Eco. Env. & Cons. 28 (October Suppl. Issue) : 2022; pp. (S45-S49)

ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i06s.007

Effect of *Lactobacillus acidophilus* (LB) and *Saccharomyces cerevisiae* (Yeast) fermentation on nitrogen, phosphorus and potassium level of poultry farm waste

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(Received 26 January, 2022; Accepted 25 February, 2022)

ABSTRACT

Present work was carried out in the Department of LPM, FVSc and AH (SKUAST- Kashmir) to assess the change in values of minerals like Nitrogen, Phosphorus and Potassium due to Lactic Acid and Yeast Fermentation of poultry waste under the temperate climate of Kashmir Valley. Poultry waste in the form of dead birds and litter manure was used for this study. Nine groups with four replicates each were formulated as: G_1: Dead birds; Poultry litter, G_2: Dead birds; Litter manure; LB @1.0 per cent G_3: Dead birds; Litter manure; LB @0.5 per cent G_4: Dead birds; Litter manure; Yeast @1.0 per cent G_5: Dead birds; Litter manure; Yeast @0.5 per cent G_6: Dead birds; Litter manure; LB@ 1 per cent; Yeast @ 0.5 per cent G_7: Dead birds; Litter manure; LB @ 1 per cent; Yeast @ 1per cent G_8: Dead birds; Litter manure; LB @ 0.5 per cent; Yeast @ 0.5 per cent T_9: Dead birds; Litter manure; LB @ 0.5per cent; Yeast @1per cent. At final stage of work it was recorded significantly highest ($P \leq 0.05$) nitrogen level of 18.2 g/kg during winter and highest nitrogen level of 17.8 g/Kg during summer in G_2 group (LB@ 1%). In the final product of fermentation significantly highest ($P \leq 0.05$) highest phosphorus level of 0.85 g/Kg in G_7 (in which LB@ 1% and Yeast@ 1% was added) during winter season and the significantly ($P \leq 0.05$) highest P level of 0.85 g/Kg in G_5 and G_6during summer season was observed. Similarly significantly ($P \leq 0.05$) highest potassium level observed in the final product of fermentation was 7.0 g/Kg in G_7 (in which LB@ 1% and Yeast@ 1% was added) during winter season and significantly ($P \leq 0.05$) highest K level of 8.0 g/Kg in G_3 group (in which LB@ 0.5% was added) during summer season was observed. There was a significant increase in the nitrogen, phosphorus and potassium level in the final product of lactic acid and yeast fermentation of poultry waste.

Key words : *Fermentation, LB, Yeast, Poultry farm waste.*

Introduction

The poultry sector in India is the fastest growing segment of the livestock sector with 16.81 % present annual growth rate (Anon. 2021). With high levels of concentrated inputs and intensive production, poultry industry involves generation of large volumes of waste in terms of mortalities, litter etc. One of the main issue and problem presently faced by the poultry farmers is the accumulation of heavy volumes of waste especially litter manure which poses different social, environmental and economic problems and thus requiring a prompt, regular and responsive disposal and removal strategy for attaining a proper

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bio-security (Bolan, 2010) of livestock and humans. Environmental pollution can be minimized by selecting a suitable processing and proper utilization method of the waste (Sheikh *et al.,* 2018).

Fermentation of poultry waste by lactic acid bacteria has been reported by many workers as effective measure against pathogens and spoilage organisms and thus is one of the biologically safe methods of better disposal and utilization technique with generation of final product like manure (Vermeiren *et al.,* 2003; Kostrzynska and Bachard, 2006; Leroy *et al.*, 2006) which is valuable in nature. Fermentation is an anaerobic process where lactic acid bacteria convert sugar into lactic acid a low pH effective preservative agent (Cai and Pancorbo, 1994). The lactic acid assists in decontamination of waste material and utilization of the final product as organic manure (Crews *et al.*, 1995) with more mineralization of nitrogen, phosphorus and potassium. Thus, the use of fermentation processes for recycling and transformation of wastes may be a good way to ensure the safety of the obtained products and offers a way for further utilization of the disposed final product in future. Over the last few decades, lactic acid bacteria (LAB) have been extensively used for preserving fermented and cooked meat products and a variety of strains have been found to be effective against pathogens and spoilage organisms related to those products (Vermeiren *et al.*, 2003; Kostrzynska and Bachard, 2006; Leroy *et al.*, 2006).

Materials and Methods

The experiment was carried out in the Department of Livestock Production and Management, FVSc and AH Srinagar (SKUAST- Kashmir), Jammu and Kashmir (India). Fermentation of the poultry waste (dead birds and poultry litter) was done under a roofed shed. The fermentation process was carried out in air tight plastic bins. Dead birds and litter manurein 1:1 ratio was fermented in different combinations. Poultry waste was humidified with water in the ratio of 1:1 and the pH was kept 6.5 with 50% H_2SO_4 solution. A total of nine groups (with four replicates in each treatment) with different individual as well as combination levels of culture of LBand Yeast (*Saccharomyces cerevisiae*) was used as shown in Table 1. Dead birds were pre-stored at –5^{o}C till sufficient waste was available to fill out all the bins in a single day. On the receipt of sufficient quantity of carcasses and poultry litter, the filling of fermentation containers was carried out uniformly. In order to judge the effect of different seasons, fermentation process was carried out during two seasons viz; summer and winter. The fermented samples were analyzed for nitrogen phosphorus and potassium as per the Jackson (1973).

Statistical Analysis

The data recorded was analyzed as per the standard methods of Snedecor and Cochran (1994). In this regard SPSS software was used for performing the analysis of variance test by comparing the different means.

Results and Discussion

Nitrogen

The final productof fermentation was having significantly highest (P≤0.05) nitrogen level of 18.2 g/kg in G_2 (with LB@ 1%) and lowest nitrogen level of 10.9 g/kg was observed in treatment group G_8 (with LB@ 0.5% and Yeast@ 0.5%) during winter season. Similarly during summer season the significantly (P≤0.05) highest and lowest nitrogen level of 17.8 and 9.8 g/kg was observed in G_2 and G_8 groups re-

Table 1. Treatment combinations of fermentation experiment

Groups	Description
Treatment 1	Dead birds + Poultry litter
Treatment 2	Dead birds + Litter manure + LB @ 1.0 %
Treatment 3	Dead birds + Litter manure + LB @ 0.5 %
Treatment 4	Dead birds + Litter manure + Yeast @ 1.0 %
Treatment 5	Dead birds + Litter manure + Yeast @ 0.5 %
Treatment 6	Dead birds + Litter manure + LB@ 1% + Yeast@ 0.5%
Treatment 7	Dead birds + Litter manure + LB @ 1% + Yeast @ 1%
Treatment 8	Dead birds + Litter manure + LB @ 0.5% + Yeast @ 0.5%
Treatment 9	Dead birds + Litter manure + LB@ 0.5%+ Yeast @1%

spectively (Table 2). An overall significant increase in the nitrogen level was observed in different treatment groups of fermentation of poultry waste ranging from 7.5 g/kg (G_8) to 14.95 g/kg (G_2) during summer and 6.5 g/kg (G_8) to 14.45 g/kg (G_2) during winter season. Comparable results were also recorded by Moller and Muller (2012) in the digestate of anaerobic fermentation of poultry droppings. Cai and Pancorbo (1994) recorded nitrogen level as high as 13.3 g/kg in fermented final product of dead birds and litter. Similarly nitrogen level of 15.3 g/kg was also reported by Thyagarajan *et al.* (2013) in the fermented poultry offals.

Phosphorus

Phosphorus level in the final product observed was significantly ($P \leq 0.05$) highest in G_7 (with LB@ 1% and Yeast@ 1%) as 0.85 g/kg and lowest as 0.35 g/Kg in G_1 (control group) during winter season (Table 3). The results observed for summer season were significantly ($P \leq 0.05$) highest (0.85 g/kg) in G_5 and G_6 and lowest (0.45 g/Kg) in G_1(control group) and G_2 (with LB@ 1% was added). Phosphorus level increased significantly from 0.15 g/kg (G_1) to 0.58 g/kg (G_6) during summer and from 0.25 g/kg (G_1) to 0.59 g/kg (G_6) during winter season. Chemical analyses showed that phosphorus (P) concentrations in the digestate were 0.3 g/L comparable to that of commercial bio-fertilizers (Tommi Kukkonen, 2014). Digestate from anaerobic fermentation of poultry droppings contained useful fungi and bacteria that form soluble phosphorus nutrient (Alfa *et al.*, 2014). Comparable results of phosphorus level in fermented organic waste were also earlier reported by Bosch *et al.* (2015).

Potassium

The significantly ($P \leq 0.05$) highest potassium level observed in the final product of fermentation was 7.0 g/Kg in G_7 (with LB@ 1% and Yeast@ 1%) and lowest (4.2 g/Kg) in G_2 (with LB@ 1%) during winter season (Table 4). Similarly significantly ($P \leq 0.05$) highest potassium level of 8.0g/Kg in G_3(with LB@ 0.5%) and treatment group G_7 (with LB@ 1% and

Table 2. Nitrogen level (g/Kg) due to fermentation during different seasons (Mean±SE).

Treatment	Winter		Summer	
	Initial	Final	Initial	Final
T_1	3.60±0.02^a	^{BC}14.70± 0.17^b	3.50±0.12^a	^{BCD}15.20±0.50^b
T_2(LB=1 %)	3.25±0.11^a	^{D}18.20± 0.17^b	3.35±0.01^a	^{D}17.80± 0.90^b
T_3(LB=0.5 %)	3.40±0.12^a	^{BC}15.70± 0.90^b	3.25±0.14^a	^{BCD}15.10± 0.80^b
T_4(Yeast =1 %)	3.70±0.04^a	^{CD}16.40±0.80^b	3.80±0.03^a	^{CD}17.1± 0.80^b
T_5(Yeast= 0.5 %)	3.65±0.03^a	^{B}13.70± 0.40^b	3.45±0.03^a	^{AB}13.10± 0.80^b
T_6(LB=1%+Yeast=0.5%)	3.35±0.02^a	^{B}14.10± 0.40^b	3.30±0.04^a	^{BC}13.70± 0.13^b
T_7(LB= 1%+Yeast=1 %)	3.80±0.05^a	^{BC}15.70± 0.17^b	3.40±0.15^a	^{BCD}16.10± 0.10^b
T_8(LB=0.5+Yeast=0.5%)	3.40±0.12^a	^{A}10.90± 0.86^b	3.30±0.22^a	^{A} 9.80± 0.09^b
T_9(LB=0.5+Yeast=1%)	3.50±0.23^a	^{BC}16.00± 0.80^b	3.70±0.20^a	^{BCD}16.10±0.08^b

Figures with different small superscripts row wise and capital superscripts column wise differ significantly($P<0.05$).

Table 3. Phosphorus level (g/Kg) due to fermentation during different seasons (Mean±SE).

Treatment	Winter		Summer	
	Initial	Final	Initial	Final
T_1	0.20±0.02^a	^{A}0.35±0.04^b	0.20±0.01^a	^{A}0.45± 0.04^b
T_2(**LB**=1 %)	0.25±0.01^a	^{A}0.55±0.04^b	0.21±0.01^a	^{A}0.45± 0.04^b
T_3(**LB**=0.5 %)	0.21±0.01^a	^{AB}0.55±0.04^b	0.23±0.02^a	^{A}0.50± 0.08^b
T_4(Yeast =1 %)	0.25±0.03^a	^{AB}0.65±0.04^b	0.27±0.03^a	^{B}0.75± 0.04^b
T_5(Yeast= 0.5 %)	0.25±0.02^a	^{B}0.75±0.04^b	0.25±0.01^a	^{B}0.85± 0.04^b
T_6(**LB**=1%+Yeast=0.5%)	0.22±0.02^a	^{B}0.80±0.04^b	0.26±0.02^a	^{B}0.85± 0.04^b
T_7(**LB**= 1%+Yeast=1 %)	0.28±0.01^a	^{B}0.85±0.04^b	0.22±0.03^a	^{B}0.80± 0. 03^b
T_8(**LB**=0.5+Yeast=0.5%)	0.26±0.01^a	^{AB}0.65±0.04^b	0.23±0.02^a	^{B}0.75± 0.04^b
T_9(**LB**=0.5+Yeast=1%)	0.27±0.03^a	^{A}0.50±0.08^b	0.25±0.02^a	^{AB}0.70± 0.08^b

Figures with different small superscripts row wise and capital superscripts column wise differ significantly ($P<0.05$).

Table 4. Potassium level (g/Kg) due to fermentation during different seasons (Mean±SE).

Treatment	Winter		Summer	
	Initial	Final	Initial	Final
T_1	2.0±0.01^{a}	^{ABC}5.75±0.20^{b}	2.4±0.03^{a}	^{B}7.00± 0.40^{b}
T_2 (LB=1 %)	2.1±0.01^{a}	^{A}4.20±0.05^{b}	2.4±0.02^{a}	^{A}4.50± 0.40^{b}
T_3 (LB=0.5 %)	2.2±0.02^{a}	^{C}6.75±0.20^{b}	2.0±0.02^{a}	^{B}8.00± 0.40^{b}
T_4 (Yeast =1 %)	2.1±0.01^{a}	^{AB}4.75±0.05^{b}	2.5±0.01^{a}	^{A}4.50±0.40^{b}
T_5 (Yeast= 0.5 %)	2.1±0.02^{a}	^{ABC}5.50±0.40^{b}	2.5±0.01^{a}	^{B}6.50± 0.40^{b}
T_6 (LB=1%+Yeast=0.5%)	2.1±0.02^{a}	^{BC}6.25±0.17^{b}	2.3±0.02^{a}	^{B}6.75±0.05^{b}
T_7 (LB= 1%+Yeast=1 %)	2.4±0.03^{a}	^{C}7.00±0.40^{b}	2.1±0.03^{a}	^{B}8.00± 0.40^{b}
T_8 (LB=0.5+Yeast=0.5%)	2.1±0.01^{a}	^{C}6.50±0.40^{b}	2.4±0.01^{a}	^{B}7.00± 0.40^{b}
T_9 (LB=0.5+Yeast=1%)	2.2±0.04^{a}	^{A}4.25±0.17^{b}	2.3±0.03^{a}	^{A}4.50± 0.40^{b}

Figures with different small superscripts row wise and capital superscripts column wise differ significantly(P<0.05).

Yeast@ 1% was added) and lowest potassium level of 4.5 g/Kg was observed in G_2(LB@ 1%), G_4(with Yeast@ 1%) and G_9 (with LB@ 0.5% and Yeast@ 1%). An overall significant increase in the potassium level was observed in different treatment groups of lactic acid and yeast fermentation ranging from 2.1 g/kg (G_2) to 4.6 g/kg (G_8) during summer and 2.1 g/kg (G_2) to 5.9 g/kg (G_8) during winter season. Bosch *et al.* (2015) reported similar results in fermented organic waste. Similarly the comparable results were recorded by Thyagarajan *et al.* (2013) in the fermentation of poultry offal and litter.

During winter and summer season the highest nitrogen level observed was 18.2 g/kg and 17.8 g/Kg in treatment group T_2 respectively. Phosphorus level during winter season was highest in treatment group T_7 (0.85 g/kg). However during summer season phosphorus levels were highest in G_5 and G_6 (0.85 g/kg). Potassium level during winter season was highest (7.0 g/kg) in treatment group G_7. During summer season it was highest as 8.0 g/Kg both in treatment groups G_3 and G_7.

Conclusion

The LB and Yeast fermentation of dead birds and litter is a biologically secure and environment friendly method of waste disposal and resulted in the generation of valuable final product in the form biomanure. It was concluded that, lactic acid bacteria and yeast fermentation litter had a significant effect on the bio-mineralization in terms of nitrogen, phosphorus and potassium levels. However at different levels of LB and yeast no consistent effect on biomineralization was found.

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