International Proceedings of Chemical, Biological and Environmental Engineering, V0l. 93 (2016)
DOI: 10.7763/IPCBEE. 2016. V93. 13

Evaluation of Phytotoxicty of Fermented Goat Manure from two Different Located South Korea Farms

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Abstract. Korea has increased the livestock population with a rise in national per capita income bringing with it the propensity to consume more livestock products. Goats are seen as important multi-functional animals in socio-economic and ecological terms in developing countries throughout the world. Goat manure has received more attention than other animal manure for the following reasons: nutrient rich content (i.e., high nitrogen and other elements) and low odor, etc. However, for the production of high nutrient quality organic fertilizers, we collected and fermented the sunchang and kimcheon region farm goat manure (GM) for 25 days. Our study focused on the evaluation of the phytotoxcity level of fermented and non fermented manure using two different commercial crop varieties, viz., sesame (*Sesamum indicum* L.), and carrot (*Daucus carota*). The results revealed that the relative seed germination (RSG), relative root elongation(RRE) and germination index (GI) values were recorded highly in fermented goat manure(FM) than non fermented manure(NFM) from both farms. The recorded range of two crops RSG (76.6- 98 %), RRE (72-135%) and GI (69.5- 98) in fermented manure and RSG (86- 100 %), RRE (95 - 149%) and GI (93.1- 119.5). However, in between the crops, carrot shown better RSG (%), RRE (%) and GI (%) values than sesame crops. Overall results concluded, the both farm F manure and NF manure did not show any phytotoxicity (based on above 50 % GI) on studied crops, in addition, F manure enhanced the seedling growth and it could be used as organic fertilizer for commercial crops.

Keywords: sunchang, kimcheon, relative seed germination, relative root elongation, germination index.

1. Introduction

Livestock are essential in supporting the livelihoods of poor farmers, labourers, consumers,traders and moreover, in agriculture area throughout the developing world. Korea has significantly increased livestock population with a boost in national per capita income bringing with it the inclination to consume more livestock products [1]. In this regards, goats are seen as important multi-functional animals in socio-economic and ecological terms. Apart from milk and consume meat products, goats produce manure daily, equal to about 5 % of their body weight and its declared as nutrient rich content material [2]. Moreover, goat manure has received more attention than other animal manure and its due to high nitrogen and other elements, low odor; naturally dry and due to pellatized state it easy to collect, store and spread into the field. However, previous research findings revealed, fresh/raw manure contains complex undigested materials, including pathogens, imbalanced nutrients and it's harmful to plants and soil microorganisms. The search of efficient and eco-friendly technologies for solid waste management is still under development. Composting is recognized as a cost-effective and effective way for the management of animal waste. But still, composting is time consuming and sometimes results in in mature composts whose soil application causes N starvation and associated phytotoxic effects [3]. Contreras-Ramos et al.[4] reported that the immature compost can exhibit phytotoxic behavior on seed germination and plant growth. The immature manure release of phytotoxic compounds such as ammonia and low molecular weight short chain volatile fatty acids, primarily

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acetic acid. To remove the phytotoxic effects and conversion of simple substances and available nutrients, fermentation process through in-vessel composting method is highly rated. There are numerous benefits of fermentation-in-vessel composting, such as an increased processing speed, year-round composting, and a highly controlled environment. Moreover, this system can be reduced the air requirement than the open system and its due to preconditioning of the supply air and the possibility of air recirculation. Ravindran et al.[5] reported that the fermentation through the composting process and results shown non phytotoxicity effect on commercial food crops. On the other hand, nutrient composition and phytotoxic effect of the manure may be differ from regions of the country which may be due to land management and livestock management (e.g. animal feeds). In this regard, the current study focused on goat manure phytotoxicity effects of farm manure (before and after fermentation/compost) from two different regions of South Korea. So, we selected seeds of the recommended crops, such as sesame (*Sesamum indicum* L.) and carrot (*Daucus carota*) were used in this study.

2. Materials and Methods

2.1. Manure Characterization

The manure samples were collected from goat farms located in Sunchang and Kimcheon in South Korea. The collected samples were stored at 4 ℃ to avoid changes in their characteristics until the start of the study. The important physical and chemical characteristics of the samples were analyzed using standard methods [6] and summarized in Table 1.

2.2. Experimental Design for Fermentation and Phytotoxicity Studies

The study was carried out in the temperature controlled research room of the National Institute of Animal Science located in Jeonju at 35.8242 ° N and 127.1480 ° E in the Jeollabuk-do , South Korea. The experiment included two different farm goat manure were conducted in fermentation reactor with 80 L working capacity was used for the experiment. Each treatment mixture consisted of goat manure plus saw dust in the ratio of 2:1 with the total mass of 80 kg. The reactors were 1m high and 0.39 m inner diameter with made up of stainless steel (Fig.1) and these are designed specially to minimize heat loss. A two layer of the removable plastic lid followed by stainless wire mesh was fitted to the top of each reactor vessel to facilitate mixing and sampling of fermentative mixtures. The initial moisture contents of the treatment mixtures were adjusted to 60% through the addition of deionized water. The mixtures were turned weekly. The temperature profile was monitored every day in each reactor between the hours of 9.00 am to 10 am when the ambient temperature was fairly stable through the temperature controlled room. From the bottom (0.12 m) of each fermentation reactor, a 5 mm stainless grid was installed to support the fermentation mixtures bed and insure uniform gas distribution. For the reactor aeration, the controllable peristaltic pump was used and set at 1 L/min/Kg fermentation mass over the whole 25 day fermentation period. The compost piles were turned on every five days for 25 days fermentation process. The focal themes of the present investigation of the phytotoxicity effect of ferment and non ferment goat manure, the following experimental design was more support for the current research study.

The phytotoxicity effect on crop seed growth was studied in terms of germination index (GI), relative seed germination (RSG) and relative root elongation (RRE) using two different crops: sesame (*Sesamum indicum* L.) and carrot (*Daucus carota*). Certified seeds of all crops were purchased from garden material stores and germination level above 95 % was obtained through pre-examination study, demonstrating the viability of the seeds. Then two pieces of Whatman paper No. 1 filter discs were placed inside a 15 mm x 100 mm sterilized petri dish and wet with 6 ml of extracts of the manure samples prepared with double distilled water (water to solid ratio of 10:1). For the controls, 6 ml of double distilled water was used. Ten uniformed seeds of sesame and carrot were selected and placed on the filter paper were incubated at 18 ℃ in a dark incubator for 7 days. Each treatment was set up in triplicate. The number of germinated seeds was then counted and the length of the roots was measured. RSG, RRE, GI and VI were calculated by counting the average number of germinated seeds, average shoot lengths and the average root length observed in different treatments compared with control treatments as per the formulas below [7].

$$RSG\ (\%) = \frac{\text{Number of seeds germinated in the sample extract x 100}}{\text{Number of seeds germinated in the control}}$$

$$RRE\ (\%) = \frac{\text{Mean root elongation in the sample extract x 100}}{\text{Mean root elongation in the control}}$$

$$GI\ (\%) = \frac{\text{(\% Seed germination) x (\% Root elongation)}}{100}$$

2.3. Physico- Chemical Analysis

The pH and EC were determined using a double distilled water suspension of the sample mixtures in the ratio of 1:10 (w/v) using a pH meter (Thermo scientific, Orion 4 Star) and conductivity meter (Yellow Springs Instrument, model 3100). This suspension was shaken on a mechanical shaker at 230 rpm for 30 mins and allowed to stand for an hour prior to pH and EC measurement. TN and TC were determined using a Vario Macro CHNS Element Analyzer. The moisture content of the sample was measured after drying at 105 ℃ for overnight. TP were analyzed using a Varian CARY 300 UV-VIS Spectrophotometer.Potassium (K) was determined by atomic absorption spectroscopy (AAS) after digesting the sample with concentrated HNO3: concentrated HClO4, (2:1, v/v). NH_4-N and NO_3-N concentrations were measured using a Kjeldahl Nitrogen analyzer (Kjeltec. Auto 1035 System, Tecator AB). All analyses were carried out in triplicate. The data reported in the present study are the means of three replicates (n = 3) and statistically analyzed for the calculation of standard errors (S. E.).

3. Results and Discussion

3.1. Major Characteristics of Raw (non Ferment) Manure and Fermented Manure

The physico-chemical composition (%) of goat manure(non-ferment and ferment) from two different regions in South Korea is shown in Table 1. According to plant growth and maturity of manure, the major nutrients of carbon to nitrogen and potassium (N, P, K) were recorded variably in the two and treatment samples.

Table 1: Major characteristics of goat manure collected from different regions of South Korea.

Parameters	**Raw/Non-ferment manure**		**Fermented manure**	
	Sunchang	**Kimcheon**	**Sunchang**	**Kimcheon**
pH	9.2 ±0.6	8.78 ±0.5	9.02	8.55
EC(µs/cm)	561 ±38	400 ±29	312	609
Moisture(%)	61 ±4.1	63 ±5.8	60.3	56.8
VS(%)	83.10 ±5.5	88.1 ±6.2	79.8	74.4
TS(%)	37.37 ±3.2	44.04 ±4.1	45.3	43.11
TN(%)	1.9 ±0.07	2.1 ±0.12	3.3	2.79
TC(%)	37.33 ±2.9	45.70 ±3.1	44.3	37.6
C:N ratio	19.6 ±2.5	21.4 ±1.5	13.42	13.4

Note: The data represent the mean ± standard deviation of three replicates

After 25 days study, the fermentation process modified the physical and chemical properties in two different farm goat manure, which indicate the maturity of these manure (Tables 1). The manure nature obtained was darker than the original material in all fermented manure,while the without processed remained in compact clumps. The final pH was recorded 9.02 and 8.55, and EC values were 312 and 609 in Sunchang

and Kimcheon respectively. Irshad et al. [8] reported that goat manure had higher pH(Alkaline) and EC values than cow and poultry manures whether in fresh or composted samples, and its plant height, number of leaves, leaf area index (LAI), total dry matter (TDM), and yield of sweet maize (*Zea mays L. saccharata Strut*I). In our study, the both farm fermented manure were recorded below 15 in both farms from Sunchang and kimcheon.). Many researchers have suggested that the less than 20 of C: N ratios in the final product, to be indicative of a mature product, releasing notable N to the crop growth [9] also suggested the C:N ratio of 20 in organic amendment is recommended for the application of different soils.

3.2. Phytotoxicity Assessment of Manure Extracts onCommercial Crop Seedlings

3.2.1 Effect of RSG ,RRE and GI

The relative seed germination (RSG) (%) recorded in the crop seeds were as follows: carrot, 76.6 – 85.5; sesame, 96.6-98 in non ferment manure from Sunchang and kimcheon respectively(Fig. 1 a,b). At the same time, from both region farm fermented manure, RSG range was recorded in the range of 86-100 and 98 respectively. Normally, crop seeds adsorbed the extracts and utilized their nutrients for various metabolic activities, including cell division and elongation. In overall RSG results, kimcheon goat farm ferment manure extracts recorded better RSG values than the sunchang goat ferment manure extracts in all crop seeds. The increases in percentage germination may be due to the favorable environmental conditions for germination and utilization of nutrients from extracts. However, possible reason for the reduction of RSG in some of the manure extracts may have been due to availability of the small amounts of phytotoxicity compounds such as ammonia, and organic acids[4]. The relative root elongation (RRE) (%) recorded from the non ferment manure extracts on the crop seeds were as follows: carrot, 128-135; sesame, 77-79, and for the fermented manure extracts, carrot, 139-149; sesame, 95-110 was recorded from Sunchang and Kimcheon respectively(Fig. 1 a,b).These results can be used to identify the crop seeds suitable for particular farm goat manure extracts. The RRE (%) maximum values were positively correlated to the RSG (%) maximum values in the fermented kimcheon extract which may be due to availability of more nutrients in that extract compared to the other extracts. The germination index (GI) is an indicator of phytotoxicity in manure extracts and also used to evaluate the suitability of organic materials for agricultural purposes. In our studies, GI (%) was recorded in the range of 98- 114.7 in carrot and 69-77.4 in sesame from non-fermented manure extracts(Fig. 1 a,b). As same RSG and RRE, GI values also recorded maximum from fermented manure extracts as in the range of 98- 114.7 in carrot and 69-77.4 in sesame crop seeds. Phytotoxicity below 50 % could indicate that the maturity of the manure is not complete (Ravindran et al. 2015). In our studies, all non-ferment and ferment manure extracts show above 50 % GI in all two crop seeds. However, Tiquia[7] reported that a GI above 80% indicates the disappearance of phytotoxicity in substrates. According this research statement, the both Sunchang and Kimcheon ferment manure extracts were recorded above 80 % GI in carrot and sesame crop seeds.

4. Conclusions

This study has shown the phytotoxicity level of raw and fermented goat manure from different farms in South Korea on different crop seeds. The results concluded that carrot shown better RSG (%), RRE (%) and GI (%) values than sesame crops from fermented GM than non ferment manure.

5. Acknowledgements

This work was carried out with the support of "Cooperative Research Program for Agriculture Science & Technology Development (Project title: *Investigation of the use of efficiency of different organic manures in upland grassland*, Project No. PJ010099022016)" and also was supported by Postdoctoral Fellowship Program (2015- 2016) of the *National Institute of Animal Science*, Rural Development Administration, Republic of Korea.

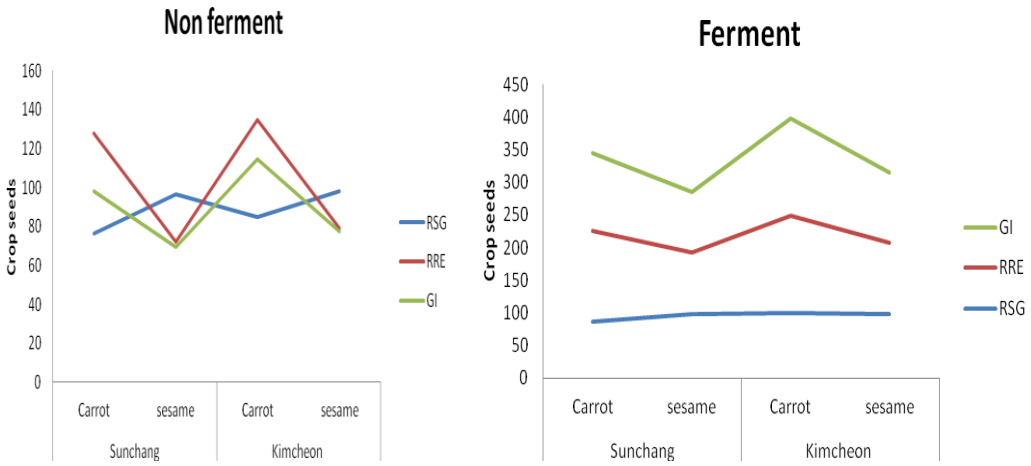

Fig. 1: Effects of RSG, RRE, GI (%) of non ferment(a) and ferment (b)manure extracts on on crop seedlings.

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