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不同離乳模式對仔豬生長性能之影響 (1)

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摘　要

本試驗旨在探討不同離乳模式對仔豬生長性能的影響。以 48 頭 4 週齡 (藍瑞斯 × 杜洛克) 離乳豬為試驗動物，依體重及性別逢機分為 3 組，每組 4 重複，每 4 頭仔豬關在一欄，分別為對照組 (A 組) 與處理組 (B 與 C 組)。A 組採一階段離乳，即仔豬離乳、併欄混養與轉換攝食保育料於同一天進行；處理組 B 組採二階段離乳：(1) 離乳併欄混養，(2) 離乳後 4 天轉換攝食保育料；處理組 C 組採三階段離乳：(1) 離乳後續攝食教槽料，(2) 離乳後 4 天併欄混養，(3) 離乳後 7 天轉換保育料。試驗為期 4 週，期間每週測定飼料採食量與體重，於第 6 週齡抽血測定血液生化指標，並每日觀察離乳豬下痢情況及記錄。試驗結果顯示，不同離乳模式對仔豬生長性能均無顯著影響。C 組仔豬在 5 週齡時，其生長性能 (平均日增重、採食量及飼料效率等)，顯著地較 A 與 B 組佳 (P < 0.05)。惟 C 組仔豬轉換攝食保育料後，其 5 － 6 週齡採食量則有低於 A 與 B 組的趨勢 (P = 0.06)；平均日增重較 A 與 B 組少 (P < 0.05)；各組間之飼料效率則無顯著差異。不同離乳模式對 7 － 8 週齡仔豬生長性能，於各處理組間均無顯著差異。但以全試驗期間，採用三階段離乳模式可改善離乳初期仔豬的增重。在血液學方面，C 組的嗜中性白血球與淋巴球比值 (NET/LYM) 於 6 週齡時顯著低於 A 與 B 組 (P < 0.05)，顯示三階段離乳可降低離乳仔豬的緊迫壓力。仔豬下痢 (嚴重軟便) 比率介於 0.0 － 7.5% 之間，A 組仔豬於 5 週齡下痢比率最高為 7.5%，顯著高於 B 與 C 組 (P < 0.05)。綜上所述，採用二或三階段離乳模式，可減緩離乳初期仔豬增重不佳的現象。

關鍵詞：離乳豬、離乳模式、生長性能。

緒　言

離乳作業使仔豬同時經歷離乳、環境改變、併欄、社會序位重排與飼料轉換等多重壓力，造成仔豬的緊迫，通常持續 4 到 24 小時 (Lewis and Berry, 2006)，經常造成仔豬於離乳後最初 48 小時內採食量下降甚至未採食 (Brooks *et al.*, 2001)，導致仔豬的生長性能下降。且離乳初期的仔豬較容易罹患疾病，尤其是 20 日齡即早期離乳的仔豬 (Deprez *et al.*, 1986; Smith *et al.*, 2010a)。另一方面，離乳造成的壓力會影響腸道功能完整性 (Smith *et al.*, 2010a; Wijtten *et al.*, 2011)，增加仔豬感染疾病的風險 (Berg, 1995)。飼料中添加抗生素可降低離乳仔豬發生疾病的機率，但抗生素可能使得細菌產生抗藥性 (Smith *et al.*, 2010b)，抗生素的使用已大幅受到限制，進而導致仔豬生產力降低。目前傳統的離乳模式，仔豬離開母豬，並與其它離乳豬混群，移置保育舍，其原有的社會序位遭到破壞，而發生打鬥，以重新建立社會序位。豬離乳時，遭遇多重緊迫因素 (如飼料型態、畜舍、豬群、母乳移行抗體喪失等)，造成仔豬生長性能下降，增加仔豬罹病的機率。本試驗旨在評估不同離乳模式對離乳豬生長性能的影響。

材料與方法

本試驗於行政院農業委員會畜產試驗所產業組的試驗豬舍進行，試驗動物之使用、飼養管理及試驗設計，經畜產試驗所實驗動物管理小組以畜試動字第 110-19 號申請核准在案。

(1) 行政院農業委員會畜產試驗所研究報告第 2713 號。
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試驗動物育成，哺乳豬 (L × D) 於 10 日齡開始給予商用教槽料 (CP 21.4%) 任食，哺乳豬於 28 日齡離乳。選用 48 頭離乳豬為試驗動物，依體重及性別逢機分為對照組 (A 組) 與處理組 (B 與 C 組) 等 3 組。每組 4 重複，每欄 4 頭 (公母各半)，離乳豬飼養於傳統高床保育舍，豬欄面積 2.55 m^2。對照組 (A 組) 採一階段離乳：依現行離乳作業流程進行，仔豬離乳、併欄混養與轉換保育料 (表 1) 等作業於同一天完成；處理 B 組將離乳作業分為二階段 (two-stage weaning)：(1) 離乳與併欄混養 (繼續給飼教槽料)，(2) 離乳後第 4 天轉換為保育料；處理組 C 組將離乳作業分為三階段 (three-stage weaning)：(1) 離乳 (給飼教槽料)，(2) 離乳 4 天後併欄混養 (續給飼教槽料)，(3) 離乳後第 7 天轉換保育料。A、B 與 C 各組離乳豬於四週齡開始試驗時，體重分別為 7.91 ± 0.23、7.90 ± 0.06 與 7.90 ± 0.13 kg/pig (mean ± SE)。試驗為期 4 週，試驗於仔豬 8 週齡結束。試驗期間採任食，每日補充飼料 2 次 (自動餵飼桶)。每週測定仔豬的飼料採食量及體重，於 6 週齡時，豬隻以人工保定後，由頸靜脈採集 3 mL 血液 (全血)，以血液分析儀 (XT-1800i Hematology Analyzer Sysmex Corporation, Co., Japan) 進行血液生化值分析。

表 1. 試驗飼料組成－保育料 (%)

Table 1. The composition of experimental diet – weaning piglets (%)

Ingredients	%
Yellow corn meal	70.05
Soybean meal, CP 43%	20.00
Fish meal, CP 60%	6.00
Soybean oil	1.00
Salt	0.40
Dicalcium phosphate	1.50
Limestone, pulverized	0.70
Choline chloride, 50%	0.10
Vitamin premix[1]	0.10
Mineral premix[2]	0.15
Total	100.00
Calculated ME, kcal / kg	3,215
Analyzed values	
Crude protein, %	16.37
Crude fat, %	3.34
Calcium, %	0.92
Total phosphorus, %	0.62

[1] Vitamin premix provided per kilogram of diet: vitamin A, 9,000 IU; vitamin D_3, 800 IU; vitamin E, 60 IU; vitamin K, 3 mg; vitamin B_1, 3 mg; vitamin B_2, 9 mg; vitamin B_6, 4.5 mg; vitamin B_{12}, 0.045 mg; nicotinic acid, 45 mg; calcium pantothenate, 45 mg; folic acid, 0.9 mg and biotin, 0.3 mg.

[2] Mineral premix provided per kilogram of diet: Cu, 5 mg; Mn, 6 mg; Co, 0.35 mg; Zn, 40 mg; I, 0.2 mg; Se 0.1 mg and Fe, 80 mg.

III. 仔豬下痢比率

參考 Hart and Dobb (1988) 與 Li *et al.* (2018) 的糞便性狀評分方式，於試驗開始後，每日下午記錄評分，糞便評分標準分成 4 級分，分別為「0」表正常成型糞便、「1」表輕微軟便 (糞便不成型)、「2」表中度軟便 (糞便不成型，亦不成堆) 與「3」表嚴重軟便 (拉稀呈糊狀)，分別以 DrI-0、DrI-1、DrI-2 與 DrI-3 表示，仔豬下痢比率之計算式 (Li *et al.*, 2018) 為：

下痢比率 (%)=(下痢仔豬數 × 下痢天數)/(仔豬總數 × 試驗天數)

IV. 統計分析

本試驗採完全隨機設計 (completely randomized design, CRD)，試驗資料使用 SAS 統計套裝軟體 (SAS, 2002)，利用一般線性模式程序 (general linear model procedure) 進行變方分析，若有顯著差異性，再以最小平方平均值 (least squares means) 比較處理組間之差異顯著性。

結果與討論

I. 不同離乳模式對仔豬生長性能的影響

(i) 飼料採食量

仔豬全期及各週齡隻日採食量列於表 2，A、B 及 C 組的仔豬於試驗全期隻日採食量分別為 0.494、0.519 及 0.513 kg，各組間無顯著差異。4 － 5 週齡 (即試驗第 1 週) C 組因仍繼續採食教槽料，其採食量顯著地高於 A 與 B 組 ($P < 0.05$)。顯示 A 組一階段離乳，同時進行離乳、併欄混養與轉換料的仔豬，其隻日採食量，較三階段離乳者減少 60 g，達 19.5% (60/306)；B 組二階段離乳，也較 C 組減少 66 g (21.5 %) 採食量。相對的，5 － 6 週齡期間 C 組 (三階段離乳) 隻日採食量則有低於 A 與 B 組的趨勢 ($P = 0.06$)，C 組 6 週仔豬隻日採食量較 A 組減少 68 g，計 16.3% (68/416)；也較 B 組減少 46 g。由於 C 組於 5 － 6 週齡採食量顯著地下降，顯示除了併欄壓力外，轉換為保育料也造成仔豬採食量下降。然而試驗全期生長性能，各處理間無顯著差異。

表 2. 不同離乳模式對離乳仔豬生長性能之影響

Table 2. Effect of weaning procedures on growth performances of LD piglets

Treatment	A	B	C
Weaning	One-stage	Two-stage	Three-stage
	Feed intake (kg/piglet/day)		
4-5-wk-old	0.246 ± 0.023[b*]	0.240 ± 0.009[b]	0.306 ± 0.005[a]
5-6-wk-old	0.416 ± 0.043	0.394 ± 0.031	0.348 ± 0.055
6-7-wk-old	0.559 ± 0.057	0.582 ± 0.040	0.560 ± 0.059
7-8-wk-old	0.801 ± 0.051	0.861 ± 0.036	0.837 ± 0.054
Whole period	0.494 ± 0.038	0.519 ± 0.024	0.513 ± 0.038
	Body weight gain (kg/piglet/day)		
4-5-wk-old	0.077 ± 0.014[c]	0.122 ± 0.024[b]	0.230 ± 0.025[a]
5-6-wk-old	0.255 ± 0.058[a]	0.260 ± 0.020[a]	0.177 ± 0.041[b]
6-7-wk-old	0.251 ± 0.042	0.277 ± 0.054	0.247 ± 0.074
7-8-wk-old	0.479 ± 0.044	0.508 ± 0.042	0.507 ± 0.019
Whole period	0.266 ± 0.023	0.292 ± 0.017	0.290 ± 0.022
	Feed efficiency (Feed intake / Body weight gain)		
4-5-wk-old	3.294 ± 0.976[a]	2.019 ± 0.393[b]	1.342 ± 0.146[b]
5-6-wk-old	1.701 ± 0.479	1.526 ± 0.208	2.060 ± 0.591
6-7-wk-old	2.281 ± 0.461	2.146 ± 0.296	1.925± 1.212
7-8-wk-old	1.678 ± 0.145	1.705 ± 0.192	1.655 ± 0.120
Whole period	1.928 ± 0.303	1.785 ± 0.143	1.763 ± 0.223

[a, b] Means in the same row with different superscripts differ significantly ($P < 0.05$).

[*] Mean ± SE.

Group A was one-stage weaning: pigs were moved away from sow, piglets grouping and feed change on the same day.

Group B was two-stage weaning: (1) pigs were moved away from sow and grouping piglets on first day, and (2) feed change on the 4th day after weaning.

Group C was three-stage weaning: (1) pigs were moved away from sow on first day, (2) grouping piglets on the 4th day after weaning, and (3) feed change on the 7th day after weaning.

Dunshea *et al.* (2002) 指出早期離乳仔豬使用含初乳粉與動物性蛋白質來源的飼糧與使用含冷凍乾燥豬血漿粉餵飼者，生長性能相似，但在飼糧中加入大豆粕則導致生長性能較差。Williams (2003) 指出，為維持離乳仔豬高採食量與生長性能，應採用分階段餵飼計畫餵飼。

(ii) 仔豬增重

A、B 及 C 各組仔豬，於試驗全期隻日增重分別為 0.266、0.292 及 0.290 kg，各組間無顯著差異。4 － 5 週齡時三組仔豬日增重依序為 0.077、0.122 及 0.230 kg，C 組的日增重顯著高於 A 與 B 組 ($P < 0.05$)，且 B 組增重顯著高於 A 組 ($P < 0.05$)，A 組分別為 B 與 C 組的 63.1 與 33.5%。C 組採三階段離乳，在離乳及併欄時餵飼教槽料，在離乳後第 7 天才將教槽料轉換為保育料，其 5 － 6 週齡的日增重為 0.177 kg，顯著低於 A 與 B 組的 0.255 與 0.260 kg ($P < 0.05$)。顯示二與三階段離乳可改善 4 － 5 週齡仔豬的增重。雖然三階段離乳 (C 組) 於 6 週齡因轉換使用保育料造成增重下降，就整體而言，二與三階段離乳依然可緩和離乳後第一週增重不佳的情形。

離乳作業使仔豬突然同時面臨多重壓力，導致飼料採食量下降、採食量不穩定、增重不佳、腹瀉、高發病率及死亡率增加 (Pluske *et al.*, 1997)。Tokach *et al.* (1992) 指出離乳豬於離乳後的發育會影響豬隻上市的時間，相較於離乳後 7 － 10 天日增重 250 g 的豬，此期間體重如未增加的仔豬，其上市天數延後 10 天，因此仔豬離乳後的營養和管理作業，主要針對鼓勵快速恢復採食為方向。本試驗一階段離乳 (A 組) 於 4 － 5 週齡的日增重為 0.077 kg 為各組最低，8 週齡試驗結束時，A、B 及 C 組的體重分別為 15.58 ± 0.82、16.31 ± 0.52 及 16.28 ± 0.58 kg，三組中仍以一階段離乳仔豬 (A) 組體重有較輕的趨勢 ($P = 0.06$)。

(iii) 飼料效率 (F/G)

A、B 及 C 組的全期仔豬之飼料效率分別為 1.928、1.785 及 1.780，各組間無顯著差異，各組 4 － 5 週齡飼料效率依序為 3.294、2.019 及 1.342，B 與 C 組顯著優於 A 組 ($P < 0.05$)，6 至 8 週齡各組間的飼料效率均無顯著差異。5 週齡後已回復攝食相同保育料，C 組因改變飼料而飼效降低，然於 7 週齡後，B 與 C 組飼料效率均較 A 組為佳。由 5 － 8 週齡飼料效率顯示 B 與 C 處理組均較 A 組為佳。顯示採取二或三階段離乳，提升 5 週齡仔豬的增重，同時改善 4 － 5 週齡仔豬的飼料效率。

Collins *et al.* (2017) 的試驗顯示，仔豬離乳後 6 天內，給飼為經熟化處理穀物及乳製品原料組 (使用熟化穀物、脫脂乳粉及菜籽油)，其增重高於給飼為一般玉米－大豆粕 (菜籽粕) 飼糧 (使用未熟化穀物、大豆粕及牛油) 者，飼料利用率亦較佳。本試驗也有類似的結果，二與三階段離乳 4 － 5 週齡給飼或部分給予高消化率教槽料 (使用商用教槽料，含脫乳乳粉)，提升 4 － 5 週齡仔豬的增重，同時改善飼料效率。

II. 不同離乳模式對仔豬血液生化值的影響

仔豬於 6 週齡時，各組的血液生化分析值如表 3，各組間之各檢測項目均介於 Ježek *et al.* (2018) 的參考值範圍內，顯示各項檢測值均在一般可接受範圍內。C 組的嗜中性白血球 (neutrophil, NET) 百分比顯著低於 A 與 B 組 ($P < 0.05$)，相對的，C 組的淋巴球 (lymphocyte, LYM) 百分比顯著高於 A 與 B 組 ($P < 0.05$)，造成 C 組的嗜中性白血球與淋巴球比值 (NET/LYM) 顯著低於 A 與 B 組 ($P < 0.05$)。Quiñonero *et al.* (2009) 指出，緊迫因子造成母豬血液中 NET/LYM 比值的增加，本試驗三階段離乳仔豬 (C 組) 的 NET/LYM 比值顯著較 A 與 B 組為低，推測三階段離乳可降低仔豬於 6 週齡時的緊迫壓力。

III. 不同離乳模式對仔豬下痢的影響

各組各週齡仔豬嚴重下痢 (嚴重軟便拉稀呈糊狀，DrI-3) 比率介於 0.0 － 7.5% 之間 (表 4)。A 組前 3 週 (5 － 7 週齡) 仔豬下痢比率，相對地高，比率介於 4.2 － 7.5%，以 5 週齡最高為 7.5%，顯著高於其它 2 組 ($P < 0.05$)，顯示二與三階段離乳可降低仔豬離乳初期下痢比率。試驗期間 B 及 C 組下痢情形較少，而試驗全期生長性能，各處理間無顯著差異。

豬的小腸粘膜在其一生中經歷二次形態學變化，首先是仔豬出生時，小腸結構功能不健全，主要攝取乳汁，以易於消化的乳糖、乳脂和乳蛋白形式提供營養物及免疫蛋白，小腸結構隨著日齡增加改變。離乳後，液態乳轉變成固體飼料，對仔豬是一很大的緊迫 (Oostindjer *et al.*, 2010)，另離乳仔豬被毛稀疏，皮下脂肪薄，大腦皮層發育尚不健全，各器官系統的調節能力差，離乳仔豬的保溫溫度為 25 － 28℃，風速 0.5 － 0.7 m/sec，仔豬對冷 (較低溫度) 較敏感，但如長時間溫度超過 30℃，仍會造成熱緊迫影響。腸道微生物系統失衡，哺乳仔豬腸道微生物主要來自母豬陰道、糞便以及環境中的微生物，腸道中以乳酸桿菌為主，而離乳後仔豬胃酸分泌不足，消化酶分泌不足及腸粘膜受損等原因，導致大腸桿菌、鏈球菌及腸桿菌等有害菌大量繁殖，造成腸道微生物態失調 (D'Eath, 2005; Mu *et al.*, 2019)。

表 3. 不同離乳模式對 6 週齡保育仔豬血液生化值之影響

Table 3. Effect of weaning procedures on hematological profile of piglets at 6-wk of age

Treatment	A	B	C	Ježek et al. (2018)
Weaning	One-stage	Two-stage	Three-stage	Reference ranges (7-14 wk-old)
No.	16	15	16	
RBC, 10^{12} cell/μL	6.71 ± 0.15*	6.81 ± 0.19	7.06 ± 0.40	5.40 — 7.28
WBC, 10^{9} cell/μL	21.42 ± 1.94	18.94 ± 1.40	18.61 ± 2.53	13.70 — 34.12
PLT, 10^{3}/μL	502.44 ± 35.06	496.75 ± 53.39	463.94 ± 42.07	273 — 730
NET, %	39.33 ± 2.97[a]	39.31 ± 5.89[a]	30.09 ± 3.30[b]	30 — 71
LYM, %	54.78 ± 3.82[a]	54.59 ± 5.19[a]	62.95 ± 3.44[b]	22 — 69
MON, %	4.76 ± 0.90	5.11 ± 1.03	6.06 ± 1.17	0 — 7
EOS, %	0.84 ± 0.24	0.71 ± 0.23	0.60 ± 0.14	0 — 9
BASO, %	0.29 ± 0.02	0.28 ± 0.07	0.30 ± 0.05	0 — 2
Hgb, gm%	11.83 ± 0.44	11.98 ± 0.21	12.45 ± 0.95	9.2 — 12.5
Hct, %	41.42 ± 2.09	41.99 ± 0.88	43.34 ± 3.37	28.0 — 41.7
MCV, fL	61.74 ± 2.30	61.74 ± 0.41	61.35 ± 1.64	47.7 — 63.0
MCH, pg	17.66 ± 0.51	17.62 ± 0.29	17.63 ± 0.38	14.0 — 18.5
MCHC, g/dL	28.62 ± 0.48	28.53 ± 0.32	28.74 ± 0.48	28.8 — 33.5
NET/LYM	0.72 ± 0.11[a]	0.73 ± 0.19[a]	0.48 ± 0.08[b]	—

[a, b] Means in the same row with different superscripts differ significantly ($P < 0.05$).

* Mean ± SE.

RBC: red blood cells; WBC: white blood cells; PLT: platelets; NET: neutrophils; LYM: lymphocytes; MON: mononuclear balls; EOS: eosinophilic white blood cells; BASO: basophilic white blood cells; Hgb: hemoglobin; Hct: hematocrit; MCV: mean corpuscular cell volume; MCH: mean corpuscular hemoglobin; MCHC: mean corpuscular cell hemoglobin concentration.

Group A was one-stage weaning: pigs were moved away from sow, piglets grouping and feed change on the same day.

Group B was two-stage weaning: (1) pigs were moved away from sow and grouping piglets on first day, and (2) feed change on the 4th day after weaning.

Group C was three-stage weaning: (1) pigs were moved away from sow on first day, (2) grouping piglets on the 4th day after weaning, and (3) feed change on the 7th day after weaning.

表 4. 不同離乳模式對仔豬下痢比率之影響

Table 4. Effect of weaning procédures on diarrhea rating of piglets

Treatment	The percentage of diarrhea (DrI-3)			
	5-wk-old	6-wk-old	7-wk-old	8-wk-old
A	7.5 ± 2.9[a]	4.2 ± 4.8	6.3 ± 0.0	2.1 ± 4.2
B	2.5 ± 2.9[b]	4.2 ± 4.8	3.1 ± 6.3	0.0 ± 0.0
C	0.0 ± 0.0[b]	2.1 ± 4.2	3.1 ± 6.3	0.0 ± 0.0

[a, b] Means in the same column with different superscripts differ significantly ($P < 0.05$).

Group A was one-stage weaning: pigs were moved away from sow, piglets grouping and feed change on the same day.

Group B was two-stage weaning: (1) pigs were moved away from sow and grouping piglets on first day, and (2) feed change on the 4th day after weaning.

Group C was three-stage weaning: (1) pigs were moved away from sow on first day, (2) grouping piglets on the 4th day after weaning, and (3) feed change on the 7th day after weaning.

結　論

本試驗採用的二或三階段離乳，可減少離乳仔豬下痢的發生，同時改善離乳初期仔豬增重不佳的情形，但依然會出現轉換飼料的負面效應，就整體而言，二或三階段離乳可緩和離乳後初期仔豬增重不佳的現象。

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Effect of different weaning procedures on the growth performance of the weaned piglets (1)

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Abstract

The purpose this study was to evaluate the effect of different weaning procedures on the growth performance of weaned piglets. A total of 48 weaned piglets (Landrace × Duroc), 4-week-old, were randomly divided into 3 groups by gender and body weight. Group A was conducting one-stage weaning: piglets were moved away from sow, grouping and provided weaning diet on the same day. Group B involved two-stage weaning: (1) moving away from sow and grouping on the first day, and (2) weaning feed was provided on the 4th day after weaning. Group C involved three-stage weaning: (1) away from sow on the first day, (2) grouping on the 4th day after weaning and (3) weaning feed was provided on the 7th day after weaning. During 4 weeks experiment, the feed intake, body weight and hematological profile were measured, and the diarrhea of the piglets was recorded. The result showed that there were no significant differences on growth performance of piglets among group A, B and C, throughout the whole period. On the 5-week-old, growth performance (body weight, feed intake and feed efficiency) of group C was significantly higher than group A and B ($P < 0.05$). However, for the 6-week-old, feed intake of group C, tended to be lower than group A and B ($P = 0.06$). Moreover, the 6-week-old, daily weight gain of group C was significantly ($P < 0.05$) lower than A and B groups and the feed intake was not different among groups at 6-weeks of age. The results showed that the two-stage or three-stage weaning procedures increased body weight gain of piglets at 5 week of age. Although the negative effect of changing diet (group C) on feed intake and body weight gain appeared at 6 weeks, it also can increase the poor body weight in the early stage after weaning. There was no significant difference on feed intake, weight gain and feed efficiency for 7- and 8-week-old piglets between the three groups. In hematological profile, the ratio of neutrophils to lymphocytes (NET/LYM) of group C was significantly ($P < 0.05$) lower than groups A and B, indicating that three-stage weaning can reduce the stress of weaned piglets at 6-weeks of age. The rate of diarrhea (severe soft feces) of piglets at each group was between 0.0 and 7.5%, and the highest ratio was 7.5% at 5-week-old of group A, which was significantly ($P <0.05$) lower than group B and C. In conclusion, the two- or three- stage weaning procedures can improve the poor body weight gain of piglets in the early stage of postweaning.

Key words: Weaned piglet, weaning procedure, Growth performance.

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