gaseous ammonia [9, 10]. This peculiar behaviour of nitrogen thus tells for further attempts in this direction to minimize the losses from the aquatic ecosystem.

The enrichment (phosphates and nitrates) in culture waters through vermiwash application leads to an increase in zooplankton biomass production. [11, 12]. In the present study, the vermiwash has brought necessary nutrients to an important primary production. In fact, in the aquatic medium planktonic organisms multiplication and growth are under nutritious resources control as inorganic nitrogen and the orthophosphate in the water [13, 14]. The nitrogen (NO₃-N) and the orthophosphates (PO₄) are utilized for the phytoplankton development [15, 16, 17]. The utilization of organic fertilizer has a positive effect on zooplankton abundance [18, 19]. The zooplankton production in fertilized ponds with organic fertilizer shows that higher zooplankton rates in treated waters than control [18].

Water temperature being an important factor controls the multiplication of zooplankton [20]. Maksimova *et al.* [21] stated optimum temperature between 22-23°C for aquatic organisms in ponds. In the present study, water temperature between 24.2 to 30.6°C (Table 4.1) was found to be quite close to that recorded by Bogatova [22] and Maksimova [21]. Such variation in temperature under Indian condition thus appears fairly suitable to support good zooplankton development in vermiwash treated waters as evidenced in the present study in T₃ which indicated temperature around 27.03°C. Villadolid *et al.* [23] and Shirgur [24] suggested a favorable pH of 8.0 for growth and multiplication of live fish food organisms. Armitage [25] and Suginome and Santomi [26] have also reported a favorable influence of high alkalinity on zooplankton production. In the present study, pH values have been recorded

in the range of 7.2 to 8.3, which is very close as suggested by Shirgur [24].



The aquatic organisms, especially microorganisms are reported to utilize the end products of degraded organic matter for obtaining required energy, thereby reducing their levels in aquatic media [27, 28]. Obviously, a very high population of SPC was noticed initially in the treated waters as compared to the controls. However, a rapid reduction in SPC was observed along with increasing populations of zooplankton and thus, SPC in the treated waters and the controls were comparable towards the end of the experiment. This reduction in SPC with increase in zooplankton was certainly due to the grazing pressure of zooplankton on micro flora [6]. The present findings are thus in agreement with those of Gak [5] and Smyly and Collins [29]. The population of zooplankton was higher at lower concentrations of (10%) than in the higher concentrations after the seventh day of inoculation. It was because at high vermiwash concentrations, low dissolved oxygen contents did not favour the multiplication of zooplankton [30, 31]. The population of zooplankton reached its highest level in the 10% vermiwash fed medium on 28 days.

The result obtained in this study (Table 3 and Figure 1) on zooplankton production and physico-chemical characteristics of water have depicted significant impact of vermiwash application in static waters. A brief summary of significant impact of vermiwash application is described as under:

- The selected dose of the vermiwash were found significant for the zooplankton production as compared to control.
- Group wise response of zooplankton production with all selected dose of organic vermiwash was recorded in following order: Rotifers > Cladocerans > Nauplii > Cyclops.
- No adverse effect on physico-chemical characteristic of water were observed with vermiwash application.
- Higher zooplankton production was reported in vermiwash treated waters than un-treated waters. Still, the highest zooplankton production was achieved with 10 % dose of vermiwash.

From the above discussions it evident that vermiwash can be used in aquaculture especially for the production of zooplankton. As such a dose of @ 10 % vermiwash is recommended for mass culture of zooplankton.

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