

Physio-chemical and microbial characterization of organic and biodynamic manures collected from different farms in India

Abstract

The organic and biodynamic manures based on animal, plant and house hold waste which have both direct and indirect benefits to soil and crop growth. This paper reports the characterization of organic and biodynamic manures collected from three farms in India. A total of 14 manures were collected and processed for determination of physico-chemical properties such as pH, EC, total nitrogen, total phosphorus, total potassium, calcium, magnesium, sodium, iron, zinc, manganese, copper, organic carbon and humic acids and microbial enumerations by following the standard methods. The present work on the physico-chemical analysis of different organic and biodynamic manures corroborated with all the results that the biodynamic preparations are rich in micronutrients and BD compost, CPP vermicompost and FarmYard Manure was high in major nutrients (N and K). Based on physico-chemical properties the nutritional index of biodynamic manures was derived. Agriculture or domestic waste can be effectively converted into nutrient enriched manures for soil fertility.

Keywords: animal waste, manures, biodynamic, characterization, major nutrients, micro nutrient

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Introduction

Many of traditional manures are produced by either composting or fermenting the animal, plant and other house-hold waste materials. Application of manures can prevent the soil degradation, improves water infiltration and moisture holding capacity and stabilizes the soil pH.¹ Reduction of bulk density could be due to higher organic matter content of soil added through Farm Yard Manure (FYM) which improved the physical condition of soil.² Similarly, Biodynamic (BD) manures such as field sprays (BD 500 and BD 501) and BD preparations (BD 502- BD 507) consisting of specific minerals or plants treated or fermented with animal organs, water and/or soil.³ Such BD products are included in the list of materials and techniques permitted in organic farming by European Commission (EC) Regulation (834/2007). Since biodynamic preparations are added to composting organic material in very low doses of a few grams per ton of compost material, the primary purpose of these preparations are not to add nutrients, but to stimulate the processes of nutrient and energy cycling, hasten decomposition and to improve soil and crop quality.⁴ Cow horn manure (BD 500) contain a very fine humus, which when sprayed on the soil containing >0.75 % of organic carbon improves soil structure, humus formation, populations of microbes, earthworm activity, deeper root penetration and strong upright growth in plants.⁵⁻¹⁰ Some studies extensively investigated the microbial and molecular characterization of some biodynamic manure like BD 500, Cow pat pit (CPP). However, there are only limited literatures available on physio-chemical characterization which induced us to explore on the same. One among our author Arunkumar¹ reported physio-chemical composition of 32 different organic and biodynamic manures. However, no attention has been so far devoted to derive nutritional index of this BD manures and other traditional organic manure like Amirthakaraisel, Panchakavya. In the literature, studies are available on impact of BD compost, CPP and liquid manures on crop growth, yield and soil health and not in characterization of manures.¹¹ But, the nutritional range of organic products used in

conventional organic farming systems has been thoroughly studied by most of state agricultural universities in India. Thus, the lack of analytical information on the nutritional range of BD preparations has not allowed yet to assess the quality of the BD manures. Hence, the present study focused on physio-chemical and microbial analysis of organic and biodynamic manures collected from different farms in India.

Materials and methods

Collection of organic and biodynamic manures

Organic manures such as Vermicompost, Farm Yard Manure (FYM). Amirthakaraisal and Panchakavya were obtained from local farmers in Ariyanoor village, Kancheepuram district, Tamil Nadu, India. The biodynamic manures such as Cow horn manure (BD 500), Cow horn silica manure (BD 501), Cow Pat Pit manure (CPP), BD compost and Biodynamic herbal preparations such as BD 502, BD 503, BD 504, BD 505, BD 506 and BD 507 were periodically obtained from Kurniji Organic Food Private Limited, Battlakundu, Dindigul district, Tamil Nadu, India and M/s. Supa Biotech Private Limited, Nainital, Uttarakhand, India. All the manure samples were brought to the laboratory, stored at 10°C under refrigerator condition and utilized for further studies. All the 14 manures were processed for the determination of physico-chemical properties such as pH, EC, total nitrogen, total phosphorus, total potassium, calcium, magnesium, sodium, iron, zinc, manganese, copper, organic carbon and humic acids and microbial enumerations such as total bacteria, total fungi and total actinomycetes.

Determination of pH and electrical conductivity(EC)

The pH of the samples was determined in 1:2.5 manure: water ratio (w/v) with the help of glass electrode pH meter (ELICO LI120).¹² Electrical Conductivity was estimated in 1:2.5 manure: water suspension with EC meter (EUTECH meter).

Estimation of macro and micronutrients

The estimation of Total Nitrogen, Phosphorus and Potassium in manures was analyzed by following the di acid and triple acid extract method respectively.¹² The estimation of Calcium and Magnesium in manures was analyzed by following dry ash method as outlined by Adrian.¹⁴ The estimation of micro nutrients such as Iron, Zinc, Copper and Manganese in manures was determined by triple acid extraction method using Atomic Absorption Spectrophotometer.

Estimation of organic carbon and humic acid

The organic carbon in manures was determined by Walkley and Black¹⁵ method and humic acid was estimated by following the methods as described by Welte.¹³ All the chemicals used were analytical reagent (AR) grade supplied by SRL (India) and Merck (India). Double-distilled water was used for analytical work.

Enumeration of microorganisms

Bacteria, fungi and actinomycetes were enumerated by following standard serial dilution and plate count technique in the manures.¹⁶ All chemicals used for microbial enumeration were purchased from Hi-media (Mumbai, India).

Result and discussion

The physico-chemical and microbial properties of these 14 different manures are presented in Table 1&2. Analyses of the 14 different

organic and biodynamic manures have revealed that the pH of organic and biodynamic manures were acidic to slightly alkaline range (5.0 to 7.8). The pH of BD compost Panchakavya, Amurthakaraisal, Vermicompost and BD 501 was acidic whereas, pH of BD 500, six BD herbal preparations (BD 502- BD 507) and CPP were neutral. The CPP manure recorded low EC values of 1.14 dS m⁻¹ whereas other manures recorded EC values ranged from 2.13 to 5.12 dS m⁻¹ in both the places. The percentage of organic carbon in different manures has shown that BD compost recorded for a high organic carbon (46.23 %) content followed by CPP I (40.46 %) and vermicompost (34.69 %). The lowest content of organic carbon (0.23 and 0.12 %) was recorded in BD 501 collected from the both places. Interestingly, the macronutrients contents of the organic and biodynamic manures have shown that the CPP I (2.85 %) and BD compost (2.08 %) recorded highest nitrogen content followed by vermicomposting (1.95 %), whereas in BD 501 contained high content of phosphorous recorded in both the places (1.96 and 1.22 %). Also, the potassium content was high in BD 501 (3.23 and 2.12 %) and BD 506 I (1.42 %) (Table 1). Thakur et al.¹⁷ too reported that biodynamic manures contained higher nutrients. It was evident with a higher percentage of total N and K recorded from all the following manures like plant & animal substrates, mineral supplements like rock phosphate, lime powder and inoculant like BD preps 502-507 used in BD compost and CPP, Earthworm in Vermicompost. Unlike other BD manures, in BD 501, which is made of quartz has the percentage indicating P and K.

Table 1 Physico chemical characterization of commercially available organic and biodynamic manures

Manures and field sprays	pH	EC (dSm ⁻¹)	OC (%)	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Na (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	Humic acid (mg 100 g ⁻¹)
BD compost	5.8	4.32	46.23	2.08	0.81	0.54	0.85	0.83	0.49	3892.0	767.00	99.00	78.00	493.00
CPP -I	7.5	1.14	40.46	2.85	0.94	0.51	0.96	0.71	0.19	2431.0	542.00	75.00	28.00	485.08
CPP- II	6.8	1.14	26.34	1.89	0.44	0.36	0.57	0.39	0.61	1660.0	512.00	82.00	45.00	443.20
BD 500-I	7.7	2.64	27.78	1.90	1.14	0.63	0.69	0.85	0.57	2026.0	237.00	77.00	4.00	300.60
BD 500- II	7.6	3.60	28.50	1.54	0.32	0.41	0.25	0.45	0.10	2087.0	242.00	50.16	7.00	466.12
BD 501-I	5.6	2.13	0.23	0.12	1.96	3.23	0.32	0.72	0.21	15.2	150.00	21.00	1.00	10.00
BD 501-II	5.0	3.23	0.12	0.02	1.22	2.12	0.45	0.32	0.10	23.0	230.00	13.00	1.00	12.00
BD 502-I	7.5	2.52	20.30	0.76	0.96	0.24	2.86	0.80	0.15	2111.0	485.00	114.00	9.00	393.80
BD 502-II	7.6	3.72	18.21	0.98	0.21	0.18	2.04	0.28	0.22	1308.0	254.00	98.00	7.00	320.70
BD 503-I	7.2	4.70	19.58	0.92	0.94	0.90	2.94	0.67	0.13	1804.0	416.00	66.00	2.00	436.75-
BD 503-II	7.3	4.74	22.90	1.56	0.33	0.82	2.76	0.53	0.19	1636.0	330.00	45.00	3.00	493.10
BD 504-I	7.4	4.47-	24.93	1.02	0.93	0.28	0.87	0.69	0.13	2378.0	310.00	79.00	3.00	456.50
BD 504-II	7.8	5.12	22.04	1.42	0.91	0.10	1.12	1.32	0.12	2692.0	323.00	50.00	4.00	316.50
BD 505-I	7.2	4.21	20.42	1.35	0.35	0.10	1.40	0.33	0.15	2713.0	272.00	75.00	7.00	474.50
BD 505-II	7.6	3.30	25.24	0.45	0.60	0.36	0.50	0.58	0.11	2577.0	265.00	69.00	7.00	480.12
BD 506-I	7.7	4.30	20.48	2.63	0.88	1.46	0.92	0.80	0.18	2162.0	449.00	33.00	6.20	473.70
BD 506-II	7.5	3.70	16.32	1.62	0.23	0.27	0.84	0.63	0.22	2187.0	423.00	96.00	6.00	445.00
BD 507-I	6.3	3.70	21.32	1.21	1.12	0.23	0.98	0.80	0.20	2126.0	432.00	54.00	BDL	238.10
BD 507-II	7.4	4.30	18.40	1.82	0.26	0.26	0.90	0.85	0.24	1853.0	452.00	80.00	5.00	200.20
FYM	7.2	3.72	27.80	1.15	0.23	0.39	1.16	0.34	0.12	1694.0	413.00	57.00	8.00	308.40
Vermicompost	6.3	4.70	34.69	1.95	0.48	0.71	1.10	0.70	0.59	2204.0	597.00	29.00	10.00	365.64
Panchakavya	5.5	3.70	15.54	0.53	0.56	0.70	1.20	0.21	0.09	49.02	482.00	45.00	8.02	341.92
Amurthakaraisal	6.2	3.24	33.50	1.42	0.92	0.24	0.13	0.63	0.21	1894.0	354.00	7.60	0.49	391.99

Note: I- Samples collected from Kurinji Organic Foods Pvt. Ltd. Dindigul, Tamil Nadu ; II- Samples collected from M/s Supa Biotech Pvt. Ltd. Uttarakhand

Table 2 Microbial enumeration of commercially available organic and biodynamic manures

Manures and sprays	Bacteria (x 10 ⁶ CFU g ⁻¹)	Fungi (x 10 ⁴ CFU g ⁻¹)	Actinomycetes (x 10 ² CFU g ⁻¹)
BD compost	30.38	11.20	16.52
CPP -I	26.12	9.68	10.98
CPP- II	27.06	7.65	14.05
BD 500-I	18.40	8.23	19.99
BD 500- II	16.56	6.21	14.50
BD 501-I	15.12	2.23	5.00
BD 501-II	10.23	2.00	6.00
BD 502-I	10.40	2.52	8.43
BD 502-II	21.70	3.86	4.20
BD 503-I	19.23	9.30	17.00
BD 503-II	8.70	6.83	12.60
BD 504-I	20.53	2.82	15.32
BD 504-II	23.28	7.28	18.00
BD 505-I	21.16	8.44	16.32
BD 505-II	15.60	4.25	11.71
BD 506-I	15.22	3.23	9.19
BD 506-II	22.90	11.16	16.79
BD 507-I	20.00	6.10	23.50
BD 507-II	16.32	5.90	12.76
FYM	13.80	5.19	12.49
Vermicompost	23.65	8.61	17.25
Panchakavya	18.83	6.34	14.05
Amirthakaraisal	11.05	6.51	14.32

Note: I- Samples from Kurinji Organic Foods Pvt. Ltd. Dindigul, Tamil Nadu ; II- Samples from Supa Biotech Pvt. Ltd. Uttarakhand

Along with essential nutrients (N, P, K, Ca, Mg, S), micro nutrients/trace elements also play vital in determining quality of the food products. Micronutrient analyses of different organic and biodynamic manures have revealed that each of preparation was rich in some of the micronutrients. Calcium content was high (2.94 %) in BD 503 I, magnesium (1.32 %) in BD 504 II, manganese (767.00 ppm) in BD compost, zinc (114.00 ppm) in BD 502 and iron (3892.0 ppm) & copper (78.00 ppm) in BD compost (Table 1). This result might be due to each of the BD preparations derived from specific herbal plants and animal organs used as container for decomposition/fermentation. The results are similar to the report by Arunkumar¹ who compared 32 different organic and biodynamic manures. The above mentioned values may have strong impact on soil as well as on quality of produces. Turiniket al.,¹⁷ mentioned each type of biodynamic preparations in soil help to stimulate, process and retain specific types of nutrients. Among the manures, BD compost recorded high amount of organic carbon (46.23 %), manganese (767 ppm), Iron (3892ppm) copper (78 ppm) and Humic acid (493mg 100g⁻¹) and microbial populations. Because of decomposition rate and microbial richness, this result may contradict from tropical and subtropical condition.

The bacteria (30.38 CFU x10⁶ g⁻¹ of manure), fungi (11.20 CFU x10⁴ g⁻¹ of manure) and humic acid content (493.00 mg 100 g⁻¹) were also high in BD compost whereas highercount of actinomycetes (19.99 x10⁶ CFU g⁻¹ of manure) in BD 500 (I) (Table 2). Stalin et al.¹⁸ and Thakur et al.¹⁷ reported that CPP manure and biodynamic compost contained the highest bacterial load and Rupela et al.¹⁹ who evaluated six other biodynamic preparations and found that the population of bacteria ranged from 3.24 log10 ml⁻¹ to 6.90 log10 ml⁻¹. Our results and the result by other researches highlight that, BD manures are rich in bacterial, fungi and actinomycetes like colonies. But Radha and Rao²⁰ and Thakur et al.¹⁷ stated that actinomycetes are not present in Panchakavya and BD 500 which might be the competition for nutrient by the fast growing *Bacilli* dominating in the manures. The overall microbial enumeration study proved the richness of microbial load in Bd compost, CPP and BD500 made by cow dung.

Based on physico-chemical properties, nutritional index of biodynamic manures was derived and presented in Table 3 &4.

Table 3 Physico -chemical characterization of commercially available organic and biodynamic manures

Manures and sprays	pH	EC(dS m ⁻¹)	OC(%)	N(%)	P(%)	K(%)	Ca(%)	Mg(%)	Na(%)
BD compost	5.8-8.4	4.32-5.26	42.82-46.23	0.91-2.08	0.15-0.81	0.34-0.54	0.40-0.85	0.28-0.83	0.11-0.49
CPP	6.8-7.5	1.14-1.14	26.34-40.46	1.89-2.85	0.44-0.94	0.36-0.51	0.57-0.96	0.39-0.71	0.19-0.61
BD 500	7.6-7.7	2.64-3.60	27.78-28.50	1.54-1.90	0.32-1.14	0.41-0.63	0.25-0.69	0.45-0.85	0.10-0.57
BD 501	5.0-5.6	2.13-3.23	0.12-0.23	0.02-0.12	1.22-1.96	2.12-3.23	0.32-0.45	0.32-0.72	0.10-0.21
BD 502	7.5-7.6	2.52-3.72	18.21-20.30	0.76-0.98	0.21-0.96	0.18-0.24	2.04-2.86	0.28-0.80	0.15-0.22
BD 503	7.2-7.3	4.70-4.74	19.58-22.90	0.92-1.56	0.33-0.94	0.82-0.90	2.76-2.94	0.53-0.67	0.13-0.19
BD 504	7.4-7.8	4.47-5.12	22.04-29.93	1.02-1.42	0.91-0.93	0.10-0.28	0.87-1.12	0.69-1.32	0.03-0.12
BD 505	7.2-7.6	3.30-4.21	20.42-25.24	0.45-1.35	0.35-0.60	0.10-0.36	0.50-1.40	0.33-0.58	0.11-0.15
BD 506	7.5-7.7	3.70-4.30	16.32-20.48	1.62-2.63	0.23-0.88	0.27-1.46	0.84-0.92	0.63-0.80	0.18-0.22
BD 507	6.3-7.4	3.70-4.30	18.40-21.40	1.21-1.82	0.26-1.12	0.23-0.26	0.90-0.98	0.80-0.85	0.20-0.24

Table 4 Micronutrient and Microbial characterization of commercially available organic and biodynamic manures

Manures and sprays	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	Humic acid (mg 100g ⁻¹)	Bacteria x 10 ⁶ CFU	Fungi x 10 ⁴ CFU	Actinomycetes x 10 ⁴ CFU
BD compost	1848.0-3892.0	138.00-767.00	21.00-99.00	11.00-78.00	443.00-493.00	12.72-30.38	5.90-11.10	11.10-16.52
CPP	1660.0-2431.0	512.00-542.00	75.00-82.00	28.00-45.00	443.20-485.08	26.12-27.06	7.65- 9.68	10.98-14.05
BD 500	2026.0-2987.0	237.00-242.00	50.16-77.00	4.00-7.00	300.60-466.12	16.56-18.40	6.21-8.23	14.50-19.99
BD 501	15.20-23.00	150.00-230.00	13.00-21.00	1.00-1.00	10.00-12.00	10.23-15.12	2.00-2.23	5.00-6.00
BD 502	1308.0-2111.0	254.00-485.00	98.00-114.00	7.00- 9.00	320.70-393.80	10.40-21.70	2.52-3.86	4.20-8.43
BD 503	1636 .0-1804.0	330.00-416.00	45.00-66.00	2.00- 3.00	436.75-493.10	8.70-19.23	6.83-9.30	12.60-17.00
BD 504	2378.0-2692.0	310.00-323.00	50.00-79.00	3.00- 4.00	316.50-456.50	20.53-23.28	2.82-7.28	15.32-18.00
BD 505	2577.0-2713.0	265.00-472.00	69.00-75.00	7.00- 7.00	474.50-480.12	15.50-21.16	4.25-8.44	11.71-16.32
BD 506	2162.0-2187.0	423.00-499.00	33.00-96.00	6.00- 6.20	445.00-473.70	15.22-22.90	3.23-11.16	9.19-16.79
BD 507	1853.0-2126.0	432.00-455.00	54.00-80.00	BDL- 5.00	200.20-238.00	16.32-20.00	5.90-6.10	12.76-23.50

Conclusion

In ancient India, Organic manures and other soil amendments are illustrated in many literatures like Rigveda, Ramayana, Mahabharata, Kautilya's Arthasashttra. The traditional way of agriculture practices in India including the biodynamic agricultural methods are getting popular and has gained importance in recent times in order to reduce the use of chemical fertilizers. In light of various farmers and other like-minded people interviews and their interest and on my own behalf, we collected and analyzed nutrients and other microbial parameters of their manures. Therefore, the physico- chemical characterization of different organic and biodynamic manures, especially biodynamic herbal preparations (BD 502 to 507) have revealed that it is indeed rich in micronutrients. Bulk manures like compost, were high in major nutrients (N and K), organic carbon, humic content and microbial load. This finding is important to assess the quality of biodynamic manures and globally thrive to understand scientific means of biodynamic agriculture. In sight of then above, the results that were analyzed for manures can lead to reduction of the input cost and improve thenutritional status for their enhanced crop performances.

As mentioned in the introductory section of this article, we have very limited literatures on physio-chemical characterization of BD manures which hindrances the further data interpretation. However, the glimpses of these are neither claims nor initial characterization of manures. From this initial effort, it may provide a better understanding for other researchers to continue their analyses statically for further data significance and scientific means.

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Conflicts of interest

Author declare there are no conflicts of interest towards this article.

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