

凝膠化保育料與傳統保育料對提升離乳仔豬之生長性狀、免疫球蛋白含量、下痢發生率與糞便微生物數量之效果⁽¹⁾

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摘 要

試驗目的評估凝膠化保育料 (gelaton of weaner diet) 與傳統保育料 (regular weaner diet) 對離乳期仔豬之生長性狀、免疫球蛋白含量、下痢發生率與糞便微生物數量之影響。試驗採用 26 – 28 日齡離乳仔豬，公母各半共 24 頭，依性別與體重完全逢機分配於保育欄舍共 12 欄 (1 公 1 母)，飼糧有傳統保育料與凝膠化保育料 (乾物量 30% – 35%)，飼驗期間共 4 週，第一週期間，分別於每日 8:00、11:00、14:00 與 17:00 各餵飼一次，第二週以後採任食方式餵飼。試驗結果，離乳仔豬體重與日增重以餵飼凝膠化保育料較傳統保育料有較佳之趨勢。仔豬的採食量與飼料效率以及血液尿素氮含量，餵飼凝膠化保育料組顯著優於傳統保育料組。在下痢發生率方面，亦以餵飼凝膠化保育料組，出現輕微與中度軟便百分率較餵飼傳統保育料組低。因此，在保育期以凝膠化保育料餵飼離乳仔豬的飼養方式，可以運用於改善離乳仔豬的生長性狀與下痢的發生率。

關鍵詞：凝膠化、生長性狀、保育豬。

緒 言

仔豬常於離乳時發生飼料適應不良的問題，導致於離乳初期仔豬常有生長停滯之現象。在一些文獻中指出，仔豬的離乳體重會影響其日後在生長期與肥育期階段之生長性狀，尤其是以統進統出、批次生產以及早期離乳等生產系統影響最為顯著 (Wolter and Ellis, 2001; Wolter *et al.*, 2002)。離乳對仔豬也是一種嚴峻的生理挑戰，例如由液態乳汁轉變為固態飼料與需要面臨重社會次序新建立等考驗，均會導致仔豬的飼料攝食量與飲水量的停然下降 (Varley and Stockill, 2001; Dybkjaer *et al.*, 2006)。飼料與飲水量的下降將會直接影響仔豬之生長表現，同時亦會提高仔豬罹病率與死亡率 (Maxwell and Carter, 2001)。仔豬飼糧中常添加血漿蛋白、乳製品以及其他高品質與高消化率之飼料原料，目的為了疏緩離乳仔豬發生生長停滯之影響 (Maxwell and Carter, 2001)。不過仔豬飼糧的物理狀態對離乳初期仔豬的採食量，亦有很大的影響，因此飼養者常會於仔豬離乳初期，以餵飼液態人工乳餵飼，藉以改善仔豬的增重表現，此現象即是應用液態人工乳中，水分含量較高可以提高仔豬採食量 (Zijlstra *et al.*, 1996)。另外亦有文獻發現以凝膠化飼糧餵飼離乳仔豬，具有舒緩於離乳過度期間，因餵飼乾式飼料所造成適應不良的問題 (Layman *et al.*, 2008)。

材料與方法

I. 試驗動物

凝膠化飼糧 (乾物量 30% – 35%) 餵飼仔豬，評估液態凝膠化飼糧對保育期仔豬的生長性狀、免疫球蛋白含量與下痢發生率之影響。凝膠化飼糧乳採用洋菜 (agar) 亦稱為瓊脂，由海藻中提製出來，屬植物性膠質富含多醣，

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外貌呈黃色透明的粉末，主要成分 100 g 的洋菜就含有 74 g 以上的膳食纖維，可吸收 20 倍的水，需加熱溶解，當溫度降至 40°C 以下後開始凝結膠體 (陳武雄，1970；江永棉及陳武雄，1972)。飼糧保育料 (如表 1) 為對照組，含粗蛋白質 18.1%、離胺酸 1.10% 與可消化能 3,390 kcal/kg，凝膠化飼糧 (乾物量 35%) 即將保育料與加熱洋菜膠混勻，放置室溫至冷卻後供餵飼試驗仔豬。試驗採用 26 - 28 日齡離乳仔豬，公母各半共 24 頭，依性別與體重完全逢機分配於保育欄舍共 12 欄 (1 公 1 母)，飼驗期間共 4 週，第一週期間，分別於每日 8:00、11:00、14:00 與 17:00 各餵飼一次，第二週以後採任食方式餵飼，每週量秤體重、記錄採食量與每日下痢指數之頭數，並於試驗開始日與結束日，以人工固定方法由頸靜脈採集血液分析免疫球蛋白含量等性狀，評估凝膠化飼糧對改善離乳期仔豬生長性能、免疫球蛋白含量與下痢發生率之效果。

表 1. 基礎飼糧之組成分

Table 1. Composition of weaner diet

Items	Regular weaner diet
Ingredient, %	
Corn, yellow	67.75
Soybean meal, 43%	19.0
Dicalcium phosphate	1.6
Limestone, pulverized	0.8
Fish meal, 65%	5.0
Skim milk, dried	2.0
Whey	2.0
Salt, iodized	0.5
Soybean oil	1.0
Vitamin premix ^a	0.1
Mineral premix ^b	0.15
Chloride-choline, 50%	0.1
Total	100
Calculated value	
Crude protein, %	18.10
Digestible energy, kcal/kg	3,390
Lysine, %	1.10
Calcium, %	0.88
Phosphorus, %	0.69
Analyzed value	
Dry matter, %	87.77
Crude protein, %	18.20
Crude fat, %	2.58

^a Vitamin premix provided the following vitamins per kg of diet: vitamin A, 8,000 IU; vitamin D₃, 800 IU; vitamin E, 30 IU; vitamin K₃, 1.0 mg; thiamin, 2.0 mg; riboflavin, 5.0 mg; vitamin B₁₂, 25 g; Ca-pantothenate, 12 mg; niacin, 18 mg; folic acid, 0.4 mg; biotin, 0.06 mg and choline, 120 mg.

^b Mineral permix provided the following minerals per kg of diet: Cu, 10 mg; Fe, 100 mg; Zn, 100 mg; Mn, 10 mg and Se, 0.1 mg.

II. 血清免疫球蛋白含量、下痢指數與腸道菌相分析

(i) 血清免疫球蛋白含量分析

以含有乙二胺四乙酸 (ethylenediaminetetraacetic acid, EDTA) 抗凝血劑的採血管，抽取試驗豬之血液樣品，經離心條件 4°C、3,000 rpm 與 10 分鐘後，收集血清樣品儲放於 -20°C 冷凍櫃，供分析免疫球蛋白含量用。在血清免疫球蛋白 IgA、IgG 及 IgM 含量測定，皆採用酵素鍵結免疫吸附法 (enzyme-linked immunosorbent assay, ELISA)，依照製造廠商生產之 Pig ELISA IgA、IgM 與 IgG 分析套組 (Leinco Technologies, Inc, USA) 建議之步驟，並以波長 450 nm 進行含量分析。

(ii) 下痢指數分析

下痢發生率分析方法，主要參考 Hart and Dobb (1988)，於試驗開始後每日上午與下午記錄糞便評分指數，糞便評分標準分成 4 級分，分別為指數「0」表正常成型糞便 (水分含量 < 70%)、「1」表輕微軟便 (水分含量 70% - 75%)、「2」表中度軟便 (水分含量 75% - 80%) 與「3」表嚴重軟便 (水分含量 > 80%)，供評估仔豬下痢的嚴重程度。

(iii) 糞便微生物數量分析

試驗仔豬糞便樣品，分別於試驗第 2 與 3 週各採集一次，每次採樣後儘速秤取 1 g 糞便先放入 10 mL 0.85% NaCl 混合均勻，接續用 0.85% NaCl 連續稀釋 (1 mL + 9 mL 0.85% NaCl) 至 1/100000000，總共需要稀釋 8 次。大腸桿菌數與其它革蘭氏陰性菌數分析，依照 Chromagar (CHROMagar company, French) 建議方法調配培養基。樣品接種方法，分別取 1 mL 之 1/1000、1/1000000 與 1/100000000 稀釋糞便樣品，再分別注入 3 個 9 cm 培養皿，接續注入適量 Chromagar 與 MRS agar (約 9 mL)，搖放均勻靜置至凝固後，放置於 37°C 培養箱經 24 小時後，計算菌落之數量。

III. 統計分析

試驗所得之各項資料係採用 SAS (2005) 的統計軟體，依一般線性模式程序 (general linear model procedure, GLM) 進行變方分析，並以鄧肯氏多變域測定法 (Duncan's multiple range test) 進行處理組平均值間之差異顯著性分析，當 $P < 0.05$ 表差異顯著。

結果與討論

I. 凝膠化飼糧與保育料對離乳仔豬生長性狀之影響

離乳仔豬餵飼傳統保育料與凝膠化保育料對其體重差異不顯著 (如表 2)。試驗初期為讓仔豬適應離乳後之飼糧，兩組均於試驗第一週以少量多餐方式餵飼仔豬。試驗結果在離乳後第 1 週、第 2 週、第 3 週與第 4 週餵飼凝膠化保育料組仔豬體重大於餵飼傳統保育料組之趨勢。在離乳仔豬日增重方面，雖然餵飼傳統保育料與凝膠化保育料對離乳仔豬日增重影響，兩者未達顯著水準 (如表 3)，但是於離乳後第 1 週、第 2 週、第 3 週與第 1 至 4 週期間，餵飼凝膠化保育料組仔豬的日增重仍有高於餵飼傳統保育料組之趨勢。此現象可能是因凝膠化飼糧含有較高量的膳食纖維與多醣成份的作用，具有改善仔豬增重的效果 (陳, 1970; Layman *et al.*, 2008)。在仔豬飼料採食量與飼料效率，除第 1 週外，餵飼凝膠化保育料組分別顯著低於餵飼傳統保育料組 (如表 4 與 5)。此現象可能由於凝膠化保育料含有洋菜膠，不僅富含膳食纖維與高的保水性外，同時讓採食仔豬具有飽足感，進而減少凝膠化保育料組飼料的採食量；另外凝膠化保育料可以減少仔豬因玩耍飼料，而導致飼料浪費的情形，進而改善離乳仔豬之飼料效率 (陳, 1970; 江與陳, 1972; Zijlstra *et al.*, 1996)。

表 2. 餵飼凝膠化保育料或傳統保育料對離乳仔豬體重之影響

Table 2. The effect of feeding gelation of weaner diet or regular weaner diet on bodyweight of postweaning pigs

Body weight	Regular weaner diet	Gelation of weaner diet
Weaning day, kg	8.47 ± 1.33*	8.45 ± 1.26
1-week postweaning, kg	9.82 ± 1.48	9.97 ± 1.22
2-week postweaning, kg	12.47 ± 1.49	12.91 ± 1.38
3-week postweaning, kg	15.17 ± 1.58	15.96 ± 1.43
4-week postweaning, kg	18.84 ± 1.59	20.05 ± 1.22

Mean ± SD.

表 3. 餵飼凝膠化保育料或傳統保育料對離乳仔豬日增重之影響

Table 3. The effect of feeding gelation of weaner diet or regular weaner diet on weigh gain of postweaning pigs

ADG ¹	Regular weaner diet	Gelation of weaner diet
1-week postweaning, kg	0.19 ± 0.02*	0.22 ± 0.02
2-week postweaning, kg	0.38 ± 0.03	0.42 ± 0.03
3-week postweaning, kg	0.39 ± 0.03	0.43 ± 0.04
4-week postweaning, kg	0.52 ± 0.04	0.58 ± 0.05
Overall period (1-4 week), kg	0.37 ± 0.02	0.41 ± 0.02

¹ ADG meant average daily gain.

Mean ± SD.

表 4. 餵飼凝膠化保育料或傳統保育料對離乳仔豬採食量之影響

Table 4. The effect of feeding gelation of weaner diet or regular weaner diet on feed intake of postweaning pigs

ADFI ¹	Regular weaner diet	Gelation of weaner diet
1-week postweaning, kg	0.17 ± 0.02*	0.20 ± 0.02
2-week postweaning, kg	0.64 ± 0.04 ^a	0.51 ± 0.03 ^b
3-week postweaning, kg	0.69 ± 0.04 ^a	0.59 ± 0.05 ^b
4- week postweaning, kg	0.94 ± 0.06 ^a	0.68 ± 0.06 ^b
Overall period (1-4 week), kg	0.61 ± 0.04 ^a	0.50 ± 0.05 ^b

¹ ADFI meant average daily feed intake.

^{a, b} Means in the same row with different superscripts differed significantly ($P < 0.05$).

Mean ± SD.

表 5. 餵飼凝膠化保育料或傳統保育料對離乳仔豬飼料效率之影響

Table 5. The effect of feeding gelation of weaner diet or regular weaner diet on feed efficiency of postweaning pigs

Feed efficiency ¹	Regular weaner diet	Gelation of weaner diet
1-week postweaning	0.89 ± 0.04*	1.01 ± 0.02
2-week postweaning	1.70 ± 0.24 ^a	1.22 ± 0.11 ^b
3-week postweaning	1.80 ± 0.16 ^a	1.37 ± 0.16 ^b
4-week postweaning	1.80 ± 0.11 ^a	1.24 ± 0.25 ^b
Overall period (1-4 week)	1.65 ± 0.10 ^a	1.25 ± 0.10 ^b

¹ Feed efficiency meant feed/gain (kg/kg).

^{a, b} Means in the same row with different superscripts differed significantly ($P < 0.05$).

Mean ± SD.

II. 凝膠化保育料與傳統保育料對離乳仔豬血液性狀與免疫球蛋白含量之影響

離乳仔豬的血液性狀，在總蛋白與肌酸酐含量，餵飼傳統保育料組與凝膠化保育料組，兩者差異不顯著，但在血漿尿素氮含量餵飼凝膠化保育料組有較低的現象（表 6）。此現象有可能因洋菜膠富含膳食纖維具有促進腸道健康與提高飼料氮的利用率的作用（Hillman *et al.*, 1994; Blottiere *et al.*, 2003; Biagi *et al.*, 2006）。在仔豬免疫球蛋白 IgA、IgM、IgG 含量，餵飼傳統保育料與凝膠化保育料組，兩者間差異不顯著（表 7）。此現象可能因洋菜膠含有之多醣（polysaccharide），主要功用在於抑制仔豬的發炎作用（Tzianabos, 2000），對於仔豬的免疫球蛋白含量沒有顯著的影響。

表 6. 飼餵凝膠化保育料或傳統保育料對離乳仔豬血液性狀之影響

Table 6. The effect of feeding gelation of weaner diet or regular weaner diet on blood traits of postweaning pigs

Blood traits	Regular weaner diet	Gelation of weaner diet
Total protein, g/dL	5.27 ± 1.90*	5.29 ± 0.14
Creatinine, mg/dL	1.24 ± 0.15	1.28 ± 0.06
BUN, mg/dL	14.53 ± 3.51 ^a	9.88 ± 1.51 ^b

^{a, b} Means in the same row with different superscripts differed significantly ($P < 0.05$).
Mean ± SD.

表 7. 飼餵凝膠化保育料或傳統保育料對離乳仔豬免疫球含量之影響

Table 7. The effect of feeding gelation of weaner diet or regular weaner diet on immunoglobulin contents of postweaning pigs

Immunoglobulin contents	Regular weaner diet	Gelation of weaner diet
IgA × 10 ⁶ , ng/mL	0.36 ± 0.07*	0.35 ± 0.06
IgM × 10 ⁶ , ng/mL	7.27 ± 2.52	7.97 ± 3.54
IgG × 10 ⁶ , ng/mL	2.54 ± 0.76	3.31 ± 1.11

Mean ± SD.

III. 凝膠化保育料與傳統保育料對離乳仔豬大腸桿菌數量與下痢發生率之影響

在糞便的大腸桿菌與格蘭氏陰性菌數量，以飼餵凝膠化保育料組有較低之趨勢（如表 8）。離乳仔豬的下痢發生率，飼餵傳統保育料組仔豬糞便呈輕微軟便與中度軟便百分比高於飼餵凝膠化保育料組（表 9）。此現象亦可能因洋菜膠富含膳食纖維，健全仔豬腸道的健康狀態，具有降低離乳仔豬腸道大腸桿菌與格蘭氏陰性菌數量之作用，進而降低離乳仔豬的下痢發生率（陳，1970；江與陳，1972；Hillman *et al.*, 1994; Biagi *et al.*, 2006）。

表 8. 飼餵凝膠化保育料或傳統保育料對離乳仔豬糞便大腸桿菌數量之影響

Table 8. The effect of feeding gelation of weaner diet or regular weaner diet on the number of fecal *E.coli* of postweaning pigs

Fecal <i>E.coli</i>	Regular weaner diet	Gelation of weaner diet	P-value
<i>E.coli</i> , cfu/g ¹	8.52 × 10 ⁷ ± 6.8 × 10 ⁴	4.25 × 10 ⁵ ± 1.3 × 10 ⁴	P = 0.08
Other <i>coliform</i> bacteria, cfu/g ²	3.78 × 10 ⁶ ± 7.5 × 10 ³	1.35 × 10 ⁴ ± 2.6 × 10 ³	P = 0.09

¹ *E.coli*: Morphology showed blue color. ² Other *coliform* bacteria: Morphology showed mauvecolor.

表 9. 飼餵凝膠化保育料或傳統保育料對仔豬下痢發生率之影響

Table 9. The effect of feeding liquid-type or gelation of milk replacer or without feeding any diet on index diarrhea of postweaning pigs

Diarrhea index*	Regular weaner diet	Gelation of weaner diet
	------%-----	
0	76.5 ^a	94.3
1	12.6 ^b	5.7
2	10.9 ^c	0
3	0 ^d	0

* Diarrhea index number 0 represented normal feces. Index number 1 represented light soft feces. Index number 2 represented intermediate soft feces. Index number 3 represented heavy soft feces.

^{a, b, c, d} Means the percentage of index number 0, 1, 2 and 3 of the each diet, respectively.

結論與建議

在離乳仔豬體重與日增重，以餵飼凝膠化保育料較餵飼傳統保育料有較佳之趨勢。在採食量與飼料效率以及血液尿素氮含量方面，以餵飼凝膠化保育料組顯著優於餵飼傳統保育料組。仔豬的下痢發生率，亦以餵飼凝膠化保育料組，發生輕微與中度軟便百分比比較餵飼傳統保育料組低。綜合試驗結果顯示，保育期仔豬運用凝膠化保育料的餵飼方式，具有改善仔豬的生長性能、健全腸道菌相與減少下痢發生率等作用。

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Assessment of gelation of weaner diet on the growth performance, immunoglobulin contents, diarrhea occurrence and the number of fecal microflora of postweaning pigs ⁽¹⁾

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Abstract

The objectives of this experiment was assessed the effect of gelaton of weaner diet and regular weaner diet on growth performance, immunoglobulin content, diarrhea incidence and the number of fecal microbial of postweaning pigs. Experimental animals adopted 26-28 days of age weaning piglets, a total of 24 hd male and female in half, and in accordance with gender and body weight random allocating to 12 pens (1 male 1 female per each pen). Feeding diets had regular weaner diet and gelation of weaner diet (dry matter roughly at 30-35%) for 4 weeks of test period, during the first week, daily at 8:00, 11:00, 14:00 and 17:00 were feeding time, after that piglets were allowed free access to diet. The results showed that in bodyweight and average daily gain fed piglets with gelation of weaner diet had a better tendency than fed pigs with regular weaner diet. In feed intake and feed efficiency and BUN (blood urea nitrogen) concentration of piglets, fed piglets with gelation of weaner diet surpassed fed pigs with regular weaner diet. Diarrhea incidence showed light soft feces and intermediate soft feces of percentage, feeding gelation of weaner diet group was lower than feeding regular weaner diet group. Thus, application of gelation of weaner diet of feeding regime might be used to rear weaning piglets to improve their growth performance and incidence of diarrhea during the weaning period.

Key words: Gelation, Growth performance, Weaner pig.

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