Research article

Characteristics of *E.coli* Loss under Different Fertilization of Manure

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Abstract Approximately 90 million tons of dung is produced annually from cattle farms all over Japan. Considering the proper treatment of this waste product, applying manure to farmlands has been focused from a viewpoint of popularizing organic agriculture. However, pathogenic bacteria known as *E.coli* may possibly be released from the immature fermented manure that was applied in farmlands. In this study, model experiments were conducted employing slope plots under artificial rainfall simulator to investigate the *E.coli* loss. The slope plots were filled with soil and then applied 3 types of manure such as cow dung, manure fermented for 2 weeks and for 12 weeks. Additionally, two methods of application were proposed such as broadcasting method and incorporating method to differentiate the loss of *E.coli* from farmlands applied manures. The experimental results showed the amounts of *E.coli* loss by the broadcasting method were significantly higher than that by the incorporating method in the plots applied cow dung. Also in both methods, surface runoff showed higher amounts of *E.coli* loss compared to percolation. In addition, there was a tendency the loss of *E.coli* decreased with fermentation stage of manures. Therefore, it was concluded that the loss of *E.coli*, being affected by the fermentation stage of manure, was remarkably influenced by surface runoff in both broadcasting and incorporating methods.

Keywords cow dung, *E.coli*, soil erosion, surface runoff,

INTRODUCTION

In Japan, about 90 million tons of dung is produced annually from cattle farms. Conforming to the viewpoint of promoting organic agriculture, proper treatment of this product has been focused. However, in a bulk production of manure, unintended inclusion of immature fermented manure may possibly occur. Thus, the tendency of pathogenic bacteria known as *E.coli* to survive and remain exists in the produced manure (Gong Chun-Ming, 2005). Once, these manures will be broadcasted into farmlands, the release of *E.coli* may occur through surface runoff resulting broad contamination into the surrounding environment particularly into the watersheds.

In this study, the degree of *E.coli* existence in different period of manure fermentation and 2 methods of manure application into farmlands has been focused through slope model experiments under artificial rainfall simulator.

METHODOLOGY

The materials used in the experiments were collected from the Fuji Farm of Tokyo University of Agriculture, Japan. As shown in Fig. 1, there were three types of materials collected; the fresh cow dung, the 2 weeks and 12 weeks fermented manures having water content at 82, 74 and 73%, respectively. In addition, organic matter of 88% constitutes in the fresh cow dung or 2 weeks fermented manure, while 85% in the 12 weeks fermented manure. The colony-forming unit (cfu) of

E.coli was 233×10^4 cfu/g for the fresh cow dung, 13×10^2 cfu/g for the 2 weeks fermented manure and 1×10^2 cfu/g for the 12 weeks fermented manure.

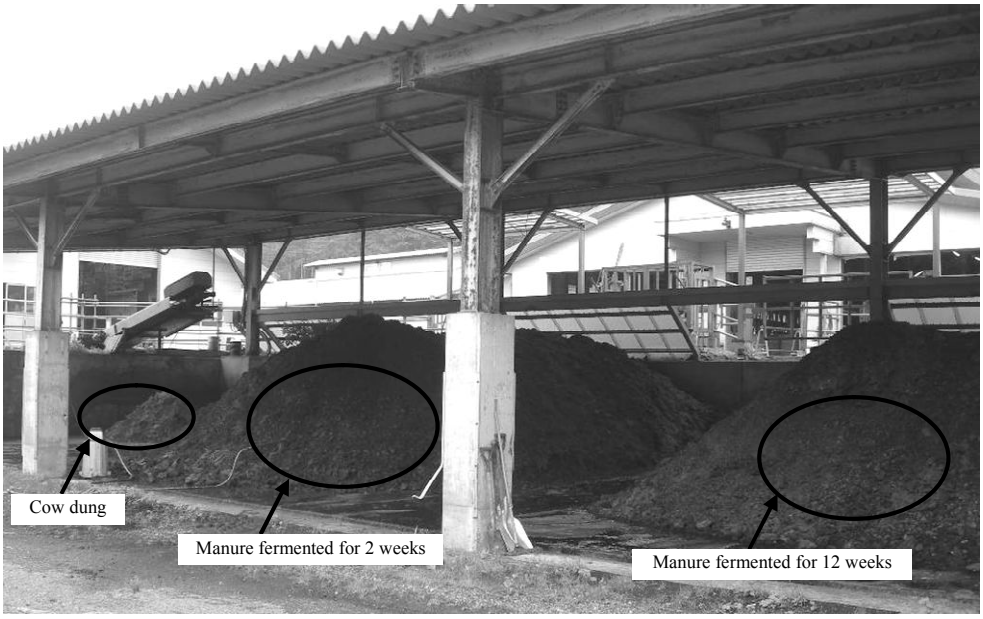

Fig. 1 Situation of manures

Table 1 Properties of cow dung and manures

	Sub material	Fermentation length	Amount of *E.coli* (cfu/g)	Water contents (%)	Organic matter (%)
Cow dung	sawdust	0 days	233×10^4	82	88
Manure fermented for 2 weeks	sawdust	2 weeks	13×10^2	74	88
Manure fermented for 12 weeks	sawdust	12 weeks	1×10^2	73	85

Stainless slope model plots of 130 cm long and 11 cm wide were filled-up with the soil (Table 2) at 5 cm deep. The plots were set up at 8 degrees in slope then applied with cow dung, 2 weeks fermented manure and 12 weeks fermented manure. The amounts of cow dung and manures applied into each plot were 315.38 g/m^2 in dry basis. Each of the three types of the materials was applied with the broadcasting method or the incorporating method in the total six slope model plots. The broadcasting method is the application of fresh cow dung or manures by spreading on the soil surface, while the incorporating method is the application by mixing the materials into the soil.

Artificial rainfall simulation was conducted under the rainfall intensity at 60 mm/hr for 2 hours. Suspended water samples from surface water discharge were collected in 6 designated sampling times up to the end of the simulation. Percolation water discharge was sampled once after 24 hours from the end of simulation (Fig. 2).

The collected suspended water samples were then evaluated for *E.coli* colonies in the laboratory experiments. The analysis was carried out with the bacteria culture medium XM-G as shown in Fig. 3.

Table 2 Properties of soil

Specific gravity	Particle size distribution (%)					Soil texture	Ignition loss (%)	Total nitrogen (mg/kg)	Total phosphorus (mg/kg)
	Gravel	Coarse sand	Fine sand	Silt	Clay				
2.68	1.97	12.3	27.82	30.21	27.70	LiC	13.41	2263.1	303.6

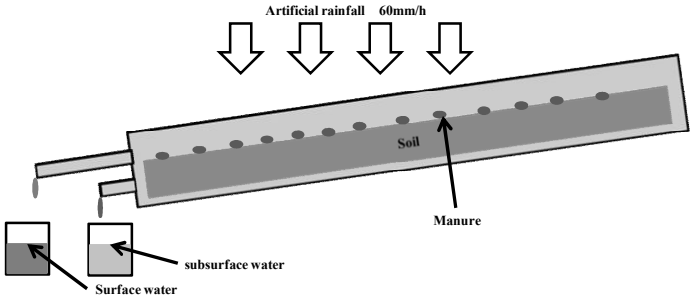

Fig. 2 Outline of slope model experiment

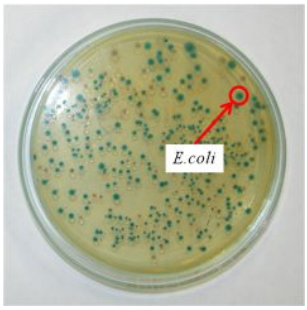

Fig. 3 Colonie of *E.coli*

RESULTS AND DISCUSSION

During the simulated rainfall for 2 hours, there was a similar tendency for *E.coli* losses from the plots applied cow dung or manures by the broadcasting method and by the incorporating method to decrease with the amounts of discharge. Also, in both application methods, *E.coli* losses through surface runoff were remarkably higher than that through percolation water. Futhermore *E.coli* loss was not observed in percolation water from the plot applied 12 weeks fermented manure through broadcasting method. Accordingly, *E.coli* capturing sytem may be applied in association with soil conservation measures such as buffer strips, mulching or settling pond in farmlands.

In addition, the numbers of *E.coli* tended to decrease with the fermention periods (Fig. 4). It means that fermentation process has an important role not only for making manure matured but also mitigating *E.coli* losses.

Fig. 5 showed the relationship of *E.coli* losses between the broadcasting method and the incorporating method. It clearly indicated the amounts of *E.coli* loss by the broadcasting method were significantly higher than that by the incorporating method in the plots applied cow dung. In the plots applied 2 weeks fermented manure, *E.coli* losses from the plot with the incorporating method were higher than that with the broadcasting method. In case appling 2 weeks fermented manure, the broadcasting method is more suitable, as the incorporating method may increase the loss of *E.coli*.

In the plots applied 12 weeks fermented manure, it was observed that the occurrences of *E.coli* losses are distributed in both the broadcasting method and the incorporating method. It may be considered the tendency of *E.coli* losses from the plots applied 12 weeks fermented manure was not affected by the application methods used in this experiment.

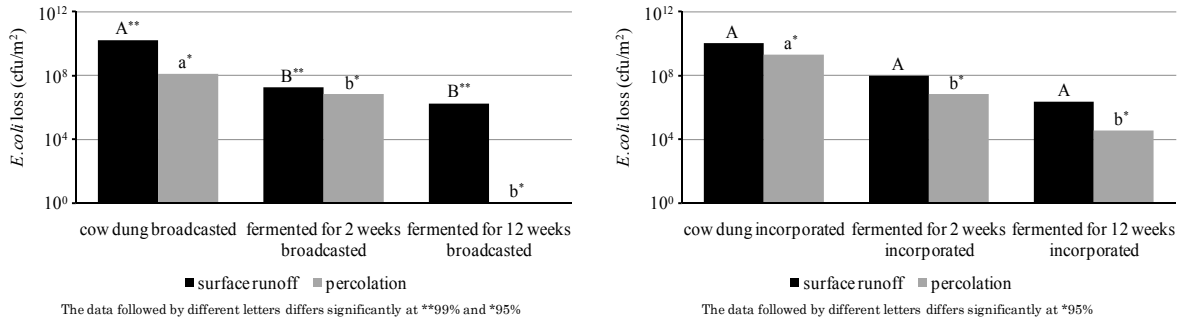

Fig. 4 Total discharge of *E.coli* from cow dung and manures

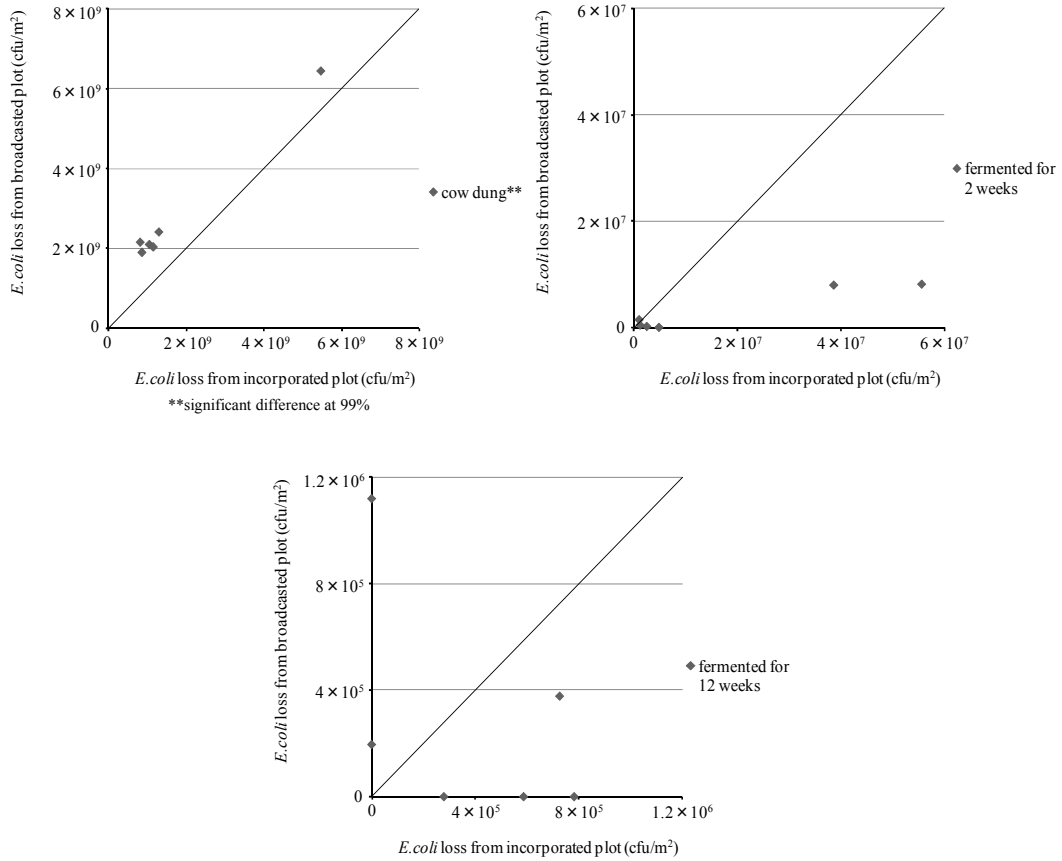

Fig. 5 *E.coli* loss from broadcasted and incorporated plots

CONCLUSION

This study aimed to evaluate the amounts of *E.coli* losses in different periods of manure fermentation and 2 methods of manure application as the broadcasting and the incorporating methods through slope model experiments under artificial rainfall simulator.

On the basis of the experimental results, the amounts of *E.coli* loss by the broadcasting method were significantly higher than that by the incorporating method in the plots applied cow dung. Also in both methods, surface runoff showed higher amounts of *E.coli* loss compared to percolation. In addition, there was a tendency the loss of *E.coli* decreased with fermentation stage of manures.

Therefore, it was concluded that the loss of *E.coli*, being affected by the fermentation stage of manure, was remarkably influenced by surface runoff in both broadcasting and incorporating methods. So, *E.coli* capturing sytem may be applied in association with soil conservation measures such as buffer strips, mulching or settling pond in farmlands.

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