Original Research Article

Effect of Solid Fermentation on Physicochemical and Microbial Compositions of Poultry Droppings for Biofertilizer

Abstract

Aim: The study was carried out with the aim of determining what would be the effect of solid fermentation on the microbial loads and physicochemical compositions of poultry droppings in preparation of biofertilizer.

Place and period: The study was carried out in the Department of Microbiology, Federal University of Technology Akure Ondo State. 2014

Methodology: Solid fermentation was carried out on the poultry dung. Before the commencement of fermentation physicochemical and initial microbial load concentrations were determined. The microbial load of the poultry was evaluated for six days via plate count method. To isolates and identify the organisms associated with the dung, pour plate method was used. The following media were used for the isolation of microorganisms in poultry dung: Nutrient agar (NA); MaConkey agar (MCA); Mann Rogosa Shape (MRS0; Mannitol Salt agar (MSA), SIM agar, Moller Heaton agar (MHA), and Potato Dextrose agar (PDA). Identification of isolated bacteria was done tentatively based on biochemical characteristics, according to the information of Bergey s Manual of Bacteriological Identification.

Results: Eleven genera of bacteria and four species of fungi were isolated and identified in this study. Isolated bacteria are; *Enterococcus feacalis, Corynebacterium xerosis, Staphylococcus aureus, Citrobacter freundii, Micrococcus reseus, Escherichia coli, Klebsiella spp, Proteus vulgaris, Staphylococcus captis* and *Streptococcus pyogen* and fungi are *Aspergillus fumigatus, Aspergillus niger* and *Aspergillus flavus* respectively. Numerical values of physicochemical parameters before fermentation were on the lower values compare with the value during fermentation. Moisture content (29.52±0.06/75.45±0.08), Ash content (%) (3.43±0.42/9.93±013), PH (6.39/6.50), Crude protein (7.70±021/9.02±0.00), Total volatile Nitrogen (58.80/92.40) In the case of bacterial load, 1.79 x 10^4CFU/g was before the commencement of fermentation while the lowest load during fermentation was on fifth day with 5.1x10^2±0.00 CFU/g. However for the fungi load, the highest load recorded was 1.0x10^5 CFU/g on second day followed by 4.0x10^4 CFU/g on third day of fermentation but on the fifth day fungi disappeared and reached zero.

Conclusion: the fermentation of poultry droppings increases the values of chemical constituents and decreases the microbial loads with time. Hence there is possibility of reducing the loads of pathogenic microorganisms in organic manure.

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Key words: poultry droppings, biofertilizers, physicochemical, microbial loads, fermentation, poultry waste, organic manure, aspergillus.

1.0 Introduction

Poultry provides rich organic manure and is an important source of income and employment to millions of farmers and other persons engaged in allied activities in the poultry industry Many States in the world rely upon the poultry industry for a substantial portion of their agricultural income. The soil fertility and productivity are considerable factors to boost agricultural produces in any geographical environment. This prompted high demand of organic manure like poultry droppings or waste. However the procedure for its application should be considered based on soil topography, soil terrain and the nature of soil among others in a given agricultural environment. If the terrain and topography of the soil is highly water retention and it dissolved (poultry droppings) during rainfall, it leads to pollution which affects human health and also causes water contamination in the environment [1].

Poultry-based organic fertilizers are usually applied into the soil to improve the structure and fertility of agricultural land. As an important source of nutrients for crop production, poultry droppings may also contain a variety of human pathogens that can threaten humans who consume the contaminated food or fruits. Fermentation can reduce and inactivate pathogens while creating a soil amendment beneficial for application to arable agricultural land [2]. Some foodborne pathogens may have the potential to survive for long periods of time in raw chicken litter or its composted products after land application, and a small population of pathogenic cells may even regrow to high levels when the conditions are favorable for growth. Fermentation of poultry droppings is necessary for destruction of potential pathogens; reduce the pungency of odor and storage characteristics. Different methods have been employed to eliminate potential pathogenic method such as composting, high heat treatment. Additional approach such as fermentation which is the physical means and cost effective should be employed.

The presence of the pathogenic microorganisms impact negatively on feed utilization and physiological functions within the animal system [3]. Poultry litter has useful properties as a fertilizer and soil amendment and has been used for many years in the production of a range of crops and products for human consumption. [4].

Nowadays enteric diseases in poultry industry cause low productivity, increased mortality and associated contamination of poultry products for human consumption. With increasing concerns about antibiotic resistance, the ban on sub-therapeutic antibiotic usage in Europe and the potential for a ban in US, there is an increasing interest in finding alternatives to antibiotics for poultry production. A public health concern associated with pathogenic bacteria is the increased incidence of strains that are resistant to antimicrobial agents. Those resistant microorganisms can be disseminated via animal feces to other animals. Resistance to antimicrobials is connected with genetic mechanisms. New trends in drug discovery from natural source emphasize on investigation of the marine ecosystem to explore numerous

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complex and novel chemical entities for the treatment of many disease such as cancer, inflammatory condition arthritis, malaria and large variety of viral, bacterial, fungal disease [5].

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2.0 Materials and methods

The following media were used for the isolation of microorganisms in poultry droppings: nutrient agar for the enumeration of total aerobic bacteria count; MaConkey for enteric bacteria; Mann Rogosa Shape for lactic acid bacteria isolation; Mannitol Salt agar for *Staphylococcus aureus* identification SIM agar for sulphide, indole and motility test, and Potato Dextrose agar for isolation of fungi. Nutrient agar was used for sub culturing the bacterial isolates.

3.1 Poultry droppings collection

Poultry droppings were collected at Federal University of Technology Akure research and teaching farm from six week old broilers. The sample was collected in sterile polythene nylon and transported to the laboratory for analysis.

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3.2 Isolation of organisms

After serial dilution (see microbial load determination below for details) of poultry droppings, 0.1ml of the diluent was dispensed into the sterile 90 mm petri dish after which the already prepared agar was poured, covered, and gently mixed to allow homogenization. The plate was incubated at 37^{o}C for 24 hours. To obtain a single pure colony after 24 hours of incubation, the culture plates were checked for visible growth. The colonies with distinct growth were then subcultured into freshly prepared nutrient agar by the streaked method and incubated at 37^{o}C for 24 hours. Isolates were identified by comparing their sugar fermentation patterns with the scheme described in Bergey s Manual of Systematic Bacteriology (8).

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3.3 Fermentation and physicochemical parameters of poultry droppings

Solid fermentation was employed in this experiment. The plastic container 5litrs capacity is 90mm in diameter and 900mm deep was used. The poultry dung of 300g was weighed into transparent sterile plastic container and covered. Before the commencement of fermentation process, initial physicochemical parameters and microbial load concentrations were determined. In this procedure, fermentation was allowed to place naturally without the introduction of any culture starter or organisms. The indigenous microorganisms carried out the fermentation of poultry droppings under natural condition. The whole set up was daily monitored at 25^{o}C. The standard method was employed to determine all the physicochemical parameters [6]. The following parameters were determined; Moisture content, Ash content (%), pH, Crude protein, Total volatile Nitrogen, Odour, Texture and Colour. [7]

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3.4 Determination of Microbial Loads

The microbial load of the poultry droppings under fermentation was evaluated daily for six days via pour plate count method. In each day, 1g of poultry dung was taken and serially diluted with 9 ml of sterile

distilled water. For bacterial load determination, 0.1ml of the diluent (serial dilution portion) was introduced into Petri dishes and then covered with already cooled nutrient agar (NA) for bacteria and Potato dextrose agar (PDA) for fungi count. Nutrient agar plates were incubated at 37^{o}C for 24 hours while PDA plates were incubated 25^{o}C for 72 hours. The experiment was carried in duplicates. These procedures were carried out daily for a period of 6days. [7]

3.5 Statistical Analysis

Statistical analyses of all data were performed using Microsoft excel 2010 package. Mean value, standard deviation and relative values of microbial loads were computed with this package.

4.0 Result and Discussion

4.1 Isolation of microorganisms

Eleven bacterial genera were isolated from poultry droppings in this study. The detail of their cultural, microscopic and biochemical characteristics are respectively shown in Tables 1. These bacteria are; *Corynebacteria xerosis*, *Staphylococcus aureus*, *Citrobacter freundii, Micrococcus reseus, Escherichia coli, Enterococcus feacalis, Klebsiella spp, Proteus vulgaris, Staphylococcus captis, Streptococcus pyogen.* However the details about the genera of Lactic acid bacilli comprise of nine species had been reported by Ayantola and Oladunmoye, 2016 in Current Research in Poultry Science (our previous report). Four of the isolates are gram negative rods made up of 45% ,five are gram positive cocci, constitute 46% and one genera made up 9% of gram positive rods.

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Fungi isolated include, *Aspergillus niger, Aspergillus flavus,* and *Aspergillus fumigatus* were isolated from the poultry droppings. The details microscopic and macroscopic identification of isolated *Aspergillus* spp are shown in Table 2.

While some of the bacteria isolated in this study are normal floral of the poultry birds other are human pathogenic for instance *Streptococcus, Enterococcus* spp, found in poultry liters **[**2] are known to cause serious health in poultry. Although some of these organisms are normal floral yet they can post great threat to plant especially during adventitious root development if apply directly to plant inform of organic fertilizer without any treatment. The availability and ease accessibility to poultry droppings and its impact in agricultural practices for food production makes it s a better alternative organic fertilizer to enhance better soil structure. But care must be taken due its microbial composition as seeing in this study. Virtually all the pathogens isolated in this study had been reported from the previous researches and they are human pathogen. They can be implicated in food production line if present in the raw poultry droppings applied to crops in agricultural fields.

Corynebacterium xerosis *is* an aerobic at 37^{o}c, gram negative rod shape, non-spore former, motile, it is positive to catalase, mannitol urease, Voges-Proskaeur can utilize glucose, lactose, sucrose and sugar as source carbon. It is negative to casein and starch hydrolysis, citrate, mannitol salt agar and methyl red. This organism has been isolated from poultry animals [8][9]

Staphylococcus aureus is an aerobic at 37^{o}C, gram positive cocci, non-motile, non-spore former, catalase positive, it is negative to casein and starch hydrolysis and citrate. It utilizes glucose, lactose, and sucrose and mannitol sugar. It produces acid and gas from glucose. The bacterium reacted positively to coagulase, mannitol salt agar, methyl red and Voges-Proskaeur tests. *S. aureus* has been isolated from poultry droppings and wastes [10][11].

Citrobacter freundii the biochemical tests on this isolate revealed that *C. freundii* a facultative anaerobic at 37^{o}C, gram negative rod shaped, non-spore former and motile. It reacted positively to; urease, catalase, methyl red citrate and casein starch hydrolysis, It utilizes glucose and sucrose and mannitol sugar, It reacted negatively on mannitol salt agar and Voges-Proskaeur and coagulase tests. *Citrobacter freundii* has been isolated from Birds faeces and Soil Samples from Poultry Farms as reported by Ayandele *et al*., [12], 2018, isolated from eggs of Ostrich [13],

Micrococcus reseus is an aerobic, at 37^{o}C , gram positive cocci, non-spore former, non-motile, tested positive for catalase, mannitol salt agar, casein hydrolysis, negative to starch hydrolysis, the bacterium showed negative for citrate and methyl red test but negative for Voges-Proskaeur tests, the bacterium utilizes glucose, lactose, and sucrose and mannitol sugar. This bacterium has been isolated from soil has reported. This bacterium can also be found in the air.

Escherichia coli

The results of biochemical tests of this isolate showed that this bacterium is gram negative rod shape, non-spore former, non-motile, tested positive for urease, catalase, starch hydrolysis, casein hydrolysis, glucose, lactose, sucrose, mannitol, and methyl red. However it tested negative for mannitol salt agar, citrate and Voges-Proskaeur. This bacterium was previously isolated from different poultry materials including chicken droppings [14] poultry litters [15], from feces and soil on a laying-hen farm [16]

Enterococcus feacalis: the tests carried out on this isolate showed that it is gram positive cocci shaped, aerobic and grew well at 37^{o}C, tested negative for spore, motility, coagulase, catalase, casein hydrolysis, starch hydrolysis and Voges-Proskaeur but tested positive for urease, glucose, lactose, and sucrose and mannitol sugar. This bacterium has been isolated from poultry liters [11] [17]

***Klebsiella* spp:** gram negative rod shaped facultative anaerobes and grew well at 37^{O}C, spore former, non-motile. It was tested positive for mannitol salt agar, catalase, casein hydrolysis, starch hydrolysis, Voges-Proskaeur, urease, glucose, lactose, sucrose and mannitol sugar. It tested negative for coagulase. This bacterium has been isolated from poultry droppings as reported by Singh *et al*., [18], from chicken cloacal swabs [19], from poultry wastes Mathan *et al*.,[20]

Proteus vulgaris test showed that is gram negative rod shaped, aerobic at 37^{o}C, non-spore former, non-motile, this bacterium tested negative for coagulase, mannitol salt agar, citrate, methyl red, Voges-Proskauer and starch hydrolysis, however the results of this study showed that this bacterium tested positive for the catalase, urease, casein hydrolysis, glucose, lactose, sucrose, and mannitol sugar. The bacterium has been reported to present in chicken and poultry materials [18].

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Staphylococcus captis is gram positive cocci in shape, the test showed this bacterium is non-motile, non-spore former, aerobic at 37^{o}C, positive for mannitol salt agar, catalase, coagulase, urease, casein hydrolysis, glucose, and lactose but the bacterium tested negative for mannitol salt agar, starch hydrolysis, citrate, sucrose, mannitol, methyl red and Voges-Proskauer.

Streptococcus pyogenes tested gram positive with cocci shape, non-motile, non-spore former and aerobic at 37^{o}C. This bacterium tested positive for catalase, mannitol salt agar, casein hydrolysis, starch hydrolysis, glucose, lactose, sucrose, mannitol and Voges-Proskauer. While it tested negative for coagulase, urease, citrate, and methyl red. This bacterium has been isolated from poultry intestine as parts of normal flora of chicken [21]

Although some of the bacteria isolated in this study are normal flora of poultry but can pose a serious challenge to food production if not eliminated before applying poultry droppings or wastes as organic manure.

Table1: Biochemical Characteristics of Isolated Bacteria

Identified Bacteria	GRR	SPO	MOT	CAT	CAH	STH	MSA	COA	URT	CIT	GLU	LAC	SUC	MAN	MR	VP
Corynebacteria xerosis	-ve rod	-	+	+	-	-	-	-	+	-	+	+	+	-	-	+
Staphylococcus aureus	+ve cocci	-	-	+	-	-	+	+	+	-	+	+	+	+	+	+
Citrobacter freundii	-ve rod	-	+	+	+	+	-	-	+	+	+	-	+	+	+	-
Micrococcus reseus	+ cocci	-	-	+	+	-	+	-	+	+	+	+	+		+	-
Esherichia. Coli	-ve rod	-	-	+	+	+	-	-	+	-	+	+	+	+	+	-
Enterococcus feacalis	+ Cocci	-	-	-	-	-	-	-	+	+	+	+	+	+	+	-
Klebsiella spp	-ve rod	+	-	+	+	+	-	-	+	+	+	+	+	+	+	+
Proteus vulgaris	-ve rod	-	-	+	+	-	-	-	+	-	+	+	+	+	-	-
Staphylococcus captis	+ cocci	-	-	+	+	-	+	+	+	--	+	+	-		-	-

Streptococcus pyogenes.	+ Cocci	-	-	+	+	+	+	-	-	-	+	+	+	+	-	+
Lactobacillus spp	+rod															

Keys: GRM: gram reaction, SPO: spore, CAT: Catalase COA: Coagulase, STH: Starch hydrolysis, MAN: mannitol, SUC: sucrose, LAC= lactose, MAL :maltose, GAL: galactose, GLU: glucose, CIT: Citrate, MOT: motility MR :methyl red, VP: Voges-Proskauer

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The term biofertilizers imply nutrient supplement inputs for plant growth which are in biological origin. Biofertilizers accelerate certain microbial processes in the soil which improve the availability of nutrients in a form easily assimilated by crop plants and also mobilizing nutritive elements from non- usable form to usable form through biological processes. The role of bio-fertilizers in agricultural production assumes special significance, particularly in the present context of expensive chemical fertilizers. Moreover, it provides the farmers with a new strategy which is helpful for achieving the targeted goal of food security in Nigeria by increasing high productivity yield of food grains.

4.2 Fungi Isolation.

The only specie of fungi isolated in this study was aspergillus spp. The presence of this fungus in poultry reported. Aspergillus spp has been frequently isolated from the poultry dropping being one of the common filamentous fungi present in air and in poultry litters [22], Aspergillus is known to cause aspergillosis of animals if implicated in food chain. Although depending on the population of this organism in the applied manure, care should be taking to ensure that the presence of aspergillus is reduce through the fermentation as it has been shown in this study that if poultry droppings are subjected to fermentation has the ability to cause reduction in their populations. However, aspergillus in the organic manure applied to the soil had been reported to be of good phosphate solubilizing fungi [23] making them a good component of biofertilizers. Therefore the knowledge of their microbial load should be determined before application.

TABLE 2: ISOLATION AND IDENTIFICATION OF FUNGAL ISOLATES

Cultural characteristics	Microscopic observation	Tentative identity
Brown mycelia growth	An upright conidiophores that terminates in a Septate mycelium	*Aspergillus fumigatus*
Blue-green growth	Bearing single conidiophores which are branched near the apex phialides that carry conidia	*Aspergilus niger*
White cotton-like mycelia spreads round whole plate	Mycelium extensive in a cottonwool-like form. Having phialides that is bearing a	*Aspergillus flavus*

	beanpod-like microconidia borne singly or in chain.

Biofertilizers made from pultry droppings are usually added into the soil to improve the structure and fertility of agricultural land. The application of poultry droppings on land for biofertilizers attracts different kinds of organism which in turn improves soil porosity and aeration; these conditions favor the plants growth. As an important source of nutrients for food crops production, chicken droppings may also contain a variety of human pathogens that can affect humans who consume the contaminated food.

Fermentation of droppings can inactivate and reduce pathogens loads while creating a soil amendment beneficial for application to arable agricultural land. Some foodborne pathogens may have the potential to survive for long periods of time in raw chicken droppings after land application, and a small population of pathogenic organisms may even regrow to high levels when the conditions are favorable for growth [2]

In table 3 the physicochemical properties were presented and it was discovered that all the quantitative parameters determined in this study have a certain percentage of increase. The increase in qualitative parameters indicates the possibility of producing good output when applied into the soil for crop productions.

Subjecting poultry droppings to fermentation before application will improve the handling characteristics of the manure by reducing its volume and weight, kills pathogenic organisms and stabilizes the nutrients and organic matter in it. Soil amendment with organic manual has increased in recent years due to the facts that it contributes indirectly to the wastes disposal [24] and prevents environmental pollution and degradation. In this study the moisture contents increases after fermentation which implies that more moisture will be available for the crops growth and development.

TABLE 3 PHYSICOCHEMICAL ANALYSIS OF POULTRY DUNG

Physicochemical property	**Before fermentation**	**After fermentation**
Moisture content	29.52±0.06	75.45±0.08
Ash content (%)	3.43±0.42	9.93±013
PH	6.39	6.50
Crude protein	7.70±021	9.02±0.00
Total volatile Nitrogen	58.80	92.40
Odour	Pungent and irritating	Irritating
Texture	Hard and coarse	Soft and watery
Colour	Mixture of whitish, darkish and ash colour substances	Only deep ashes colour

The moisture determination on the sample (Table 3) showed the increase in moisture contents. The uptake of nutrients through the roots is intermediated by soil water. Consequently, water and soil are the elementary requirements for the life and growth of plants.

The report on pH after fermentation showed that it approaches neutral. Although it was a little higher compare with initial pH values. [25]. The fact that has this near-to-neutral value makes it a great asset in crop production. Soil pH affects the amount of nutrients and chemicals that are soluble in soil water, and therefore the amount of nutrients available to plants. Some nutrients are more available under acid conditions while others are more available under alkaline conditions. However, most mineral nutrients are readily available to plants when soil pH is near neutral. It has been reported that the correct balance is where the soil pH is between 5.5 and 7.5. Having the correct pH is important for healthy plant growth. Being aware of the long term effects of different soil because it influences several soil factors affecting plant growth. management practices on soil pH is also important. [26]

The results showed the total protein concentration of the fermented droppings was slightly higher than that of before fermentation. The increase in the content of crude protein is line with the increase in moisture content. Most earlier reports showed decrease in droppings that lack moisture due drying process[7].

In this study it was observed that the contents of total volatile nitrogen increases with time. Nitrogen is one of the major elements required for plants development. It will stimulate above ground growth, and produces the rich green colour that is the characteristic of healthy plants, because of this Nitrogen is important for plant growth[27]. Because of Ammonia or Ammonium is produced by the decomposition process, the decomposition of poultry droppings at the point of application will serve a source of Nitrogen.,

4.3 Bacterial Count during Fermentation

The microbial load was determined before the commencement of the fermentation and this serves as first day while the second day to sixth day was done during fermentation. However, the results of microbial load for six days discus in table 4-8 and figure 1 respectively. In both tables and figure presentations the values of microbial loads reduce as the experimental days progressing. The reduction in the amount of bacterial and fungi during this period is linked to the physicochemical properties of the fermented poultry droppings. Although the specific factor responsible for this reduction was not determine at course of this study. However one may wonder why the reduction of both fungi and bacteria? The fermentation has such a negative effect on fungi isolates that it was eliminated within the fourth day of the experiment (figure 2). On the first day before the commencement of fermentation the bacterial count was 1.79 x 10^4CFU/g which made up of population bacterial species present in the sample. This high microbial density of bacteria in one gram of poultry sample had been reported [28].

First day

1.79 x 10^4CFU/g. Microbial load before fermentation

Table 4: Bacterial load at Second Day

Dilution factor	First Exp. Colony count	Second Exp. Colony count	Mean Value	Standard Deviation	Relative value (CFU^{-g})
10^{-1}	81	58	69.5	16.26346	6.9x 10^2±16.26
10^{-2}	155	156	155.5	0.707107	1.55x 10^4±0.74
10^{-3}	160	187	173.5	19.09188	1.73x 10^5±19.09
10^{-4}	181	151	166	21.2132	1.66x 10^6±21.21
10^{-5}	131	141	136	7.071068	1.36x 10^7±7.07

Table 5: Bacterial load at Third day

Dilution factor	First Exp. Colony count	Second Exp. Colony count	Mean Value	Standard Deviation	Relative value (CFU^{-g})
10^{-1}	Swamp	Swamp	-	-	-
10^{-2}	140	183	161.5	30.40559	1.62x10^4±20.41
10^{-3}	147	168	157.5	14.84924	1.58x10^5±14.85
10^{-4}	101	91	96	7.071068	9.6x10^5±7.07
10^{-5}	104	73	88.5	21.92031	8.85x10^6±21.9

Table 6: Bacterial load for Fourth Day

Dilution factor	First Exp. Colony count	Second Exp. Colony count	Mean Value	Standard Deviation	Relative value (CFU^{-g})
10^{-1}	86	86	86	0	8.6x10^2±0.00
10^{-2}	147	170	158.5	16.26346	1.59x10^4±16.26
10^{-3}	159	163	161	2.828427	1.61x10^5±2.83
10^{-4}	110	99	104.5	7.778175	1.05x10^6±7.78
10^{-5}	51	51	51	0	5.1x10^5±0.00

Table 7: Bacterial load at Fifth Day

Dilution factor	First Exp. Colony count	Second Exp. Colony count	Mean Value	Standard Deviation	Relative value (CFU^{-g})
10^{-1}	70	70	70	0	7.0x10^2±0.00
10^{-2}	126	102	114	16.97056	1.14x10^4±16.97

10^{-3}	111	111	111	0	$1.11x10^{5}$±0.00
10^{-4}	59	70	64.5	7.778175	$1.05 x 10^{5}$±7.78
10^{-5}	51	51	51	0	$5.1x10^{6}$±0.00

Table 8: Bacterial load at Sixth Day

Dilution factor	First Exp. CFU/g	Second Exp. CFU/g	Mean Value	Standard Deviation	Relative value (CFU^{-9})
10^{-1}	Swamp	Swamp	-	-	-
10^{-2}	60	54	57	4.242641	$5.7x10^{3}$±4.24
10^{-3}	95	123	109	19.79899	$1.09x10^{5}$±19.30
10^{-4}	93	98	95.5	3.535534	$9.55x10^{5}$±3.54
10^{-5}	56	104	80	33.94113	$8.0x10^{6}$±3.91

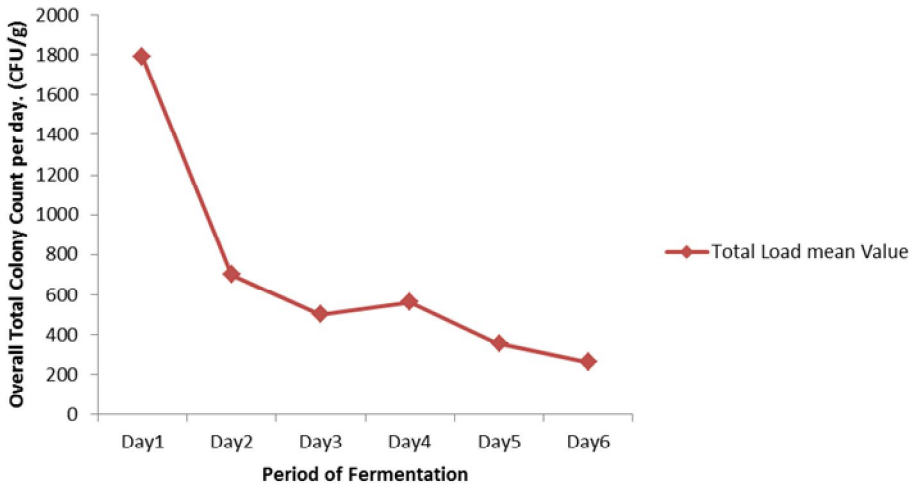

Figure 1: Effect of Solid Fermentation on Daily Total Bacterial Loads

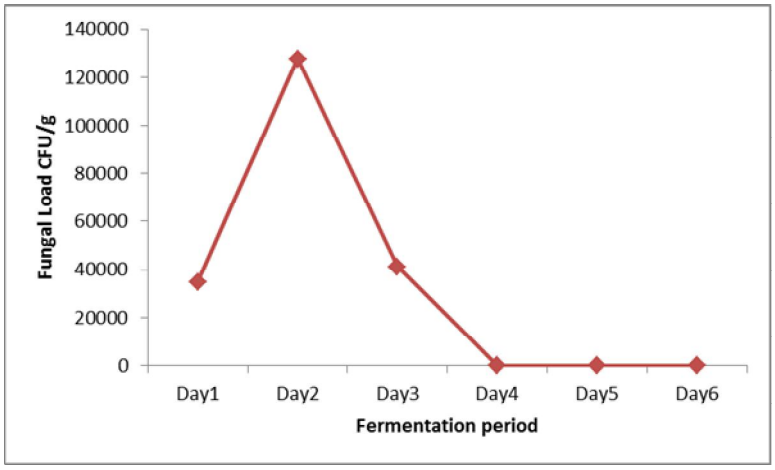

Figure 2: Effect of Solid Fermentation on Daily Total Fungal Loads

5.0 Conclusion

The effect of solid fermentation on poultry droppings has been reported in this study. There was reduction in microbial loads at the end of the first stage of this experiment. Majority of pathogenic organisms were eradicated in the process. The common practice of applying poultry droppings to soil as a source of biofertilizer to crops is of great importance in sustainable agriculture. While solid fermentation to some extent, is an effective method for reducing pathogen concentrations in poultry manure, pathogens can still survive in the fermentation product as reported in this study. The fermentation of poultry droppings increases the values of chemical constituents and decreases the microbial loads with time. Thus the reduce the risk of pathogenic microorganisms

5.1 Recommendations

There should be more study to find out why both bacterial and fungal populations reduced with time? What factors could be responsible and what would be the effect of this on plant growth. What types of bacteria actually present at the end?

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References

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