World Journal of Zoology 7 (1): 23-29, 2012
ISSN 1817-3098

DOI: 10.5829/idosi.wjz.2012.7.1.56439

Effect of Binary Combinations of Buffalo, Cow and Goat Dung with Different Agro Wastes on Reproduction and Development of Earthworm *Eisenia fetida* (Haplotoxida: Lumbricidae)

Harendra Kumar Chauhan and Keshav Singh

Department of Zoology D.D.U. Gorakhpur University, Gorakhpur-273009 U.P. India

Abstract: The aim of present study was to investigate the effect of binary combination of different animal dung with agro-wastes on the reproduction and development of earthworm *Eisenia fetida*. There was significantly increase in reproduction rate as cocoon production in binary combination of buffalo dung with wheat straw 0.160±0.016 cocoons worm^{-1}day^{-1}. The net weight gain by *E. fetida* was significantly highest in buffalo dung with gram bran 12.83±0.25 mg worm^{-1}day^{-1} followed by 10.83±0.11 mg worm^{-1}day^{-1} in buffalo dung with barley bran. Food quality influences not only the size of earthworms but also their reproduction and development. After physical analysis of initial feed mixture and the final vermicompost the significant decrease level of pH, C/N ratio and EC (electrical conductivity). The pH of initial mixture in all binary combinations tend to acidic/neutral nature. The C/N ratio in all final vermicompost ranged 8.8 to 22.4 and significant decrease from initial feed mixture. In final vermicompost has significantly decreased electrical conductivity1.05±0.08 dms^{-1} in combination of cow dung with gram bran. The chemical analysis before and after vermicomposting the TOC significantly highest in goat dung with rice bran combination 296.13±1.06 g kg^{-1}. In final vermicompost TKN, TK, TAP and TCa significantly increased in final vermicompost with respect to initial mixture. This study demonstrated that the binary combination of initial feed mixture of buffalo dung with wheat straw is better option for enhancement of earthworm's population as well as provides the potent vermicomposts.

Key word: Agro wastes · Binary Combination · Eisenia · Vermicomposting · Reproduction · Development · Physico-Chemical Analysis

INTRODUCTION

Abundant uses of chemical fertilizers have made our soils sick and problematic because the preliminary basis of green revolution was chemical fertilizers and pesticides which ignored the green manure and organic forming. Addition of vermicompost enhances the soil fertility as changes physical and chemical properties of soil [1]. Organic matter status of the soil of humid tropical country is generally low [2]. In India the livestock dung are produced annually million of tons as the rate of buffalo dung 12.20 kg animal^{-1} day^{-1}, cow dung 11.6 kg animal^{-1} day^{-1} and goat dung 0.70 kg animal^{-1} day^{-1} [3]. The large amounts of agricultural wastes are produced in intensive agriculture. Disposal of these large quantities of animal and agro wastes cause a serious problems if not proper management [2]. Vermicomposting is the best option for management of animal dung and agro waste by epigeic earthworm [4- 6]. The awareness of organic matter and concept of sustainable agriculture is gaining impetus among our farmers to produce good quality consumable agricultural products [7]. Vermicomposting is important component of organic farming without much financial involvement [8], which can convert bio wastes into nutrient rich organic manure, as well as intensify the worm populations [9].

Our ancestor used as a traditional composting for these which are not being fully utilized results a loss of latent nutrients [2]. The epigeic earthworm *Eisenia fetida* well suitable for vermicomposting and its product quality better than traditional composting [10]. Universally, unique and useful waste management by vermicomposting as reduction public hazards, well stabilized as easily available for plants and minimize the

Corresponding Author: Keshav Singh, Department of Zoology,
D. D. U. Gorakhpur University, Gorakhpur-273009 U.P. India.
Mob: 09450433313.

soil toxicity due to produced different tilth by earthworms [11, 12]. The aim of present research work to enhance the reproduction and development progenies of *E. fetida* in different binary combination and also estimate physical and chemical changes in nutrient content for plants.

MATERIALS AND METHODS

Collection of Earthworm *E. Fetida*: The cultured earthworm *Eisenia fetida* were used for experiment from Vermiculture Research Centre, Department of Zoology, D. D. U. Gorakhpur University (U.P.) INDIA.

Collection of Animal Dung and Agro Wastes: Animal dung of cow, buffalo and goat collected from dairy, goatry from different parts of Gorakhpur City. The agro wastes as barley bran, gram bran, rice bran, wheat bran and banana pills collected from rice mills, pulse mill and fruit seller of different parts of Gorakhpur City.

Reproduction and Development: Biomass gains development and cocoon production recorded up to 11 weeks from each bed. Vermicomposting bed of binary combinations of animal and agro wastes prepared for inoculation of twenty (20) young *Eisenia fetida* of same age group. After 10 days number of clitellum will be counted in each inoculated *E. fetida* of each vermibed. After 4th week of inoculation, the number of cocoon in vermicompost bed counted up to 9th week. Growth (biomass) of inoculated worms measured at the end of experiment. The prepared vermicompost were used for chemical analysis.

Chemical Analysis: The pH and electrical conductivity determined using a double distilled water suspension of each waste in the ratio of 1:10 (w/v) that has been agitated mechanically for 30 minutes and filtered through Whatsmann No.1 filter paper, total organic carbon (TOC) measured by the method of Nelson and Sommers [13]. Total khjeldahl nitrogen (TKN) determined after digesting the sample with conc. H_2S0_4 and conc. $HClO_4$, (9:1 v/v) according to the method of Bremmer and Mulvaney, [14]. Total Phosphorus (TAP) analyzed using the colorimetric method with molybdenum in sulfuric acid [9]. Total potassium (TK) determined by flam photometer.

Statistical Analysis: All the studies replicated at least six times and find out mean with standard error and student 't' test applied to determine significant ('t' test $p<0.05$) difference for reproduction and growth and two way analysis of variance (ANOVA) was applied to determined significant difference between initial feed mixture and final vermicompost [15].

RESULTS

The different binary combination of cow, buffalo and goat dung with agro-wastes rice bran, wheat straw, barley bran, gram bran and banana pills caused a significant growth of *E. fetida* as well as significantly increase in number of cocoons, initiation of clitellum development and cocoon production and weight gain. There was also significantly initiation of clitellum development 14±2.4 days in binary combination of buffalo dung with wheat straw. Initiation of cocoon production significantly earliest 30±3.4 days in buffalo dung with wheat straw combination. The reproduction rate significantly highest 0.16±0.016 cocoons worm^{-1} day^{-1} in buffalo dung with wheat straw (Table 1). The average weight gain 1268.16±35.46 mg worm^{-1} in buffalo dung with gram bran significant highest in *Eisenia fetida* where as the inoculated earthworms weight ranged 208±3.42 to 262.14±4.12 mg worm^{-1}. The growth rate significantly highest in buffalo dung with gram bran 12.83±0.25 mg worm^{-1} day^{-1} (Table 2).

The physical properties of initial feed mixture were changed after vermicomposting like pH, C/N ratio and electrical conductivity (EC). The pH value slightly basic (7.8±0.02 to 8.9±0.06) in all combination of initial feed mixture tend to slightly acidity or neutral in final vermicompost. The C/N ratio significantly decrease in all final vermicomposts than the initial feed mixtures. The C/N ratio significantly highest decrease 296.25±1.5 g kg^{-1} in goat dung with gram bran. The EC significant decreased in all combination of final vermicompost in comparison to initial feed mixtures. The significantly lower EC 1.06±0.04 dsm^{-1} in final vermicompost of buffalo dung with rice bran combination (Table 3).

During vermicomposting there was significant increase in different biochemical parameter as TOC, TKN, TK, TAP and TCa in all final vermicompost than the initial feed mixtures (Table 4). The maximum significant increase 296.25±1.98 g kg^{-1} was observed in level of TOC in final vermicompost of combination of cow dung with rice bran. The TKN level was also significantly increasing 3.5 to 11.0 g kg^{-1} in all final vermicompost than the initial feed mixtures. The maximum highest significant TKN 26.1±0.19 g kg^{-1} in vermicompost of goat dung with barley bran. The level of TK slightly increases in all final vermicompost. Total Potassium in buffalo dung with

Table 1: Effect of binary combinations of animal dung with agro wastes on the cocoon production of Eisenia fetida.

Combinations	Initiation of clitellum development (in days)	Initiation of cocoon production (in days)	Rate of cocoon production: Coccons worm^{-1} (90 days)	Rate of cocoon production: Coccons worm^{-1} day^{-1}
Buffalo Dung	22±2.5	38±3.2	3.9±0.07	0.052±0.008
Dung +Rice Bran	16±3.0*	32±3.0*	5.2±0.08*	0.071±0.007*
Dung +Wheat straw	14±2.4*	31±3.5*	10.1±0.1*	0.160±0.016*
Dung +Barley bran	15±3.2*	32±3.4*	5.4±0.09*	0.072±0.009*
Dung +Gram bran	18±2.8*	30±3.1*	7.1±0.05*	0.097±0.004*
Dung +Banana pills	17±3.5*	31±2.8*	4.7±0.09*	0.060±0.005*
Cow Dung	27±3.2	40±2.9	3.3±0.06	0.042±0.007
Dung +Rice Bran	20±2.8*	35±3.2*	6.0±0.06*	0.076±0.007*
Dung +Wheat straw	14±2.5*	30±2.7*	9.6±0.08*	0.123±0.008*
Dung +Barley bran	16±2.7*	32±3.1*	5.1±0.07*	0.065±0.006*
Dung +Gram bran	18±3.1*	34±2.8*	4.6±0.08*	0.058±0.008*
Dung +Banana pills	19±3.4*	38±2.4	3.5±0.05	0.049±0.004
Goat Dung	24±3.0	42±3.5	2.7±0.06	0.034±0.006
Dung +Rice Bran	22±2.8*	36±3.5*	3.7±0.08*	0.057±0.005*
Dung +Wheat straw	15±3.6*	38±3.6*	6.2±0.07*	0.079±0.008*
Dung +Barley bran	19±3.2*	35±3.1*	6.0±0.08*	0.076±0.004*
Dung +Gram bran	21±3.6*	33±2.5*	5.1±0.07*	0.065±0.006*
Dung +Banana pills	21±3.5*	39±2.4	6.7±0.09*	0.085±0.005*

Each value is the mean ± SE of six replicates.

*Significant growth (P<0.05)'t' test between treated and control group

Cocoons production in 30.0x30.0x30.0cm3 area of vermicompostiong bed.

Table 2: Growth rate of Eisenia fetida in different binary combinations of animal dung with agro wastes.

Binary combinations	Mean initial weight (mg worm^{-1})	Maximum weight achieved (mg worm^{-1})	Net weight gain (mg worm^{-1})	Growth rate (mg worm^{-1} day^{-1})
Buffalo Dung	218.52±3.12	863.54±25.436	384.42±3.54	8.20±0.12
Dung +Rice Bran	208.61±3.42	1060.62±31.25	842.64±2.87	10.80±0.20*
Dung +Wheat straw	218.42±2.94	1022.42±36.40	789.54±2.74	10.11±0.16*
Dung +Barley bran	228.63±3.01	1080.46±30.91	845.72±2.98	10.83±0.11*
Dung +Gram bran	212.16±3.08	1268.16±35.46	1002.42±3.64	12.83±0.25*
Dung +Banana pills	219.87±3.14	985.32±18.61	725.23±3.26	9.29±0.16*
Cow Dung	221.64±2.94	822.21±18.42	600.17±2.98	7.69±0.25
Dung +Rice Bran	218.13±3.12	953.62±15.46	726.54±2.75	9.30±0.18*
Dung +Wheat straw	230.42±2.64	972.54±18.56	710.14±2.44	9.10±0.20*
Dung +Barley bran	242.40±2.96	1025.34±32.5	749.15±2.64	9.60±0.22*
Dung +Gram bran	223.28±3.01	1182.53±38.61	945.24±2.87	12.11±0.32*
Dung +Banana pills	243.41±2.89	899.65±24.35	651.19±2.64	8.34±0.18*
Goat Dung	248.54±3.00	786.85±20.32	533.98±2.08	6.83±0.32
Dung +Rice Bran	240.16±3.02	876.52±18.69	430.17±2.52	5.51±0.30*
Dung +Wheat straw	251.23±3.03	865.33±21.85	612.54±2.17	7.84±0.40*
Dung +Barley bran	246.41±4.12	869.42±20.56	620.17±2.09	7.94±0.46*
Dung +Gram bran	262.14±4.12	941.53±25.42	678.26±2.17	8.69±0.20*
Dung +Banana pills	260.62±3.02	810.13±21.45	579.53±2.54	7.42±0.18*

Each value is the mean ± SE of six replicates.

*Significant growth (P<0.05)'t' test between treated and control group

Growth rate in 30.0x30.0x30.0cm^3 area of vermicompostiong bed.

Table 3: Different physical parameters in initial feed mixture and the final vermicompost of different combinations of animal dung and agro wastes.

	PH		C/N ratio		EC (dms^{-1})	
Binary combinations	Initial mixture	Final Vermicompost	Initial mixture	Final Vermicompost	Initial mixture	Final Vermicompost
Buffalo Dung	8.5±0.02	6.8±0.33	91.2±0.81	13.2±1.72	2.60±0.05	1.32±0.03
Dung +Rice Bran	8.4±0.04	7.5±0.06	53.8±0.96	10.8±0.54	2.75±0.08	1.09±0.04
Dung +Wheat straw	8.5±0.02	7.1±0.04	76.2±1.06	12.0±0.81	2.95±0.18	1.23±0.05
Dung +Barley bran	8.0±0.03	7.2±0.08	43.2±0.98	8.9±1.08	2.96±0.12	1.15±0.05
Dung +Gram bran	8.6±0.12	6.9±0.05	46.8±0.32	10.1±0.43	2.62±0.14	1.09±0.06
Dung +Banana pills	8.1±0.06	7.0±0.06	52.6±0.62	11.0±0.82	2.72±0.08	1.42±0.80
Cow Dung	8.0±0.03	6.8±0.02	86.4±2.41	12.6±0.98	2.16±0.04	1.30±0.08
Dung +Rice Bran	8.5±0.06	7.5±0.03	52.0±0.12	10.7±0.96	2.75±0.14	1.06±0.04
Dung +Wheat straw	8.6±0.05	7.3±0.06	74.6±0.80	12.3±0.72	2.98±0.06	1.20±0.06
Dung +Barley bran	8.2±0.01	7.2±0.05	45.8±1.12	8.8±0.63	2.81±0.05	1.14±0.07
Dung +Gram bran	7.8±0.02	6.9±0.04	46.1±0.32	10.2±0.51	2.60±0.08	1.06±0.08
Dung +Banana pills	7.8±0.04	6.8±0.07	50.2±0.82	10.3±0.72	2.78±0.09	1.18±0.06
Goat Dung	8.5±0.03	6.7±0.04	93.1±0.16	22.4±0.56	2.55±0.18	1.18±0.09
Dung +Rice Bran	8.5±0.06	7.3±0.07	49.6±0.75	11.2±0.43	2.81±0.09	1.25±0.05
Dung +Wheat straw	8.6±0.12	7.0±0.02	78.0±0.57	12.8±0.52	3.01±0.16	1.45±0.02
Dung +Barley bran	8.9±0.06	7.1±0.03	52.6±1.62	10.0±0.82	2.75±0.09	1.39±0.15
Dung +Gram bran	8.5±0.08	7.2±0.04	44.3±1.60	11.2±0.79	2.50±0.16	1.21±0.09
Dung +Banana pills	7.9±0.06	7.0±0.06	42.6±0.89	21.5±0.81	2.80±0.14	1.30±0.08

Each value is the mean ± SE of six replicates.

Significant variance ($P<0.05$) two way analysis of variance (ANOVA) was applied in between initial mixture and final vermicompost.

Table 4: Different chemical parameters in initial feed mixture and the final vermicompost of different combinations of animal dung and agro wastes.

	TOC ($g\ kg^{-1}$)		TKN ($g\ kg^{-1}$)		TK ($g\ kg^{-1}$)		TAP ($g\ kg^{-1}$)		Tca ($g\ kg^{-1}$)	
Binary combinations	Initial Mixture Vermicompost	Final Vermicompost	Initial mixture	Final Vermicompost	Initial mixture	Final Vermicompost	Initial mixture	Final Vermicompost	Initial mixture	Final
Buffalo Dung	516.53±3.42	198.06±1.02	6.6 ± 0.42	15.4±0.04	4.9±0.05	6.9±0.32	5.0± 0.04	7.1±0.04	1.4±0.2	1.9±0.31
Dung +Rice Bran	614.41±3.98	255.12±4.98	11.5±0.34	24.6±0.64	6.6±0.07	8.2±0.41	8.1±0.06	8.8±0.05	1.7±0.3	2.7±0.42
Dung +Wheat straw	686.52±4.01	220.36±4.16	8.8 ±0.09	19.2±0.28	6.9±0.04	7.8±0.19	4.8±0.12	5.6±0.07	1.5±0.4	2.3±0.50
Dung +Barley bran	520.32±3.60	218.16±3.20	11.9±0.42	24.5±0.82	6.7±0.03	8.0±0.42	6.4±0.08	7.4±0.02	1.6±0.3	2.2±0.31
Dung +Gram bran	645.24±2.51	266.56±1.26	13.9±0.42	25.4±0.08	7.5±0.08	7.8±0.14	6.9±0.03	7.4±0.42	2.2±0.3	2.4±0.50
Dung +Banana pills	590.24±2.51	221.15±2.42	9.2 ±0.51	20.2±0.75	6.9±0.07	8.3±0.36	5.3±0.09	7.0±0.51	2.3±0.3	2.5±0.48
Cow Dung	482.14±4.24	178.54±1.57	6.1±0.03	15.8±0.42	5.2±0.08	5.9±0.05	3.6±0.04	7.2±0.82	1.4±0.2	2.0±0.08
Dung +Rice Bran	567.12±6.11	250.42±2.42	11.2±0.41	25.2±0.04	5.9±0.41	6.4±0.08	7.0±0.06	8.6±0.86	1.4±0.4	2.7±0.10
Dung +Wheat straw	637.09±3.12	216.25±2.06	8.8±0.06	19.0±0.27	6.5±0.09	6.9±0.10	3.7±0.05	5.5±0.06	2.0±0.3	2.4±0.22
Dung +Barley bran	485.18±3.01	214.41±2.00	10.5±0.06	25.0±0.16	5.9±0.05	6.6±0.08	4.8±0.03	7.5±0.09	1.3±0.1	2.1±0.14
Dung +Gram bran	596.12±6.26	261.57±1.82	14.3±0.86	25.2±0.25	7.1±0.04	7.6±0.06	4.9±0.12	7.4±0.42	2.1±0.3	2.4±0.21
Dung +Banana pills	588.03±5.42	250.64±1.96	8.2±0.12	19.4±0.25	5.1±0.12	6.5±0.06	5.4±0.04	7.7±0.89	2.2±0.1	2.9±0.32
Goat Dung	436.51±4.21	222.43±1.07	4.6±0.31	10.5±0.18	6.1±0.16	6.9±0.07	4.1±0.08	5.3±0.62	1.7±0.5	2.5±0.30
Dung +Rice Bran	532.15±1.24	296.13±1.06	10.3±0.36	25.4±0.24	7.9±0.80	8.1±0.10	7.7±0.12	8.2±0.87	1.2±0.6	3.4±0.23
Dung +Wheat straw	598.22±4.15	250.23±1.41	7.3±0.08	18.9±0.15	6.9±0.21	7.3±0.09	4.5±0.08	4.9±0.65	2.2±0.1	3.6±0.40
Dung +Barley bran	465.61±3.87	252.14±1.87	9.1±0.16	26.1±0.19	7.9±0.16	8.2±0.12	5.5±0.09	6.5±0.20	1.8±0.5	3.1±0.20
Dung +Gram bran	558.69±3.02	296.25±1.98	12.5±0.14	24.0±0.20	7.2±0.18	8.6±0.04	5.8±0.18	7.1±0.50	1.6±0.4	3.2±0.31
Dung +Banana pills	510.12±3.14	241.42±1.05	8.9±0.21	12.4±0.25	6.8±0.21	8.0±0.02	8.2±0.16	6.8±0.48	2.2±0.3	3.8±0.42

Each value is the mean ± SE of six replicates.

Significant variance ($P<0.05$) two way analysis of variance (ANOVA) was applied in between initial mixture and final vermicompost.

banana pills 8.3±0.36 g kg^{-1} significantly highest. Due to stabilization TK may be enhance in vermicompost as result significant increase 4% to 39%. Total available phosphorous significantly increase 0.81% to 42.2% in all final vermicompost all binary combination of different animal and agro wastes. The significantly highest TAP 8.8±0.54 g kg^{-1} in buffalo dung with rice bran. In all combination of different animal and agro wastes significant increase Tca in final vermicomposts than initial feed mixtures. Total calcium (TCa) significantly highest 3.8±0.42 g kg^{-1} in goat dung with banana pills (Table 4).

DISCUSSION

The different binary combination of buffalo dung with agro-wastes rice bran, wheat straw, barley bran, gram bran and banana polls caused a significant growth of *E. fetida* as well as significantly increase in number of cocoons, clitellum development and initiation of cocoon production and weight gain. There was also significant initiation of clitellum development 14±2.4 days in binary combination of buffalo dung with wheat straw. The combination of feed material, temperature, humidity, but all of them food material very important factor for growth and reproduction [16]. Elvira *et al.*. [17] reported 22 to 36 folds increase the number of earthworm and also increased 2.2 to 3.9 times total biomass in the combination of paper mill sludge with cattle wastes. Initiation of cocoon production significantly earliest 30±3.4 days in buffalo dung with wheat straw combination. The reproduction rate significantly highest 0.16±0.016 cocoons worm^{-1} day^{-1} in buffalo dung with wheat straw because it may be due to presence of hemicellulose, high C/N ratio and good aeration. Hemicelluloses, lignin and cellulose are the main component of wheat straw [18]. The combination of agro and kitchen wastes with animal dung provides a suitable environment for better growth and development of *E. fetida* [19].

The average weight gain in combination of buffalo dung with gram bran significant highest in *E. fetida.* Suthar [20] studied that change in biomass and cocoon production of *Perionyx sonsbarious* affected by different feeding material quality. Loh *et al* [21] reported that biomass gain and cocoon production by *E. fetida* more in cattle wastes in compression to goat wastes. Nath *et al* [19] reported that the combination of agro and kitchen wastes with cattle dung have significant growth and development of *E. fetida*.

The physical and chemical parameters were changed in all final vermicomposts with respect to initial feed mixtures. The pH value slightly basic in all combination of initial feed mixture tend to slightly acidity or neutral in final vermicompost because the decrease in pH by microbial activity present in earthworms gut [22]. The highest pH due to nitrogen and during vermicomposting elimination of nitrogen as volatile ammonia [5].

Brady and Weil [23] studied that the agro wastes have low nitrogen residue due to immobilization of inorganic nitrogen of soil by microbes resulted unavailable to plants. Three fold earthworm's biomass in high C/N ratio compare to low C/N ratio [24]. The C/N ratio significantly highest decrease 296.25±1.5 g kg^{-1} in goat dung with gram bran because may be due to loss of CO_2 during microbial respiration, production of mucus and nitrogenous excrement [25].

Electrical conductivity significant decreased in all combination of final vermicompost in comparison to initial feed mixtures. Garg *et al.* [3] observed that the reduced 46.0% to 28.4% EC from initial feed mixture. EC and pH are limiting factors for *E. fetida* growth and development [26]. The significantly lower EC 1.06±0.04 dsm^{-1} in final vermicompost of buffalo dung with rice bran combination, it is due to the increased rate of loss of organic matter, consequently release different minerals salt of this combination [27].

During vermicomposting there was significant increase in different biochemical parameter as TOC, TKN, TK, TAP and TCa in all final vermicompost than the initial feed mixtures. It is due to the vermicomposting mechanism by microbial degradation, organic residue assimilation and expiration CO_2 that all responsible for carbon losses from initial mixture. Thus vermicomposting directly influence the TOC level in mixture which have highly TOC [21, 28,29]. The maximum significant increase 296.25±1.98 g kg^{-1} was observed in level of total organic carbon (TOC) in final vermicompost of combination of cow dung with rice bran because rice bran content significant amount of nitrogen, lignin, cellulose, hemicellulose, residual ash, calcium, magnesium, sodium, potassium and phosphorus. Thus use of rice bran in binary combination with animal dung increase the nutrients in vermicomposting [30].

Total kjeldhal nitrogen level was also significantly increasing 3.5 to 11.0 g kg^{-1} in final vermicompost than the initial feed mixtures. Because mineralization of organic matte during vermicomposting. Nitrogen surplus by microorganism in the intestine as well as by earthworm stabilized nitrogen excreta, mucus, enzyme and certain hormones [28, 31]. Tripathi and Bhardwaj [28] reported that due to decay after worms body as proteineous portion in to ammonia and nitrogenous like substances. The maximum highest significant TKN 26.1±0.19 g kg^{-1} in vermicompost of goat dung with barley bran may be due to the decay of high organic carbon might be responsible for nitrogen addition in the form of micro-nutrients, excretory substances, from the earthworm gut [22, 28, 32].

The level of total potassium (TK) slightly increases in all final vermicompost. The TK in buffalo dung with banana pills 8.3±0.36 g kg^{-1} significantly highest. Due to stabilization TK may be enhance in vermicompost as result significant increase 4% to 39%. Kaveiraj and Sharma [27] reported that TK level increase 5-10 % during

vermicomposting by different earthworm species. According Suthar [20] increase conc. due to enhance rate of mineralization by microbial activity during vermicomposting. Increase TK in leached from vermicomposting bed so decrease in final vermicompost [3, 33-34] .The combination of buffalo dung with banana pills have various organic compounds and may be due to presence of these compounds it enhance the rate of K mineralization [20].

Total available phosphorous (TAP) significantly increase 0.81% to 42.2% in final vermicompost all binary combination of different animal and agro wastes. . It is because of in vitro nitrification of ammonium salt and in vivo as worm gut enzyme role in phosphate solublizing by microbes resulted phosphorous increase in vermicompost recognized [35,36]. Suthar and Lee [37] studied that the organic content when pass through gut where is soluble and stabilizing phosphorous. The significantly highest TAP in buffalo dung with rice bran. The rice bran have conjugated pyridoxine, like thiamine pyrophosphates may be conjugates with phosphoric acid through the 3-hydroxyl [38,39]. It is possible that break down of these organic compounds in vermicomposting enhanced the total phosphorus level.

In all combination of different animal and agro wastes significant increase TCa in final vermicomposts than initial feed mixtures. The pattern of calcium enhancement by unavailable calcium compound to available form in the vermicompost by organic wastes pass to earthworm gut [5, 20]. Total calcium (TCa) significantly highest in goat dung with banana pills because high rate of Ca^{++} mineralization take place in to this combination during vermicomposting [17].

CONCLUSION

It is clear from the results that there was significant growth and development of earthworm *Eisenia fetida* in vermibed combination of different animal dung with agro wastes. The use of earthworm *E. fetida* also improve the biofertilizer by the enhance the quantity of nitrogen, phosphorus and potassium significantly and also significantly decrease the pH, electric conductivity as well as C/N ratio that characteristics features of an ideal fertilizer. Use of epigeic earthworm *E. fetida* minimized the pollution hazard caused by organic wastes degradation. More population of earthworm necessary for better conversion of wastes through. vermicomposting.

REFERENCES

1. Purakeyastha, T.J. and R.K. Bhatnagar, 1997. Vermicompost: a promising source of plants nutrients. India Fmg., 46(2): 35-37.
2. Gupta, P.K., 2005. Vermicomposting for sustainable agriculture. Bharat Printing Press. Jodhpur, India, pp: 11-14.
3. Garg, P., A. Gupta and S. Satya, 2006. Vermicomposting of different types of waste using *Eisenia foetida:* A comparative study. Biores. Technol., 97: 391-395.
4. Sabin, J.R., 1978. The Nutritive value of earthworm meals. In Hartenstein, R. ed. (Utilization of soil organisms in sludge management, Syracuse, state university of New York), pp: 122-130.
5. Hartenstein, R. and F. Hartenstein, 1981. Physico-chemical changes affected in activated sludge by the earthworm *Eisenia foetida*. J. Environ. Quality. 10: 377-382.
6. Shweta, Y.P. Singh. and K. Kumar, 2004. Vermicomposting-A profitable alternative for developing country. Agrobios News Letter Aug., III(4): 15-16.
7. Eastman, B.R., P.N. Kane, C.A. Edwards, L. Trytek, B. Gunadi, A.L. Stermer and J.R. Mobley, 2001. The effectiveness of vermiculture in human pathogen reduction for USEPA biosolids stabilization. Compost Science and Utilization. 9: 38-49.
8. Soytong, K. and K. Soytong, 1996. *Chaetomium* as a new broad spectrum mycofungicidde. Proc. of the First International Symposium on Biopesticides, Thailand, October 27-31, pp: 124-132.
9. Garg, V.K., S. Chand, A. Chhillar, Y.K. Yadav, 2005. Growth and reproduction of *Eisenia foetida* in various animal wastes during vermicomposting. Applied Ecol. and Environ. Res. Hungary. 3(2): 51-59.
10. Ndegwa, P.M. and S.A. Thompson, 2001. Integrating composting and vermicomposting the treatment and bioconversion of biosolids, Biores. Technol., 76: 107-112.
11. Bansal, S. and K.K. Kapoor, 2000. Vermicomposting of crop residues and cattle dung with Eisenia foetida. Biores. Technol., 73: 95-98.
12. Kaushik, P. and V.K. Garg, 2003. Vermicomposting of mixed solid textile mill sludge and cow dung with the epigeic earthworm *Eisenia foetida*. Bioresource Technol., 90: 311-316.

13. Nelson, D.W. and L.E. Sommers, 1982. Total organic carbon and organic matter, in: Page, A.L. Miller R.H. Keeney D.R. (Eds. Method of Soil Analysis). American Society of Agronomy. Medison, pp: 539-579.
14. Bremner, J.M. and R.G. Mulvaney, 1982. Nitrogen Total in Method of Soil Analysis in: Page. A.L. Millar, R.H. Keeney, D.R. (Eds.), American Society of agronomy, Madison, pp: 575-624.
15. Sokal, R.R. and F.J. Rohlf, 1973. Introduction of biostatistics. W. H. Freeman & Co. San Francisco.
16. Fayolle, L., H. Mitchell, D. Cluzeau and J. Stawiec, 1997. Influnence of temperature and food source on the life cycle of the earthworm *Dendrobaena veneta* (Oligochaeta). Soil Biology and Biochemistry. 29: 747-750.
17. Elvira, C., L. Sampedro, E. Benitez and R. Nogales, 1998. Vermicomposting of sludges from paper mill and dairy industries with *Eisenia andrei*: A pilot scale study. Bioresource. Technol., 63: 205-211.
18. Pan, X. and Y. Sano, 2005. Fraction of wheat straw by atmospheric acetic acid. Biores. Tech., 96: 1256-1263.
19. Nath, G., K. Singh and D.K. Singh, 2009. Effect of Different Combinations of Animal Dung and Agro/ Kitchen Wastes on Growth and Development of Earthworm *Eisenia foetida.* Australian Journal of Basic and Applied Sci., 3: 3553-3556.
20. Suthar, S., 2007. Nutrient changes and biodynamic of epigeic earthworm *Perionyx excavatus* (Perrier) during recycling of some agriculture wastes. Bioresour. Technol., 98: 1608-14.
21. Loh, T.C., Y.C. Lee, J.B. Liang and D. Tan, 2005. Vermicomposting of cattle and goat manures by *Eisenia foetida* and their growth and reproduction preference. Bioresource Technol., 96: 111-114.
22. Nath, G., K. Singh and D.K. Singh, 2009. Chemical analysis of vermicompost/vermiwash of different combinations of animal, agro and kitchen wastes. Australian J. Basic and Applied Sci., 3: 3672-3676.
23. Brady, N.C. and R.R. Weil, 2002. The nature and properties of soils, 13th ed. Pearson Education, Singapur, pp: 960.
24. Aira, M., F. Monroy and J. Domínguez, 2006. C to N ratio strongly affects population structure of *Eisenia foetida* in vermicomposting systems. European J. Soil Biol., 42: 127-131.
25. Suthar, S., 2008. Feasibility of vermicomposting in bio-stabilization of sludge from a distillery industry. Science of total Environ., 394: 237-243.
26. Edwards, C.A., 1998. The use of earthworms in the breakdown and management of organic wastes. in: Edwards, C.A. (Eds.), Earthworm Ecology. St. Lucie Press. Boca Raton, pp: 327-351.
27. Kaviraj and S. Sharma, 2003. Municipal solid waste management through vermicomposting employing exotic and local species of earthworms. Bioresource Technol., 90: 169-173.
28. Tripathi, G. and P. Bharadwaj, 2004. Comparative studies on biomass production, life cycles and composting efficacy of *Eisenia foetida* (Savigny) and *Lampito maruitti* (Kinberg). Biores. Technol., 92(3): 275-283.
29. Garg, V.K. and P. Kaushik, 2005. Vermistabilization of textile mill sludge spiked with poultry droppings by an epigeic earthworm *Eisenia fetida.* Bioresource Technol., 96: 1063-1071.
30. You, I.S., R.A. Jones and R. Bortha, 1982. Evaluation of chemically defined for attachment of 3, 4 dichloroaniline to humans, Bull. Env. Contam. Toxicol., 29: 476-482.
31. Hobson, A.M., J. Fedrickson and N.B. Dise, 2005. CH_4 and N_2O from mechanically turned windrow and vermicomposting systems following in-vessel pretreatment. Waste. Manag., pp: 345-352.
32. Viel, M., D. Sayag and L. Andre, 1987. Optimization of agricultural, industrial waste management through in-vessel composting, in: de Bertoldi, M. (Eds.), Compost: Production Quality and Use, Elsevier Appl. Sci. Essex, pp: 230-237.
33. Orozco, F.H., J. Cegarra, L.M. Trujillo and A. Roig, 1996. Vermicomposting of coffee pulp using the earthworm *Eisenia foetida* on C and N contents and the availability of nutrients. Biol. Fertil. Siol. 22: 162-166.
34. Benitez, E., R. Nogales, C. Elvira, G. Masciandaro and B. Ceccanti, 1999. Enzyme activities as indicators of stabilization of sewage sludges composting with *Eisenia foetida*. Biores. Technal., 67: 297-303.
35. Alaxander, M., 1983. in: Introduction to Soil Microbiology second ed. Welly Eastern Limited, New Delhi pp: 467.
36. Satchel, J.E. and K. Martin, 1984. Phasphate activity in earthworm faeces. Soil. Biol. Biochem., 16: 198-194.
37. Suthar, S. and K.E. Lee, 1992. Some trends and opportunities in earthworm research. Soil Biol. Biochem., 24: 1765-1771.
38. Anderson, R.J., 1915. Concerning phytin in wheat bran. The J. Biological Chemistry, pp: 493-497.
39. Scudi, J.V., 1942. Conjugated Pyridoxine in rice bran concentrates, J. Biol. Chem., pp: 637-639.