International Journal of Veterinary Sciences and Animal Husbandry

ISSN: 2456-2912
VET 2023; SP-8(5): 01-04

www.veterinarypaper.com
Received: 02-04-2023
Accepted: 03-05-2023

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Effect of chemical composition of different ingredients and micro and macro climatic data on the time duration of compost making

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DOI: https://doi.org/10.22271/veterinary.2023.v8.i5Sa.670

Abstract
A study to assess the effect of chemical composition of different ingredients and micro and macro climatic data on the time duration of compost making was conducted under the agro climatic conditions of Kashmir Valley. Poultry farm waste in the form of poultry carcass and poultry litter was selected for this purpose. Four t group recipes formulated for composting were: G_1: Poultry carcass + Poultry litter, G_2: Poultry carcass + Poultry litter + Paddy straw, G_3: Poultry carcass + Poultry litter + Effective Microbes and G_4: Poultry carcass + Poultry litter + Paddy straw + Effective Microbes. Moisture content of 59.34 per cent and a slightly acidic pH of 6.7 were observed in poultry carcass. Electrical conductivity (EC) and total dissolved salts (TDS) recorded were 2.89 mS/cm and 4.31 ppt respectively. Poultry carcass contained 7.94 g/Kg nitrogen, 1.24 g/Kg phosphorus and 3.18 g/Kg potassium. Poultry litter had a moisture content of 65.13 per cent and a basic pH of 10.1. Electrical conductivity (EC) and total dissolve salts (TDS) recorded were 1.35 mS/cm and 0.9 ppt respectively. 0.42 g/Kg nitrogen, 0.03 g/Kg phosphorus and 0.48g/Kg potassium was also observed. Paddy straw was used as a carbon source during composting experiment. A lower moisture content of 25.03 per cent and pH of 6.7 were observed in paddy straw. Compost making was fast in group 4 with 93.03±1.77 days during summer and 96.04±1.99 during winter season. In group 1 (control group) the time duration was highest with 114.01±1.35 days in summer and 122.4±3.22 during winter season.
Conclusion: Chemical composition of different ingredients, climatic parameters had a significant effect on compost making

Keywords: Composting making, ingredients, climatic parameters, poultry carcass

Introduction
Waste accumulation in and around farm premises beyond a carrying capacity create lots of issues in the form of smell, rodents, and flies; besides air, soil and water pollution (Zervas and Tsiplakou, 2012) [22]. So there is a need to dispose the farm waste in a scientific way to avoid the different kinds of problems associated with it (Bolan, 2010) [4]. Composting is one of the environment-friendly, safe, practical and easy to operate methods of waste disposal (Bhave and Joshi, 2017) [3]. A valuable end product is derived from composting in the form of compost; a bio-manure which contains the entire essential and readily available plant nutrients (Baba *et al.,* 2022) [2]. For effective and successful compost making proper setting carbon nitrogen ratio (30-40: 1) requires a proper balance of different ingredients like carcass, litter and other carboneous/bulking agent (Paddy straw/wheat straw) is needed and hence chemical composition of composting material plays a pivotal role (Morais and Queda, 2003) [14]. Climatic data like; ambient temperature, relative humidity, cloud cover and sunshine hours etc has direct impact on the quality and time duration of compost making (Qi-fei Huang, 2005) [17]. Composting is generally fast in summer and slow in winter due to more active microbial growth at higher temperatures and humidity.

Materials and Methods
The present work was carried out in the Division of Livestock Production and Management, Faculty of Veterinary Sciences and Animal Husbandry Shuhama Srinagar (SKUAST

Kashmir). The climate of Kashmir Valley ranges from temperate (during winter) to sub- tropical (during summer) with frequent dry spell occurrence. Winters remain cool with day time temperature averaging to 6.5 °C and drops below freezing point to an average temperature of – 6.7 °C during night. Summers are warm with a day time average temperature of 24.1 °C and maximum of 38.1 °C. Poultry farm waste (dead birds and poultry litter) were utilized to study the composting during summer and winter seasons. Composting of poultry litter was done in wooden bins (Mini composter) with a specification of 3 feet length x 3 feet width x 3 feet height designed as per the method of Donald *et al.*, (1996) [6]. (Table 1) The floor of the compost bin was made impervious to prevent seepage of leachiates and subsequent moisture and nutrient loss. The sidewalls of the compost bins were made up of country wooden planks of 4 to 5 inches wide and one inch thick. An air space of 1-2 inch was provided between wooden planks to aid sufficient aeration to the compost piles. Dead birds for the present study were collected from poultry farm of Division of LPM and stored at – 5 °C till sufficient carcasses were made available to fill all the compost bins in a single day. Similarly, poultry litter was also collected from poultry farm of LPM. Paddy straw (*Oryza sativa*) was used as a carbonaceous as well as bulking agent wherever it was required. Paddy straw was purchased from local farmers.

Results and Discussion

Micro and Macro climatic data

Micro and macro climatic data recording gives an indication of geographical and agro-climatic conditions of a place and helps in assessing the feasibility of a particular experiment. The different meteorological variables recorded were grouped into two seasons' *viz*., winter and summer (Table. 4.1). The microclimate showed a consistent increase of 12.72 ºC in the maximum temperature from winter to summer. The highest maximum temperature of 29.05 ºC was recorded during the month of May and lowest maximum of 3.6 ºC in January. The highest minimum temperature of - 2.9 ºC was recorded during the month of December. Relative humidity recorded was slightly lesser during the summer months (72.54 per cent) as compared to winter (84.30 per cent). Among the macroclimatic data the maximum temperature of 30.50 ºC was recorded during the month of May and the highest minimum temperature of – 6.90 ºC was recorded in the month of December. The highest relative humidity of 89.60% was recorded in January. The rainfall received during the study period was highest (11.3 mm) during the month of January (with a cloud cover of 7.5 okta) almost 1.5 times more than pool rainfall recorded during winter and summer seasons. The highest wind speed recorded during the experimentation period was 2.25 Km/hour in the month of May. Although macroclimatic factors have no strong influence on the process of composting and other microbial degradation processes as indicated by Larney *et al.* (2000) [10] but moisture and nutrient loss may occur due to leaching or volatilization particularly during composting as reported by Tirado and Michael (2010) [19]. In contrast to this Cook *et al.* (2015) [5] observed a significant (p<0.05) effect of macroclimate on the chemical parameters of composting and the quality of compost developed.

Chemical Properties of Different Ingredients

Poultry Carcass

Moisture content and pH are two important parameters which influence the quality of compost. In the present study the moisture content of 59.34 per cent and pH of 6.7 (Table. 4.2) is optimum for better bacterial degradation as reported earlier by Rynk *et al*. (1992) [18]. Similarly electrical conductivity (EC) and total dissolved salts (TDS) recorded were 2.89 mS/cm and 4.31 ppt respectively which were optimum for composting as reported earlier by Langston *et al*. (2002) [9]. In the present study 7.94 g/Kg nitrogen, 1.24 g/Kg phosphorus and 3.18 g/Kg potassium were estimated which coincides with the earlier reports of Keener and El-Jalil (2008) [8]. In the present study total ash, total organic matter, total organic carbon and carbon nitrogen ratio of 13.35 per cent, 80.93 per cent, 46.94 per cent and 5.9:1 respectively were also recorded by a number of workers (Abdelhamid *et al*., 2004; Keener *et al.*, 2000; Mahimairaja *et al*., 1994 and McCaskey, 1994) [1, 8, 11, 13].

Poultry Litter

The poultry litter used had a moisture content of 65.13 per cent and a pH of 10.1 (Table. 4.2) which was optimum for composting. The results are similar to the earlier reports of Rynk *et al*. (1992) [18]. In the present study electrical conductivity (EC) and total dissolve salts (TDS) recorded values of 1.35 mS/cm and 0.9 ppt respectively were comparable as per the earlier reports of Prasanthrajan, 2004 [16]. The results of present study with respect to N (0.42 g/Kg), P (0.03 g/Kg) and K (0.48 g/Kg) were in agreement with the earlier reports of USDA-NRCS (2000) [20]. Similar results of total ash, total organic matter, total organic carbon and carbon nitrogen ratio of the poultry litter were also reported earlier by Mahimairaja, *et al.* (1994) [11].

Paddy Straw

In the present study paddy straw which was used as a carbon source had lower moisture content of 25.03 per cent and pH of 6.7. The values were comparable with the earlier reports of Prasanthrajan, 2004 [16]. The other chemical properties like EC, TDS and H of paddy straw recorded in the present study were in agreement with the finding of Abdelhamid *et al*. (2004) [1]. The content of N, P and K were 0.71, 0.14 and 0.24 g/Kg (Table. 4.2). These values were comparable with the earlier reports of Prasanthrajan, 2004 [16].

Time Duration

The time duration for compost making during summer and winters season clearly observed a significant (p<0.05) difference within treatments as well as between seasons (Table 4). Compost making was fast in group 4 with 93.03±1.77 days during summer and 96.04±1.99 during winter season. In group 1 (control group) the time duration was highest with 114.01±1.35 days in summer and 122.4±3.22 during winter season. More ambient temperature during summer season enhances the composting process due to rapid microbial growth which leads to faster decomposition of organic matter in the waste (Lalremruati and Devi, 2021) [12]. Moreover due to presence of effective microbes (additional inoculation) and additional carbon and bulking agent (paddy straw which increases the oxygenation process due to more porosity and higher carbon content) in group 2 a fast composting process has resulted in less time duration (Wang and Liang, 2021) [21]. A significant effect of treatment combination on time duration was observed in both the seasons (Pan and Sen, 2013) [15].

Table 1: Different groups of composting

Groups	Details
Group 1	Dead birds + Poultry litter (Control)
Group 2	Dead birds + Poultry litter + Paddy Straw
Group 3	Dead birds + Poultry litter + Effective Microbes
Group 4	Dead birds + Poultry litter +Paddy straw + Effective Microbes

Table 2: Micro and macro climatic data obtained at the site of experimentation (Mean±SE)

Parameters	Inside Shed							
	Winter				Summer			
	November	December	January	February	March	April	May	June
Maximum temperature (°C)	8.49±1.01	10.80±2.01	3.60±0.02	11.09±1.52	13.79 ±3.02	20.79±4.67	21.21±0.21	29.05±3.01
Minimum temperature (°C)	-2.43±0.01	- 2.90±0.03	-2.20± 0.01	2.20±0.02	4.79 ±0.28	5.63±1.01	7.29±0.03	11.47±1.01
Relative Humidity (%)	84.30±5.01	85.70±3.57	88.60±5.18	78.60±6.78	72.63±2.45	77.11±3.60	72.54±3.03	67.89±4.67
Parameters	**OUTSIDE SHED**							
	Winter				Summer			
	December	January	February	Overall	March	April	May	Overall
Maximum temperature (°C)	13.50±1.01	6.70±0.01	14.90±1. 12	11.70±1.20	16.95 ±1.02	24.76±2.12	30.50±2.0	24.07±1.21
Minimum temperature (°C)	-6.90±0.02	-5.50± 0.01	4.25±0.03	-5.55±0.02	7.79 ±1.22	9.63±1.01	14.65±1.01	10.69±1.03
Relative Humidity (%)	87.60±14.57	89.60±2.18	81.40±4.71	86.20±3.01	76.60±4.50	83.20±3.04	70.50±2.35	76.76±3.01
Wind speed (Km/hour)	1.00±0.01	1.00±0.01	1.00±0.01	1.00±0.01	1.00±0.01	1.00±0.01	1.00±0.01	1.00±0.01
Rain fall (mm)	2.20±0.01	11.30±1.12	4.50±1.02	6.00±0.02	9.68±1.02	2.68±0.32	9.89±1.21	7.41±0.2
Cloud cover (Octa)	3.20±1.01	7.50±0.98	1.50±0.02	4.06±0.01	6.05±0.51	3.79±0.65	5.26±0.76	5.03±0.02

Table 3: Chemical properties of different ingredients for composting (Mean±SE).

Ingredients	Moisture %	pH	Electrical conductivity (mS/cm)	TDS (ppt)	Nitrogen g/Kg	Phosphorus g/Kg	Potassium g/Kg	Total Ash %	Total organic matter %	Total organic carbon %	C/N ratio
Poultry carcass	^{B}59.34 ±0.67	^{B}6.70 ±0.08	^{B}2.89 ±0.24	^{C}4.31 ±0.07	^{C}7.94 ±0.29	^{C}1.24 ±1.12	^{C}3.18 ±1.03	^{C}13.35 ±1.97	^{B}80.93 ±2.04	^{B}46.94 ±1.14	^{A}59.4 ±1.44
Poultry litter	^{C}65.13 ±2.1	^{C}10.01 ±1.01	^{A}1.35 ±0.02	^{A}0.90 ±0.01	^{B}4.2 ±0.02	^{B} 0.03 ±0.01	^{B}0.48 ±0.02	^{B}8.28 ±1.09	^{A}58.85 ±3.09	^{A}34.14 ±1.07	^{B}81.2 ±2.02
Paddy straw	^{A}25.03 ± 1.2	^{A} 6.21± 1.03	^{C}3.58 ± 1.51	^{B}2.39 ±1.09	^{A}0.71 ±0.01	^{A} 0.014 ±0.01	^{A} 0.24 ±0.02	^{A} 5.01 ±0.12	^{C}85.12 ±2.79	^{C}49.37 ±2.22	^{C}695.3 ±1.78

-The values are means of four observations and means bearing different superscripts in column different significantly (p<0.05)

Table 4: Time duration of compost making (days) in different treatment combinations

Groups	Time duration of compost making (days)	
	Summer	Winter
Group 1	^{A} 114.01±1.35^{a}	^{A} 122.4±3.22 ^{b}
Group 2 (Paddy Straw)	^{B} 100.02±2.95 ^{a}	^{B} 108.03±4.01 ^{b}
Group 3 (Effective Microbes)	^{BC} 94.11±3.01 ^{a}	^{C} 101.1±2.55 ^{b}
Group 4 (Paddy Straw + Effective Microbes)	^{C} 93.03±1.77 ^{a}	^{D} 96.04±1.99 ^{b}

-The means bearing different superscripts in column (upper case) and row (lower case) different significantly (p<0.05).

Conclusion

A proper balance of the ingredients; dead birds, litter, paddy straw was selected for composting in appropriate proportions and results yielded were perfect due to better compost quality. Climatic parameters like; maximum and minimum temperature, relative humidity and cloud cover had a significant effect on the time duration of compost making. Composting was fast in summer as compared to winter.

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