Stability and function of an encapsulated probiotic bacterium for foodborne pathogen control

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Introduction

- *Lactobacillus* are commonly used as probiotics to dampen enteric infection and promote animal gut health. However, they are heat sensitive, which limits their application. We developed a novel spray-drying encapsulation technology that resulted in approximately 0.5-log reduction of *Lactobacillus zeae* LB1, a probiotic with the function to control *Salmonella* and enterotoxigenic *E. coli* in vivo.
- In the current study, encapsulated LB1 was evaluated for its stability during storage and feed pelleting and for the function on pig gut health.

Materials and Methods

Encapsulation of probiotics

The probiotic culture (*L. zeae* LB1) was encapsulated using the method described previously (Liu ea al. 2015).

Survival of encapsulated LB1 after storage

After 14 month-storage at at 4℃ and 22℃, the content of LB1 was measured to test the storage stability of encapsulated LB1.

Survival of encapsulated LB1 after pelleting

100 g of encapsulated LB1 (1.4×10^9 CFU/g) was added in 49.9 kg of mash feeds and mixed well, the expected final concentration of encapsulated probiotics was 2.8×10^9 CFU/kg feed. Meanwhile, 300 ml of fresh LB1 culture (5×10^8 CFU/ml) was mixed with 50 kg of mash feed to get the final concentration of LB1 at 3×10^9 CFU/kg feed, which serves as a control. 6 mash feed samples with 500 g of each before pelleting were collected in zip bags and stored in 4℃. 6 pelleted feed samples with 500g of each were collected at different time points (4 samples before cooling and 2 samples after cooling) during the pelleting (temperature setting: 80℃; speed: 25 kg /min) and stored in zip bags at 4℃. The fresh LB1 control feeds were also treated as described above. All the feed samples were analyzed for probiotics contents after being stored at room temperature for 7 and 30 days, respectively.

Animal trial design and sample collection

80 newly-weaned piglets were equally allocated to five groups: **1)** basal diets (control, CTL); **2)** basal diets supplemented with non-encapsulated LB1 (1x108 CFU/pig per day, NEP); **3)** basal diets supplemented with encapsulated LB1 (1x108 CFU/pig per day, EP); **4)** basal diets supplemented with 5% bovine colostrum (BC); **5)** basal diets supplemented with EP and BC (EP-BC, same dose as in Group 3 or 4).

After five days' treatment, the gastrointestinal tract of euthanized piglets were excised for tissue and intestinal samplings. Intestinal content from the ileum, caecum and colon were also collected for analysis of microbial populations.

Results

- In the storage test, the concentration of encapsulated LB1 was initially 1.17×10^9 CFU/g powder. After 14-month storage at 4℃ and 22℃, the concentration was decreased to 9.7×10^8 and 1.68×10^8 CFU/g powder, representing 17.1% and 85.6% reduction, respectively.
- Probiotic contents of all the feed samples in the feed pelleting test are showed in **Table 1**. The initial concentration of LB1 was 2.8×10^6 CFU/g for the encapsulated form and 3.0×10^6 CFU/g for the non-encapsulated form.

Table 1. Probiotic contents after pelleting

Feed samples	Probiotic contents after 7 days storage (CFU/g)	Probiotic contents after 30 days storage (CFU/g)
Mash non-encapsulated	1.6×10^6	5.0×10^4
Pellet non-encapsulated	2.5×10^4	2.0×10^4
Mash encapsulated	2.3×10^6	1.6×10^6
Pellet encapsulated	4.0×10^5	2.8×10^5

- For the pig trial test, the treatment groups showed no significant difference to the CTL group in growth performance. Supplementation of LB1 or colostrum individually did not affect the population size of *Lactobacillus* in the ileum and colon of pigs. However, the EP-BC group had a significantly increased population of *Lactobacillus* in both the ileum and colon (94.57-fold and 23.51-fold, respectively) compared with the CTL group (**Figure 1**).

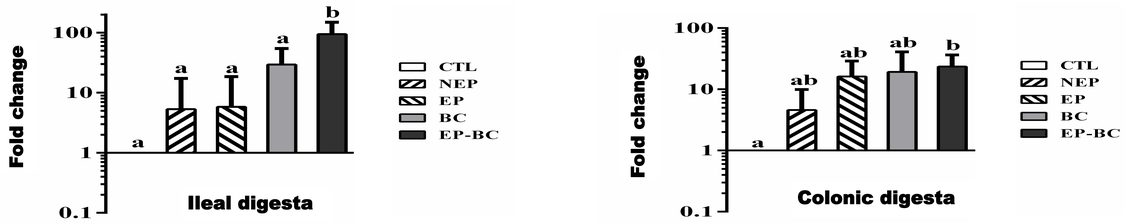

Figure 1. Fold changes of *Lactobacillus* population in ileal and colonic digesta from pigs with different treatments.

All values were caculated using the method of $2^{-\Delta\Delta Ct}$ (value >1.0 represents up-regulation; value < 1.0 represents down-regulation) and expressed as mean±standard deviation. Different letters represent significantly different ($P < 0.05$) from each other.

Conclusion

- Spray-drying encapsulation is an effecive method to protect *Lactobacillus zeae* LB1 during storage and feed pelleting.
- Supplementation of both LB1 and colostrum promoted *Lactobacillus level* in both the ileum and colon of newly-weaned piglets.

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To Know More

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