Journal of Environmental Science International
22(9); 1235~1239; September 2013

pISSN: 1225-4517 eISSN: 2287-3503
http://dx.doi.org/10.5322/JESI.2013.22.9.1235

RESEARCH NOTE

Effects of Probiotic Additions to Feed and Manure on Temperature, Humidity, and Carbon Dioxide Emissions in Hanwoo Manure during Summer - A Field Study

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Abstract

The effects of probiotic additions to feed and manure on temperature, humidity and carbon dioxide (CO_2) emissions in Hanwoo manure during summer (4 weeks) were evaluated. Fifteen Hanwoo (24-mo-old, 580 ± 20 kg) were housed in individual pens (5 × 8 m) and randomly assigned to 1 of 3 treatments (n = 5 cattle per treatment). Hanwoo were fed experimental rations as follows: control (10 kg roughage + 2 kg concentrate); T1 (10 kg roughage + 2 kg concentrate, 2% probiotics on as-fed basis); and T2 (10 kg roughage + 2 kg concentrate, 2% probiotics on as-fed basis + 7 kg probiotics as top-dressing on the surface of Hanwoo manure). In comparison to the control, the addition of probiotics to feed or feed and manure had an effect ($P < 0.05$) on temperature and humidity over the 4 weeks, except for humidity at 0 weeks. The only significant difference ($P < 0.05$) observed in CO_2 emission was among all treatments at 3 and 4 weeks (but not at 0 through 2 weeks). These results indicated that use of probiotics as feed and manure additives did not have a significant effect on environmental parameters.

Key words : Probiotics, Temperature, Humidity, Carbon dioxide emission, Feed, Hanwoo manure

1. Introduction

For more than 50 years, antibiotics have been extensively used worldwide for the treatment of a variety of infectious diseases in humans and animals. These products can also provide several benefits to food safety and animal welfare, and antibiotics are very important in the livestock industry (Chowdhury et al., 2009). Recently, concerns about antibiotics and antimicrobial resistance, antibiotic residues in animal products, or overuse of antibiotics in animals have been addressed, including mechanisms that should be put in place to minimize the risks to human and animal health. Most countries have banned the use of antibiotics in farm animals or in animal feed for the reasons given above.

Received 5 September, 2013; **Revised** 23 September, 2013;
Accepted 24 September, 2013

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Current research has mainly focused on the role of probiotics as sustainable alternatives to antibiotic growth promoters for animal production (Tellez et al., 2012). Probiotics are being developed commercially for animal feed, as dietary supplements for use as growth promoters and prevention of gastrointestinal bacterial infections, thereby suppressing the development of pathogenic bacteria (Anadón et al., 2006; Cartman et al., 2008). According to the Fuller (1989) and FAO and WHO (2002), probiotics are defined as live microorganisms which, when administered in adequate amounts, have a health benefit for the host. Improved growth rate and feed efficiency has been shown in piglets and grower pigs using *Bacillus* spp., as described by Succi et al. (1995) and Kyriakis et al. (1999). Experiments in which direct-fed microbials were given to growing-finishing pigs showed an improvement in growth performance (Shon et al., 2005). In addition, Galyean et al. (2000) and Rust et al. (2000) reported that daily addition of lactate-utilizing bacteria and/or lactate-producing bacteria to cattle diets improved feed efficiency and average daily gain (ADG) in feedlot cattle. However, no research has examined the effectiveness of probiotics as feed and manures additives on environmental impacts. Accordingly, the purpose of this study was to evaluate the effect of probiotic additions to feed and manures on temperature, humidity, and carbon dioxide (CO_2) emission in Hanwoo cattle manure during summer.

2. Materials and Methods

All experimental procedures were performed in accordance with the guidelines for animal care of the experimental Hanwoo farms in Jinju (South Korea). Fifteen Hanwoo (24-mo-old, 580 ± 20 kg) were housed in individual pens (5 × 8 m) and randomly assigned to 1 of 3 treatments (n = 5). Hanwoo were fed equal portions twice daily, at 10:00 AM and 17:00 PM, and drinking water was available at all times. Hanwoo were fed experimental rations as follows: control (10 kg roughage + 2 kg concentrate); T1 (10 kg roughage + 2 kg concentrate, 2% probiotics on as-fed basis); and T2 (10 kg roughage + 2 kg concentrate, 2% probiotics on as-fed basis + 7 kg probiotics as top-dressing on the surface of Hanwoo manure). Probiotics used in this study were obtained from Animal Research Unit, Gyeongsang National University (Jinju, South Korea), and consisted 2×10^6 cfu/g of *Bacillus subtilus* and 1×10^6 cfu/g of *Lactobacillus spp.* Temperature, humidity, and CO_2 emissions from Hanwoo manure were measured weekly from 5 random locations in each pen using a multigas analyzer (Yes Plus LGA, Critical Environment Technologies Canada Inc., Delta, Canada). Also, temperature, humidity, and CO_2 concentration were measured onto the Hanwoo manure surface immediately. All data were analyzed by ANOVA using General Linear Model (GLM) procedures with the SAS program (SAS Institute, 2000). Differences among means were determined using Duncan's multiple range tests (Duncan, 1955), with $P < 0.05$ considered significant.

3. Results and Discussion

3.1. Effects of probiotic additions on temperature and humidity

The effects of probiotic additions to feed and manure on temperature and humidity as a function of time are shown in Table 1. Overall, the addition of probiotics to feed or to feed and manure had an effect ($P < 0.05$) on temperature over the experimental period compared with the control. Temperature in all treatments was below 27.1 °C to 1 week, decreased to 22.6-24.2 °C at 3 weeks, and then increased to 23.6-24.3 °C at 4 weeks. Compared with the control, temperature in treatments with probiotic-treated feed (T1) or probiotic-treated feed and manure (T2)

Table 1. The effects of probiotic additions to feed and manures on temperature and humidity as a function of time

Items	Treatments1)			Significance	
	Control	T1	T2	SEM	P value
Temperature (°C)					
0 week	24.9^{a}	24.8^{b}	24.8^{b}	0.02	0.0023
1 week	27.1^{a}	26.9^{ab}	26.7^{b}	0.06	0.0060
2 week	23.5^{b}	23.6^{b}	23.7^{a}	0.05	0.0430
3 week	24.2^{a}	22.7^{b}	22.6^{b}	0.11	<0.0001
4 week	24.3^{a}	23.6^{b}	24.1^{a}	0.09	0.0042
Humidity (%)					
0 week	63.6^{a}	63.3^{a}	63.6^{a}	0.08	0.0989
1 week	68.8^{b}	72.5^{a}	72.1^{a}	0.47	0.0008
2 week	89.2^{c}	94.7^{b}	96.7^{a}	0.49	<0.0001
3 week	91.2^{b}	98.3^{a}	99.7^{a}	0.93	<0.0001
4 week	87.5^{b}	95.3^{a}	97.2^{a}	0.61	<0.0001

Data are means ±standard error.

$^{a\text{-}c}$Means within row with different superscripts are significantly different ($P<0.05$).

[1] Control: no treatment (10 kg roughage + 2 kg concentrate); T1: 10 kg roughage + 2 kg concentrate, 2% probiotics on as-fed basis; T2: 10 kg roughage + 2 kg concentrate, 2% probiotics on as-fed basis + 7 kg probiotics as top-dressing on the surface of Hanwoo manure.

tended to decrease as time increased. In addition, our results also observed no effects of probiotics in two treatments (T1 and T2).

As seen in Table 1, all treatments showed an increase in humidity until 3 weeks, ranging from 63.3% to 99.7%, and then declining to 87.5-97.2% at 4 weeks ($P < 0.05$). However, there were no differences ($P > 0.05$) among treatments in humidity at 0 weeks. In this study, the treatment with probiotic-treated feed and manure had higher humidity (99.7%) compared with the control and with the treatment with probiotic-treated feed at 3 weeks. Among all weeks, the highest temperature was observed at 3 weeks in all treatments, possibly as a result of heavy rain. Furthermore, we found that trends in humidity tended to follow those of temperature in T1 and T2; that is, humidity was not affected by either of these treatments. In general, the factor that determines the quality of successful probiotic organisms is the activity of extracellular enzymes under gut environments (Kirjavainen et al., 2001), and these activities are very sensitive to temperature (Jones *et al.*, 1987). In addition, the use of probiotics as feed additives is one strategy for improving production in animals. At present, it is unclear why the two treatments with probiotics did not influence temperature or humidity, and limited published information is available concerning probiotic additives to feed and manure. One clear finding in the present study was that the difference between our results and those of other studies is that our field study of the Hanwoo facility was conducted during the summer

3.2. Effects of probiotic additions on carbon dioxide (CO_2) emission

Table 2 presents the effects of probiotic additions to feed and manure on CO_2 emissions as a function of time. In this study, the only significant difference ($P < 0.05$) observed in CO_2 emissions was among all treatments at 3 and 4 weeks (but not at 0 through 2

Table 2. The effects of probiotic additions to feed and manures on carbon dioxide emissions as a function of time

Items (ppm)	Treatments[1)]			Significance	
	Control	T1	T2	SEM	P value
0 week	1,458.20^a	1716.00^a	1520.00^a	278.06	0.8032
1 week	483.60^a	512.60^a	502.40^a	9.16	0.4730
2 week	591.40^a	607.00^a	618.20^a	18.13	0.6269
3 week	581.00^{ab}	605.20^a	545.00^b	13.59	0.0450
4 week	446.00^b	450.40^b	489.20^a	8.33	0.0453

Data are means ±standard error.

$^{a-b}$Means within row with different superscripts are significantly different (P<0.05).

[1]Control: no treatment (10 kg roughage + 2 kg concentrate); T1: 10 kg roughage + 2 kg concentrate, 2% probiotics on as-fed basis; T2: 10 kg roughage + 2 kg concentrate, 2% probiotics on as-fed basis + 7 kg probiotics as top-dressing on the surface of Hanwoo manure.

weeks). During summer, the initial CO_2 concentrations ranged from 1458.20 to 1716.00 ppm at 0 week. At 1 week, CO_2 concentrations abruptly increased (483.60 to 512.60 ppm) and again increased (591.40 to 61 8.20 ppm) at 2 weeks. At 3 weeks, CO_2 emissions in all treatments increased (545.00 to 605.20 ppm), and then decreased (446.00 to 489.20 ppm) at 4 weeks. The investigated high CO_2 emissions of the treatments followed the order T1 > T2 > Control. This result indicated that the use of probiotic-treated feed or probiotic-treated feed and manure had no important effect on reducing CO_2 concentrations. The use of probiotics in ruminant diets is known to change the rumen environment or fermentation and to increase the productivity of livestock (Mwenya et al., 2004). To our knowledge, information about the ways in which use of probiotics may affect CO_2 patterns in livestock facilities is limited.

4. Conclusions

The results from the present study indicate that inclusion of probiotics in feed or in feed and manure did not affect temperature, humidity, or CO_2 emissions during summer. The exact reason for these findings could not be explained by the parameters observed in this study. Hence, the mechanisms of action of probiotics in relation to environmental conditions require further investigation.

Acknowledgments

This research was supported by Bio-industry Technology Development Program (No. 312058-03-1-WT012), Ministry of Agriculture, Food and Rural Affairs.

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