African Journal of Basic & Applied Sciences 1 (3-4): 70-75, 2009
ISSN 2079-2034

Composting of Food Wastes Using Cow and Pig Dung as Booster

D.V. Adegunloye and F.C. Adetuyi

Department of Microbiology, Federal University of Technology,
P.M.B. 704, Akure Nigeria West Africa

Abstract: Microbial analysis of composting of food wastes using cow and pig dung as a booster was investigated. Various values such as bacterial and fungal counts, temperature, pH, moisture content were determined. Bacterial and fungal counts in composting recorded 4.0 x 10^6 to 1.3 x 10^{10} cfu/ml and 2.0 x 10^4 to 8.0 x 10^7 sfu/ml respectively. The temperature of decomposing materials ranged from 26°C to 43°C, pH was between 4.37 to 9.50, moisture content of the composting recorded 26.19 to 58.14%. The bacterial isolateed include; *Micrococcus virians, Micrococcus luteus, Bacillus pumilus, Bacillus sphaericus, Bacillus licheniformis, Bacillus macerans, Proteus mirabilis, Klebsiella pneumonia, Staphylococcus aureus, Corynebacterium diphtheria* and *Enterobacter aerogenes* and the fungal isolateed include; *Aspergillus niger, Aspergillus flavus, Saccharomyces cerevisiae, Mucor mucedo, Candida albicans, Umbelopsis* sp, *Penicillium notatum, Trichoderma* sp, *Gonatrobotryum apiculatum, Varicosporium elodeae*, *Schizosaccharomces pombe*, *Kloeckera apiculata, Cunninghamella elegans* and S*yncephalastrum rasmosum*.

Key words: Booster · Composting · Cow · Decomposing · Dung · Food · Pig and wastes

INTRODUCTION

Composting provides a means of recycling solid wastes and has the potential to manage most of the organic material in the waste stream including restaurant waste, leaves, farm wastes, animal manure, paper products, sewage sludge and domestic wastes. The organic waste materials mainly of animal and plant origin are potential sources of organic matter and plant nutrients [1] and the benefits derived from the utilization of this organic materials range from improvement of soil fertility to a reliable means of waste disposal.

Backyard composting speeds up the natural process of decomposition, providing optimum conditions so that organic matter can breakdown more quickly. As you dig, turn, layer and water your composite pile, you may feel as if you are doing the composting, but the bulk of the work is actually done by numerous types of decomposer organisms.

Composting is the natural process of "rotting" or decomposition of organic matter by microorganisms under controlled condition.

Composting can also be defined as the conversion of wastes; plants and animal remains, noxious organic waste materials into stable sanitary humans - like substance under aerobic conditions. Compost is a mixture of partially decomposed organic material or waste applied to the soil to supply necessary nutrients. Composting can also be said to be the controlled decay of organic matter in a warm moist environment by action of bacteria, fungi and other organisms [2]. The process can either be anaerobic or aerobic, but it is much faster and less odourferous if done aerobically.

The organic waste material used for the composting varies in their nutrient and mineral composition as this affects the rate of decomposition of the compost and the composition of matured composts [3]. The organic waste materials for the composting process include; food wastes (cooked rice, cooked beans and steamed fermented cassava (eba)) cow dung and pig dung. The objectives of the research include: determination of the temperature, pH, moisture content, microbial load, identification of microorganisms in composting.

MATERIAL AND METHODS

Sources of Materials: The organic waste materials used in the composting process include: wasted cooked rice, beans, "eba" (steamed fermented cassava), cow and pig dung which mainly serve as the booster. The rice

Corresponding Author: D.V. Adegunloye, Department of Microbiology, Federal University of Technology, P.M.B. 704, Akure Nigeria West Africa

obtained was the waste food collected in a wedding ceremony at Morims Plaza, High court Junction, Akure. The beans and "eba" were obtained in Annex 2 Hostel of The Federal University of Technology, Akure (FUTA), Ondo State. Cow and pig dung were obtained from the Animal farm of the department of Animal Production and Health of The Federal University of Technology, Akure, Ondo State.

Compost Preparations: The materials used for the compost preparation are: rice, beans, 'eba' cow and pig dung. 1 kilogram (kg) each of the food wastes were weighed into seven well labelled (A, B, C, D, E, F, G) compost bins making a total of 3kg of food waste in each compost bin. One kg, 2kg and 3kg of cow and pig dung were added to compost bin A, B, C, D, E and F respectively. Food wastes only (G) served as the control sample. The content of the compost bins were mixed properly and they were left opened for proper aeration and allowed to decompose for the period of 6- 8weeks. The decomposing materials were frequently watered and turned.

Composting Analysis: Temperature, pH and the microbial load and identification of the isolates were carried out on each decomposing materials on the first day of composting (zero day). The temperature of the compost was measured using a mercury thermometer graduated in degree centigrade. The temperature measurement was determined daily for two weeks and subsequently a week interval until compost matured.

The pH of the compost was determined on the zero day of composting and subsequently determine weekly until full compost matured. The pH was determined using a glass electrode pH meter. The moisture content of the compost was determined weekly by using METTLER LJ 16 moisture analyzer.

The microbial load of the compost was determined on the zero day of composting and subsequently weekly until full compost maturation. The production of microbes mainly bacteria and fungi were determined by using nutrient agar for bacteria enumeration and potato dextrose agar for fungi enumeration. Other microbiological analyses were further carried out to aid in the characterization and identification of the isolates.

Samples were collected from decomposing material A, B, C, D, E, F, G respectively using spatula sterilized with 70% ethanol. The spatula was used to mix the decomposing material slightly and used to transfer the decomposing sample into a sterile container and sealed tightly before been taken for microbial analysis using conventional techniques. Bacteria were isolated and identified according to Cowan and Steel [4], Holt *et al*., [5] and fungi identification was carried out according to Barnett and Hunter [6].

RESULTS AND DISCUSSION

The bacterial count of the composting materials as illustrated in Table 1 and 2 shows a large population of bacterial in the first three weeks of composting and reduces down the maturity of the decomposing. The bacterial count recorded $4.0x10^{6}$ to $1.3x10^{10}$cfu/ml. The fungal count of the composting materials as illustrated in Table 2 shows a large population of fungal in the first three weeks of composting and reduces down the maturity of the composting materials. The fungal count recorded 2 $x10^{4}$ to 8.0 $x10^{7}$ sfu;ml.

The different temperatures during decomposing of waste materials are illustrated in Table 3. The decomposing waste materials experienced a sharp increase in the first three weeks of decomposing and decrease gradually until maturity. The highest temperature of 43°C was seen in sample A (Food wastes + 1kg of cow dung) this was recorded on the third week of decomposing. The lowest temperature was 26°C and this was recorded on the seventh week of decomposing for sample D (Food wastes + 1 kg of pig dung).

The weekly pH of the decomposing materials is shown in Table 4. The Table shows an acidic material in the first week of composting between 4.37 and 5.55. The materials became alkaline on the third week of decomposing; they became neutral on the seventh and eighth week respectively.

The percentage moisture content of composting materials as illustrated on Table 5, shows increase in the first three weeks of decomposing and decreases towards the maturity of compost. The moisture content of the decomposing waste materials ranged from 26.19 to 59.52%.

Composting is the natural decomposition of organic matter by microorganisms under controlled conditions; it could also be defined to be the controlled decay of organic matter in a warm moist environment by action of bacteria, fungi and other organisms [2]. Various factors are necessary for successful composting such as type of organic material or food factor, Carbon to Nitrogen ratio, air, moisture, temperature, particle size, volume factor, turning and so on.

Table 1: Bacterial population of decomposing waste materials (cfu/ml)

Week	A	B	C	D	E	F	G
1	$2.3x10^7$	$4.0 x10^7$	$4.3 x10^7$	$1.3 x10^{10}$	$9.8 x10^9$	$1.1 x10^{10}$	$1.0 x10^{10}$
2	$1.9x10^7$	$2.1 x10^7$	$5.0 x10^7$	$8.9 x10^{10}$	$9.2 x10^9$	$8.2 x10^9$	$2.2 x10^9$
3	$9.0 x10^6$	$1.8 x10^7$	$2.8 x10^7$	$7.4 x10^9$	$8.2 x10^9$	$8.6 x10^9$	$1.9 x10^9$
4	$1.1 x10^7$	$5.0 x10^6$	$2.0 x10^7$	$2.0 x10^9$	$1.1 x10^9$	$1.1 x10^9$	$9.0 x10^9$
5	$8.0 x10^6$	$2.2 x10^7$	$1.8 x10^7$	$2.3 x10^9$	$1.5 x10^9$	$2.2 x10^9$	$1.0 x10^9$
6	$7.0 x10^6$	$1.4 x10^7$	$1.6 x10^7$	$1.1 x10^9$	$1.4 x10^9$	$1.8 x10^9$	$1.4 x10^9$
7	$4.0 x10^6$	$2.1 x10^7$	$2.1 x10^7$	$6.0 x10^9$	$5.0 x10^8$	$8.0 x10^8$	$6.0 x10^8$
8	$5.0 x10^6$	$1.0 x10^7$	$1.7 x10^7$	ND	ND	ND	$6.1 x10^8$

Key:

ND - Not determined, A = Food wastes + 1 kg of cow dung, B = Food wastes + 2 kg of cow dung, C = Food wastes + 3 kg of cow dung, D = Food wastes + 1 kg of pig dung, E = Food wastes + 2 kg of pig dung, F= Food wastes + 3 kg of pig dung and G = Food wastes only.

Table 2: Fungal population of decomposing waste materials (sfu/ml)

Weeks	A	B	C	D	E	F	G
1	$3.0 x10^7$	$3.8 x10^7$	$4.0 x10^7$	$5.7 x10^5$	$6.1 x10^5$	$5.6 x10^5$	$5.4 x10^5$
2	$1.8 x10^7$	$1.8 x10^7$	$2.5 x10^7$	$7.2 x10^5$	$2.9 x10^5$	$3.1 x10^5$	$7.0 x10^4$
3	$9.0 x10^6$	$1.5 x10^7$	$1.7 x10^7$	$5.7 x10^5$	$1.3 x10^5$	$2.0 x10^5$	$8.0 x10^4$
4	$5.0 x10^6$	$8.0 x10^6$	$2.7 x10^7$	$2.2 x10^5$	$1.5 x10^5$	$1.4 x10^5$	$1.2 x10^5$
5	$3.0 x10^6$	$1.5 x10^7$	$1.5 x10^7$	$3.2 x10^5$	$6.0 x10^4$	$1.1 x10^5$	$3.0 x10^4$
6	$5.0 x10^6$	$1.7 x10^7$	$1.0 x10^7$	$8.0 x10^4$	$7.0 x10^4$	$1.2 x10^5$	$3.0 x10^4$
7	$2.0 x10^6$	$1.2 x10^7$	$8.0 x10^7$	$4.0 x10^7$	$2.0 x10^4$	$3.0 x10^4$	$2.0 x10^4$

Key:

ND - Not determined, A = Food wastes + 1 kg of cow dung, B = Food wastes + 2 kg of cow dung, C = Food wastes + 3 kg of cow dung, D = Food wastes + 1 kg of pig dung, E = Food wastes + 2 kg of pig dung, F= Food wastes + 3 kg of pig dung and G = Food wastes only.

Table 3: Weekly temperature (°C) of the decomposing waste materials

Week	A	B	C	D	E	F	G	Ambient temperature
1	33	34	32	32	33	34	33	32
2	33	34	33	34	35	32	33	34
3	43	38	34	30	28	29	32	29
4	30	34	33	29	31	31	30	31
5	31	30	28	30	29	28	29	28
6	29	31	28	28	27	28	27	27
7	30	33	31	31	28	30	29	30
8	31	32	32	ND	ND	ND	ND	26

KEY:

ND - Not determined, A = Food wastes + 1 kg of cow dung, B = Food wastes + 2 kg of cow dung, C = Food wastes + 3 kg of cow dung, D = Food wastes + 1 kg of pig dung, E = Food wastes + 2 kg of pig dung, F= Food wastes + 3 kg of pig dung and G = Food wastes only.

Table 4: Weekly pH of decomposing waste materials

Weeks	A	B	C	D	E	F	G
1	4.56	4.96	5.23	4.70	4.87	5.55	4.37
2	6.60	5.80	5.00	6.86	6.90	6.57	4.56
3	6.50	8.50	9.30	6.67	6.95	6.80	6.50
4	6.80	8.90	9.50	6.74	7.00	7.20	7.30
5	8.80	9.20	9.20	6.80	8.40	8.70	9.20
6	7.98	8.56	8.34	6.74	7.90	8.50	8.80
7	7.20	7.10	7.80	6.70	7.60	8.20	7.90
8	7.00	7.20	7.60	ND	ND	ND	7.64

KEY:

ND - Not determined, A = Food wastes + 1 kg of cow dung, B = Food wastes + 2 kg of cow dung, C = Food wastes + 3 kg of cow dung, D = Food wastes + 1 kg of pig dung, E = Food wastes + 2 kg of pig dung, F= Food wastes + 3 kg of pig dung and G = Food wastes only.

Table 5: Weekly moisture content of decomposing waste materials

Weeks	A	B	C	D	E	F	G
1	26.19	26.92	27.42	32.10	30.10	29.30	30.00
2	42.86	44.23	38.71	56.04	56.35	56.76	42.19
3	40.48	42.31	45.16	56.02	56.22	56.54	40.63
4	50.00	51.92	46.77	55.00	55.02	55.23	52.76
5	59.52	57.70	53.23	50.50	50.70	50.43	49.41
6	53.45	54.75	56.45	49.23	49.54	49.81	44.11
7	52.42	50.90	52.01	44.23	44.40	45.02	44.12
8	49.48	48.28	50.21	ND	ND	ND	48.11

ND - Not determined, A = Food wastes + 1 kg of cow dung, B = Food wastes + 2 kg of cow dung, C = Food wastes + 3 kg of cow dung, D = Food wastes + 1 kg of pig dung, E = Food wastes + 2 kg of pig dung, F= Food wastes + 3 kg of pig dung and G = Food wastes only.

The composting process was observed to be fastest in sample F (food waste and pig dung in ratio 3:3) which contained food wastes and pig dung of ratio 3:3 due to the high mineral and knutrient content of the pig dung favourable for microbial growth and activities which in turn speed up the rate of organic matter decomposition by microorganisms. Sample G which is the control sample contained food wastes with no animal dung experienced the longest time prior maturity and this is due to the low microbial activities in the composting. The addition of animal (cow, pig) dung to composting materials was observed to have significant effects in the composting process as observed in the six composting preparations with varying ratio of animal dung.

The consistent values obtained from the set of composting indicated that the organic materials experienced similar degradation processes and the temperature pattern of the composting followed similar results obtained in many other composting systems [7]. The ambient temperature played a significant role in the resulting temperature pattern of the composting. The rapid mineralization of organic carbon and nitrogen contained in food wastes in the presence of adequate aeration and moisture as required by microorganisms for the decomposition of organic compounds is responsible for the temperature pattern of the composting. This process probably would have generated reactants whereby carbondioxide and bacteria were released into the composting system [8]. The temperature pattern for the compost varies somewhat with the size of the pile, the ambient temperature, the moisture content, the degree of aeration and the nature of composting material. The temperature conditioning of composting determines the duration of decomposition and maturity of compost.

The pH values of the compost were observed to consistently increase as the composting process progresses. The pH of compost in the first week of composting was considerably low indicating the acidic nature of the organic material. The pH values were observed to significantly increase by second week of composting crossing over to the alkalinity range of the pH scale. These alkalinity natures of compost were observed with little variations throughout the composting process to maturity.

A fresh and relatively pleasant odour production was observed in the compost material at the early first week of composting. Unpleasant odour was later observed from the second week to about the fifth week of composting; this explains the nature of odourferous compounds like ammonia gas released as a result of metabolic activities by the microorganisms in the compost piles. A relatively pleasant odour was observed in the sixth week and seventh week of composting indicating the reduced microbial activities in the compost pile hence, the maturity.

The aeration of compost pile by mixing of material, turning and watering of the compost enhanced the decomposition process. The turning ensures an adequate supply of oxygen to the microorganisms and at the later stages, the turning process failed to reheat the composting pile indicating that the composting material is biologically stable. The moisture content of the composting was considerably high and the moisture content values were maintained by preventing the excess watering of the composting. The moisture content values of the composting increased gradually as the decomposing waste materials matured indicating that composting microorganisms utilize the moisture and that they thrive in the moist conditions. The considerably large surface areas of the organic materials made the microorganisms to digest more materials, multiply more rapidly and generate more heat which invariably speed up the composting process.

Microbial load of the composting was observed to increase any time the composting were aerated by turning, suggesting that the turning procedure increased oxygen level in the composting pile which favours the growth of microorganisms. The microbial growth as seen in Table 1and 2 were on the increase in the first three weeks of composting due to the synthesis and utilization of the various nutrient present in the composting by microorganisms. A report from Hargerty *et al*., [9] said there is maximum increase in microbial population of composting in the early period of composting which is dependent on the rich nutrient composition of the composting and the favourable environmental conditions of the composting. The growth phase or rapid activities by the microorganisms can be described as the log phase. Subsequently, at the later week of composting, there was a gradual decline in the microbial population. The remaining microorganisms were those that were able to survive the mesophilic range of temperature experienced in the composting pile, hence the rate of increase in population of microbes was dependent on the supply of nutrient in the composting and other environmental factors of the composting such as temperature, aeration and moisture content.

Some larger decomposers or macroorganisms presence were observed in the composting pile. These are physical decomposers that grind, bite, tear and chew their way through composting and these are higher up in the food chain [10]. Most of these decomposers function best at moderate or mesophilic temperatures. Among these are; flies, ants, millipedes, beetles and so on.

Few of the microorganisms like; *Klebsiella pneumoniae* and *Proteus mirabilis* (Enterobacteriaceae) isolated in the early weeks of composting could be suggested to be accompanying microbes with the pig dung used as booster in composting pile. Bacteria and fungi were the microorganisms isolated from the composting. The groups of microorganisms isolated from the composting were able to survive under the mesophilic range of temperature, the near fairly neutral pH of the composting and the moderately high moisture content of the composting [11].

Great and consistent reduction in the size of the composting material was observed from composting preparation down to composting maturity. Also, varying appearance (colour) of composting were observed through the composing process, a cream to light brown was observed in the first two weeks of composting to darker brown and finally to dark chocolate brown colour at composting maturity. Considerably amount of mineral components especially needed for proper plant growth and yield were observed in the matured compost after chemical analysis was carried out.

CONCLUSION

The actions of microorganisms and some macroorganisms with the appropriate environmental conditions and factors such as; temperature, aeration, moisture content on organic materials such as food and animal wastes produce a good quality of dark chocolate brown compost. The pig dung enhanced the early maturity of the composting than cow dung and also contributed to the nutritional content of compost. The different organic materials used in the composting process were totally utilized and converted to nutrient rich compost hence, making composting an excellent waste recycling process and also help in the control of environmental pollution.

REFERENCES

1. Adediran, J.A., L.B. Taiwo and R.A. Solubo, 2003. Effect of organic wastes and method of composting on compost maturity. Nutrient composition of compost and yields of two vegetable crops. J. Sustainable Agriculture, 22(4): 95-101.
2. Salvator, K. and W.E. Sabee, 1995. Evaluation of fertilizer value and nutrient release from corn and soybean residues under laboratory and green house. Condition. Common soil/science. Plant Anal., 26(3x4): 469-484.
3. Taiwo, L.B., 1997. Development of organic based fertilizer from sorted urban wastes. PhD Thesis, University of Ibadan, Nigeria, pp: 205.
4. Cowan, S.T. and Steel 1997. *Manual for the identification of Medical Bacteria*. Cambridge University Press, pp: 201.
5. Holt, J.G., N.R. Krieg, P.H. Sneath, J.J. Stanley and S.T. Williams, 1994. *Bergeys manual of determinative bacteriology.* Wilkins Publishers, Baltimore 5th Edition.
6. Barnett, E.A. and B.H. Hunter, 1980. *Illustrated Genera of Imperfect Fungi*. Burges Publishing Company, Minneapolis, pp: 13-55.
7. John, N.M., G.O. Adeoye and M.K.C. Shridhar, 1995. Effect of a binding agent and sawdust amendment on the stabilization of compost, soil particles and crop growth. In: Agoola *et al* (eds). Proceedings of the 23rd All African Soil Science Conference, pp: 283-394.
8. Foth, H.O., 1980. *Fundamentals of soil science*. John Wiley and Sons Inc.. Cananda, pp: 157-166.

9. Hargerty, D.J., J.L, Pavoni and J.E. Heer, 1999. Solid Waste Manangement Van Nostrant Reinhold, New York, pp: 12-13.
10. Stainer, A., R. Levi-Minzi and R. Riffaldi, 1998. Maturity evaluation of organic wastes. Biocycle, 29: 54-56.
11. Blanc, M., L. Marilley, T. Beffa and M. Aragno, 1997. Rapid identification of heterotrophic, thermophilic, spore forming bacteria isolated from hot composts. Int. J. Syst. Bacteriol., 47(4): 1246-649-666.