EFFECT ON CARBON NITROGEN RATIO, AMMONIA NITROGEN IN FOOD WASTE COMPOSTING USING DIFFERENT TECHNIQUES

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ABSTRACT:

Chemical changes related to food waste compost are strongly affected by different composting techniques. For evaluation of compost maturity two locally fabricated composters were examined at seven days interval up to 91 days by loading food waste along with bulking agent. Gradual changes in chemical characteristics related to stability and maturity of compost were studied and compared. Increase in ammonia nitrogen level due to rise in temperature was maximum in aerobic process than others. Optimal level in stability and maturity parameters like C/N, was attained earlier in aerobic process as compared to facultative processes due to continuous aeration. The aerobic process provided good quality of compost and result from this study will assist in method optimization and quality of the compost product.

INTRODUCTION

Composting is a process involving a complex ecosystem with many interacting factors. There have been several studies of the nature of the physicochemical and biochemical changes that occur during the composting process. The process can be greatly affected by succession of the microbial community, which is also influenced, by physicochemical factor. Characterization of the relationship between the physicochemical properties is important for a clear understanding of composting process [1]

Many studies have mentioned the differences in quality of end product of different common feedstock. Differences in results of some physical and chemical parameters have been observed in different methods of composting [2], [3], [4], [5].

Composting methods differ in duration of decomposition and potency of stability and maturity. Mechanical composting physically breaks up organic matter yielding a texturally and chemically homogenous end product in less time where as in other composting, at least 60-90 days are required to stabilized organic waste. [6]. Static passively aerated composting is another method, which is less laborious than mechanical method and requires less time as compared to windrow process. Various techniques have been developed for forced aeration system to control odour and minimum processing time [7], [8].

The stability of compost is the degree to which the organic fraction is stabilized during the decomposition process. Compost is considered unstable if it contains a high fraction of biodegradable matter and underpin microbial activity. Stability is an important aspect of composting in relation to its field application, potential of odour generation and pathogen regrowth [9], [10].

Maturity indices of food waste compost are still not developed. A number of criteria and parameters have been proposed for testing compost stability and maturity. But no single method has been universally applied to all compost due to the variation in field stock composition and composting process [11] For stability, chemical methods are widely used including measurement of C/N ratio, CEC (Cation Exchange Capacity), and degree of organic matter humification.

C/N ratio has been used as an index of compost maturity [12]. Reference [13] has compared initial to final C/N ratio to relate them to maturity. Reference [14] have reported (30:1) C/N ratio for raw material and 13:1 for mature compost**.** Reference [15] recorded the decrease of total carbon including hemicelluloses, cellulose and increase in total nitrogen, crude ash and lignin during maturation of city refuse compost.

Nitrification is the oxidation of ammonia NH_4^+ to $NO_3^{--}$by microorganisms. Reference [16] reported the total amount of soluble nitrogen decrease during composting and it represents mineralization. During maturation the ammonium nitrogen level continues to decrease while the nitrate level increases. The increased ratio of NH_4^+ ,N–NO_3^{--} ratio is an indicator of compost maturity [17].

Cation exchange capacity describes the quantity of negative charges in the matrix to hold cations. CEC is one of the factor used in describing the properties of soil and its importance in determining the compost maturity. CEC is reported to increase during composting [18]. Highly significant correlation was noted between CEC and C: N ratio of city refuses compost. CEC greater than or approximately 60 is considered to be sufficiently matured for the application to crop land [19].

The aim of this study was to evaluate the C/N and Ammonia Nitrogen changes in food waste compost stability by using different techniques.

METHODOLOGY

Food waste collected from Sunday bazaar Lahore, Pakistan was haulted to the composting site at PCSIR Laborites Complex Lahore. Cow dung manure was obtained from animal farm and bulking agent, saw dust and wood shaving (0.5-2.5 cm long) was taken from the PCSIR work shop. The process of composting was studied by using two different types of locally fabricated composters. The composters were loaded with food waste, bulking agent, which were homogenized by cutting the material to approximately 4-8 cm in length and loaded for 91 days. The chemical analysis of loaded sample was also analyzed. The technologies used in the study were as follows.

Table:1 Chemical properties of food wastes used for composting

Parameters	***Concentration***
pH	7.53
C:N	35.74
Potassium (%)	0.2
Phosphate (%)	0.12
Moisture (%)	78 -84

AEROBIC COMPOSTER

In order to study the compost stability on laboratory scale, a composter of 20 L capacity was used. The main unit of the composter i.e. the drum is of 610 mm in length and 480 mm diameter, made of a 3 mm thick stainless steel sheet. The inner side of the drum is covered by anti corrosive coating. The drum is mounted and fixed on iron metal stand. In order to provide appropriate mixing of waste, steel angles were welded horizontally inside the drum. To regulate the temperature a hot water jacket covered drum. In addition to that two holes of 400 mm and 203 mm on upper and lower portion of the drum were made, respectively. The mixed organic waste with cow dung was loaded into the composter by means of plastic containers and filled up to 75% of the total volume. Rotation was provided on continuous basis to ensure proper mixing and aeration by electrical gearbox of variable rpm. Temperature was monitored regularly from thermocouple attached to the composter.

FACULTATIVE COMPOSTER

The facultative type composter was similar in dimensions as of aerobic but fixed on iron stand in vertical position. The only difference was that holes were present on the upper lid of the composter. The loading of the waste was also on the same pattern as in aerobic type composter but no mixing was done during the process. Temperature of the waste was also monitored.

ANALYTICAL METHODS

Samples from each composter were collected after every seven days interval up to 91 days, and recorded the changes in different parameters. The dried compost sample (75^o C) was ground to pass through 2mm sieve.

Measurements of Nitrogen and Carbon in compost were carried out on the dried sample. The C/ N ratio was calculated as the quotient of C over N. Carbon was also calculated by loss of weight by ignition at 550^0C and Nitrogen by Kjeldhal method. The ammonium nitrogen was determined by using the Standard methods of water and wastewater [20]. Potassium concentration was determined by using flame photometer (Jenway) and it was calculated. [21].

RESULTS AND DISCUSSION

The comparisons of the results for compost analyzed after every seven-day was carried out for a period of 91 days. The variations in the parameters during different times of study was documented for two composters (aerobic, facultative). Table 2, 3, presents the C/N ratio and Concentration of Ammonia Nitrogen of waste matter composted in different composters at different time intervals respectively.

The Changes in the C/N ratio reflect organic matter decomposition and stabilization during composting process because microorganisms used carbon as source of energy and N for building cell structure. As shown in table -2 with an increase in the composting time there was a decrease in C/N ratio for two processes.

In the initial stage of composting, intense mineralization processes take place, which were manifested by considerable decrease and increase in total organic carbon and nitrogen respectively in all treatments as result the C/N ratio decrease consistently across all methods as composting progress.

Ammonia nitrogen concentration was also an indicator of compost maturity. Its concentration was highest during the first 28 days in aerobic composting reflecting the more organic matter decomposition as compared to facultative composting. Mostly ammonia nitrogen present during aerobic composting was derived from rapidly decomposition of waste. When ammonia concentration decreases and nitrate appears in composting material, it is considered ready to be used as compost. [22].

Nitrate –N concentration rises gradually during composting and is a limited factor in assessing compost maturity [23]. Reference [24] also reported that the greatest decrease of ammonia nitrogen occurred after thermophilic stage leading to an increase of nitrate concentration through nitrification. In aerobic process the percentage conversion of ammonia to nitrate was highest than others due to continuous aeration of waste.

CONCLUSION

From the above comparison, it was concluded that compost prepared in aerobic type composter showed the high level of nutrients and reached an acceptable degree of maturity more early as compared to facultative, compost. However the compost prepared by different methods yield chemically different product, by utilization of various production methods may help to optimize composting strategies to conserve the nutrients, provide appropriate and cost effective compost product for plant application.

Table: 2 Chemical changes in C/N ratio during composting

No of days	Aerobic	Facultative
7	26.2	30.2
28	18.09	26.9
49	15.31	25.2
70	14.04	23.9
91	13.86	23.1

Table 3: Chemical changes in ammonia nitrogen (mg/kg) during composting

No of days	Aerobic	Facultative
7	45.3	12.31
28	62.7	15.21
49	35.1	23.75
70	23.9	24.35
91	17.25	19.1

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