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Effect of weaning age on growth performance of crossbred pigs reared up to 70 kg body weight under intensive system

Theresa Theresia Montsho, John Cassius Moreki*, Christopher Mareledi Tsopito and Shalaulani James Nsoso

Department of Animal Science and Production, Botswana University of Agriculture and Natural Resources, Private Bag 0027, Gaborone, Botswana.

*Corresponding author. Email: jcmoreki@gmail.com

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ABSTRACT: This study investigated the effect of weaning age on growth performance of crossbred piglets reared up to 70 kg body weight (BW) under intensive system from May to November 2013. The experiment was conducted in a completely randomized design where weaner pigs were randomly allocated to three weaning ages (treatment) of 21, 28 and 35 days. Each treatment had 16 weaner pigs with four replicates (pen) each having four pigs of equal sex. The study was divided into three rearing periods: weaning phase (WP) (weaning to 70 days), grow to finish period (GFP) (70 days to 70 kg BW) and wean to finish period (WFP) (weaning to 70 kg BW). The growth parameters studied were BW, average daily gain (ADG), average daily feed intake (ADFI), feed conversion ratio (FCR) and days on test. Data were analysed using General Linear Model Procedures of Statistical Analysis System. The results showed that BW for piglets weaned at 21 days of age was significantly ($P<0.05$) lower (17.93 ± 0.69 kg) than that of piglets weaned at 28 days (21.57 ± 0.78 kg) but similar to piglets weaned at 35 days (19.34 ± 0.78 kg) which was intermediate during WP. Piglets weaned at 21 days of age had significantly lower ADG (0.267 ± 0.01 kg), ADFI (0.651 ± 0.01 kg) and higher FCR (2.56 ± 0.12) than piglets weaned at 28 and 35 days of age at the end of WP. Average daily gain (0.884 ± 0.02 kg), ADFI (2.31 ± 0.02 kg) and days on test (57 ± 2) significantly improved during GFP with respect to 21 day weaned group compared to 28 and 35 days groups. All the measured parameters did not significantly vary during WFP. Generally, weaning age had no effect on growth performance of piglets weaned at 21, 28 and 35 days of age suggesting that piglets can be weaned at these periods without adversely affecting growth performance. It is therefore recommended that further studies can be conducted to evaluate the effect of weaning age on the reproductive performance of the sows and profitability of the three weaning ages.

Key words: Average daily gain, feed conversion ratio, feed intake, grow to finish period, growth performance, pigs, wean to finish period, weaning age.

Introduction

The age at which piglets are weaned depends on sow productivity, herd health, pig performance and profitability of pig operations (Smith et al., 2006). According to Main et al. (2004), weaning age is determined by the number of sows farrowed in a week and the space available for the nursing sows. Early weaning is associated with high standard of management practices compared to late weaning (Worobec, 1997). In commercial pig operations, piglets can be weaned early from 10 to 21 days of age (Fangman and Tubbs, 1997) or late from 28 to 56 days of

age (Dunshea et al., 2003; Narayanan et al., 2008).

Early weaning improves body weight (BW) during the weaning phase (WP) (Drizt et al. (1996a). The improvement in BW is due to limited transfer of pathogens from the sow to the weaner pigs. The disadvantages of early weaning are low average daily gain (ADG), average daily feed intake (ADFI) and BW during weaning phase (WP) (van der Meulen et al., 2010). In addition, Main et al. (2005) reported high postweaning mortality rates in early weaned piglets than late weaned piglets. Previous study of Collins et al. (2009) showed that weaning age has no effect on ADG, ADFI and BW during WP, grow to finish period (GFP) and wean to finish period (WFP). According to Dritz et al. (1996b), the influence of weaning age is observed immediately postweaning but has no effect on WFP. Piglets that are weaned early compensate for their slow growth during GFP (Udomprasert, 2001). On the contrary, early weaning has negative long term effects on BW, ADG, ADFI and feed conversion ratio (FCR) (Main et al., 2005) and negative economic effects on the pig production enterprise (Hameister et al., 2010) due to expensive high quality diets (Richert et al., 1996).

Late weaning reduces postweaning growth check (Leibbrandt et al., 1975), BW variation (Main et al., 2004), development of behavioural patterns (Worobec et al., 1999), villous atrophy and ileal permeability **(**McLamb et al**.,** 2013.), improves gastrointestinal morphology and function (Gu et al., 2010), increases pathogen pressure (de Grau et al., 2005) and health costs (Hameister et al., 2010).

No studies have been conducted in Botswana to investigate the effect of weaning age on growth performance of pigs reared up to 70 kg BW under intensive system despite its importance in the performance of pig enterprise. Therefore, this study was undertaken to investigate the effect of weaning age on growth performance of crossbred pigs reared up to 70 kg BW under intensive system.

MATERIALS AND METHODS

Experimental site

The experimental site was Chemae Piggery farm in Mmatshipa lands at Matebele in Kgatleng district of Botswana. The farm is situated at 24^0 32′ 54.12″S, 26^0 1′ 3.55″E and at an elevation of 980.200 metres above sea level. The experiment started in May 2013 through mid-November 2013. The minimum and maximum temperatures from May to July 2013 (i.e., winter) were -5.0 ^oC and 21.0 ^oC respectively. From August to November 2013 the minimum temperatures (i.e., summer) were 18.0 ^oC and 32.0 ^oC respectively.

Experimental design

Forty eight weaner pigs (Landrace × Large white × Topigs × Topigs cross) were used in this experiment. The experiment was conducted in a completely randomized design (CRD) where weaner pigs were randomly allocated to three weaning ages (treatments), i.e., 21 days, 28 days and 35 days. Each treatment had 16 weaner pigs with four replicates (pen) each having four weaner pigs. The number of females and males in each replicate was equal.

Animal management

Piglets were farrowed by seven primiparous sows in May 2013. Docking and teeth clipping were carried out immediately after farrowing. Piglets were injected with one millimetre (ml) alfafer (200 mg elemental iron per ml) intramuscularly three days postfarrowing to prevent piglet anaemia. All male piglets were castrated at seven days of age (Smith et al., 2008) using open castration method. The open wounds were dressed with Supona aerosol (chlorfenivos 0.48% m/m, dichlorovos 0.74% m/m and gentian violet 0.145% m/m).

Each pen measuring 2.2 × 2.2 m was naturally ventilated and housed four weaner pigs. Weaner pigs were reared in pens with complete solid concrete floors equipped with long feeding troughs and drinking nipples. Wheat straw was used as bedding and was covered at a depth of 15 cm (Li and Johnston, 2009). The pig house was covered with a curtain (black polythene sheet or sacks) from the roof down to the dwarf walls to protect the pigs from cold during winter. Charcoal and fire wood burnt in a perforated drum (locally known as mbaula) was used to supply heat to weaners of all age groups during winter. Daily house temperatures were monitored throughout the experimental period. Curtains were physically raised when pig house temperatures increased and pulled down as temperatures decreased.

Pig pens were cleaned and disinfected with VIROCID® solution (alkyldimethylbenzalkonium chloride gluteraldehyde) seven days prior to the arrival of weaner pigs. Pens were cleaned twice daily (i.e., in the morning and afternoon) before feeding. A footbath solution was prepared from VIROCID® solution and replenished as necessary. Flies in the pens were controlled with Aromac fly bait powder (animal protein) while scientific super kill rodent bait (bromadiolone 0.05 g/kg) was used to kill rodents. Biosecurity procedures were followed as described by Fangman and Tubbs (1997) and Seaman and Fangman (2001). Piglets were all identified using ear tags at weaning, weighed at 21 days of age and their individual weights recorded. Weaners were also weighed individually at weaning and thereafter weekly until slaughter at 70 kg BW.

On arrival at Chemae Piggery Farm weaner pigs were dipped with 2% triatix® pig pours on (amitraz 2% m/v) per BW basis and dewormed with piperazine (piperazine adipate 100%) per feed weight basis. Ecomectin 1% injectable solution (ivermectin 1% m/v) was administered subcutaneously to control susceptible internal and external parasites after 10 days of administering triatix® 2% pig pour on. In addition, Hipraminchok P (amino acids and vitamins) was administered in water for five consecutive days as a stress depressant, production stimulant and to prevent vitamin deficiency. Weaner pigs that showed signs of diarrhoea during the first week of the experiment were treated with Cosumix Plus® (trimethoprim).

Feeding management

All age groups were fed commercial pig diets (creep, weaner and grower). Feed and water were provided *ad libitum* throughout the experimental period. The feeding of all age groups was in accordance with Botswana standard for pig feeds (BOS 190, 2006). Creep diet was introduced to piglets of all age groups from 10 to 35 days of age. Thereafter, all age groups were fed weaner diet from 36th to 70th day and grower diet from 71st day up to 70 kg slaughter weight.

The nutrient composition of commercial pig diets was analysed using the proximate analysis procedures to determine moisture, crude protein, crude fibre, fat contents, phosphorus and calcium [Official Methods of Association of Analytical Chemists (AOAC), 1996]. The nutrient composition of the commercial pig diets is presented in Table 1.

Data collection

The period from weaning to 70 days of age was considered as the WP (European Commission Directive, 2009) while GFP was from 70 days of age up to 70 kg slaughter weight. The WFP was from weaning (21, 28 and 35 days) to 70 kg BW. Individual BW of weaner pigs was recorded and weights measured weekly before feeding using a pig and sheep platform scale (Kattleway, AGFAB Services PTY Ltd). The final BW was recorded at the end of the experiment. Average BW was determined by dividing the total weight of pigs by the number of pigs. Body weight gain (BWG) was measured as the difference between the final and initial BW (Onyimonyi and Okeke, 2007). Average daily gain was calculated as the ratio between BWG and feeding days. Feed was weighed on daily basis before feeding using Mettler Tolido, (PS7) digital scale with a precision of 0.1 g. Unconsumed feed was collected and weighed daily (Onyimonyi et al., 2010; Njoku et al., 2012). Average daily feed intake was calculated by dividing total feed consumed in a given period by the number of pigs fed daily (Onyimonyi et al., 2010; Njoku et al., 2012), whereas FCR was calculated as the proportion of total feed consumed in relation to BWG (Onyimonyi and Okeke, 2007). Days on test was calculated as the ratio between BWG and ADG.

Statistical analysis

Data were analysed using General Linear Model procedures in Statistical Analysis System (SAS), version 9. 2 (SAS Institute Inc., 2003).

The model was fitted as $Y_{ij} = \mu + \tau_i + e_{ij}$

Where: Y_{ij} = response variable (Average daily feed intake, body weight, average daily and feed conversion ratio)
μ = general mean effect
$\tau_{i=i}^{th}$ age effect, where i= 1, 2, 3 (21 days , 28 days , 35 days)
$e_{ij=}$ random error
The reported least squares means were separated using PDIFF at 5% level of significance.

RESULTS AND DISCUSSION

Body weight

Piglets weaned at 21 days of age had significantly ($P<0.05$) lower final BW during the wean rearing period than those weaned at 28 days of age but did not differ ($P>0.05$) from those weaned at 35 days of age which was intermediate (Table 2). The lower BW found in piglets weaned at 21 days of age could be associated with under-developed gastrointestinal tract (GIT) which probably was unable to efficiently digest and utilize solid creep diet for growth. The solid diet might have caused severe irritation of the mucosal lining of the GIT resulting in mild diarrhoea, which was observed during the first week of feeding creep diet postweaning compared to other age groups. Early weaned piglets have an under-developed immune system (Niekamp et al., 2007) while decreasing weaning age increases the incidence of diarrhoea (Dunshea et al., 2002). Similarly, Fangman et al. (1996) weaned piglets at 13 and 21 days of age and found that piglets weaned at 13 days of age had significantly lower BW than those weaned at 21 days of age 42 days postweaning.

As shown in Table 2, there were no weaning age effects on BW among age groups GFP. Similarly, Narayanan et al. (2008) compared piglets weaned at 28 and 56 days of age and found no significant differences in BW. However, Main et al. (2004) found that final BW and of GFP increased with increasing weaning age (12,

Table 1. Nutrient composition of diets fed to Landrace × Large white × Topigs × Topigs cross pigs reared up to 70 kg body weight under intensive system.

Diet composition	Creep		Weaner		Grower	
	Min	Max	Min	Max	Min	Max
Metabolisable energy, MJ/kg	12.5	-	12.5	-	12.5	-
Crude protein	20.00	-	18.00	-	16.00	-
Moisture	-	12.00	-	12.00	-	12.00
Crude fat	2.50	-	2.50	-	2.50	-
Crude fibre	-	6.00		6.00	-	6.00
Calcium	0.90	1.30	0.85	1.0	0.8	1.0
Available Phosphorus	0.50	-	0.40	-	0.40	-
Lysine	0.8	-	1.24	-	1.08	-

BOS 190, 2006. **Min,** minimum; **max**, maximum.

15, 18 and 21 days). The difference between the results of the study by Main et al. (2004) and the current results is due to different ranges of weaning age. Dunshea et al. (2003) and de Grau et al. (2005) suggested that pigs with high weaning weights are able to cope with solids better postweaning than those with low weaning weights. Furthermore, de Passille et al. (1989) found that piglets with high BW had a higher level of digestive enzyme activity than those with low BW at 21 days of age. Mahan and Lepine (1991) weaned piglets at 21 days of age and found that final BW increased with increasing weaning weight. In addition, heavy piglets (7.3 to 8.6 kg) at weaning reached final BW 15 days earlier than light piglets (4.1 to 5.0 kg).

Average daily gain

Piglets weaned at 21 days of age had significantly ($p<0.05$) lower ADG (0.267 ± 0.01 kg) than those weaned at 28 and 35 days of age (0.433 ± 0.02 and 0.434 ± 0.02 kg) respectively which were similar during the weaner rearing period (Table 2). Piglets weaned at 21 days grew slowly because they suffered a severe postweaning growth lag seven days post-weaning compared to those weaned at 28 and 35 days of age which suffered less severe postweaning growth lag. Shields et al. (1980) and Lindemann et al. (1986) reported that piglets weaned early experienced a severe postweaning growth lag than those weaned late. Previous study by Lecce et al. (1979) reported that slow growth rate occurred due to low ADFI during the postweaning growth lag period. The results of the current study are in agreement with Kornegay et al. (1979) and Leviveld et al. (2013) who weaned piglets at 15 to 21 and 19 to 35 days of age and found that weaning early decreased ADG. In disagreement with the current results, piglets weaned at 10 days of age had higher ADG than those weaned at 30 days of age 42 days postweaning during weaner rearing period (Hohenshell et al., 2000). The differences in the results between the study by Hohenshell et al. (2000) and the current study are due to breed differences, physical form of diet, composition of diet and feeding regime which was practiced on the early weaned piglets. Hohenshell et al. (2000) used a faster growing breed (Large white × Landrace × Hampshire × Duroc) than the breed used in the current study. Feeding milk pellet diets with additives (antibiotics) improved ADG in the early weaned piglets in the study by Hohenshell et al. (2000) while feeding creep meal without milk ingredient and additives limited early weaned piglets from growing faster than late weaned piglets in the current study. Creep feed is not a basal diet but a supplementary diet to milk and therefore diets of early weaned piglets should be formulated to substitute the sow's milk.

Piglets weaned at 21 days of age had significantly higher ADG than those weaned at 28 and 35 days of age which did not differ from each other during GFP (Table 2). Furthermore, piglets weaned at 21 days of age recovered from postweaning growth lag earlier and grew faster than those weaned at 28 and 35 days of age. Piglets weaned at 21 days of age compensated growth during grow to finish rearing period due to higher growth rate than other age groups. Shields et al. (1980) and Lindemann et al. (1986) observed that piglets that are weaned early recover from postweaning growth lag faster than those weaned late. The present results are in agreement with Dunshea et al. (2001) who found that piglets weaned at 17 days of age grew faster than those weaned at 25 days of age during finish rearing period. Main et al. (2004) carried out two trials to determine the effects of weaning age on pig performance in a multisite production system and found that increasing weaning age increased ADG and tended to decrease mortality in the initial 42 days weaning. Finishing ADG also improved with increasing age. The authors concluded that increasing weaning age up to 21.5 days can be an effective management strategy to improve wean to finish

Table 2: Effect of weaning age on weaner grow to finish phase and wean to finish period in Landrace × Large white × Topigs × Topigs cross reared up to 70 kg body weight under intensive system

Parameter	Weaning age (days)		
	21	28	35
Weaner rearing period			
Initial body weight (kg)	4.50±0.70	4.30±0.70	4.30±0.70
Final body weight (kg)	17.93±0.69[a]	21.57±0.78[b]	19.34±0.78[ab]
Average daily gain (kg)	0.267±0.01[a]	0.433±0.02[b]	0.434±0.02[b]
Average daily feed intake (kg)	0.651±0.01[a]	0.704±0.01[b]	0.728±0.01[b]
Feed conversion ratio	2.56±0.12[a]	1.74±0.11[b]	1.75±0.11[b]
Grow to finish rearing period			
Final body weight (kg)	71.54±0.37	70.75±0.32	70.62±0.32
Average daily gain (kg)	0.884±0.02[a]	0.744±0.02[b]	0.807±0.02[b]
Average daily feed intake (kg)	2.31±0.02[a]	2.06±0.02[b]	2.12±0.02[b]
Feed conversion ratio	2.63±0.05	2.70±0.05	2.64±0.06
Days on test	57±2[a]	69 ±2[b]	67±2[b]
Wean to finish rearing period			
Average daily gain (kg)	0.621±0.01	0.629±0.01	0.661±0.01
Average daily feed intake (kg)	1.57±0.01	1.54±0.02	1.61±0.01
Feed conversion ratio	2.58±0.06	2.45±0.06	2.45±0.06
Days on test	110±2	107±2	102±2

[a,b] Means (±SE) within a row with different superscripts are significantly (P<0.05) different.

growth performance in multisite pig production.

Weaning age had no influence on ADG in piglets weaned at 21, 28 and 35 days of age during wean to finish rearing period (Table 2). The current results are consistent with Dunshea et al. (2001) and Partanen et al. (2007) who found no difference in ADG between piglets weaned at 17 to 26 and 25 to 35 days of age during WFP. In disagreement with these results, Main et al. (2004) found that increasing weaning age improved wean to finish ADG. The differences between the results of the current study and those of Main et al. (2004) may be due to weaning age and weight. Mahan and Lepine (1991) weaned piglets at 21 days of age and reported that ADG increased with increasing weaning weight. The current results are slightly lower than those of Mahan and Lepine (1991) probably due to low weaning weights. Cabrera et al. (2010) also reported that piglets that are heavy at weaning grow faster than light weight piglets.

Average daily feed intake

Piglets weaned at 21 days of age had significantly lower ADFI compared to those weaned at 28 and 35 days age which were similar during weaner rearing period (Table 2). The lower ADFI observed in piglets weaned at 21 days of age may be associated with immature GIT. The GIT undergoes morphological and physiological changes at weaning (Miller et al. 1986) which are more pronounced at 21 days than other ages in the current study resulting in insufficient production of enzymes and absorptive capacity of the small intestines due to low ADFI (Amstrong and Clawson, 1980; Cera et al., 1988). Jin et al. (1998) and Weary et al. (2008) observed that transition from a liquid (i.e., sow's milk) to a less palatable and digestible pre-starter diet decreases ADFI. The change of diet in early weaned piglets reduces production of hydrochloric acid in the stomach and this may result in high pH which may favour the multiplication of microorganisms causing diarrhoea and low ADFI (Vondruskova et al., 2010). Similarly, Patience et al. (2000), Dunshea et al. (2002) and Baas et al. (2007) found that piglets weaned at 21 to 24 days of age had higher ADFI compared to those weaned at 12 to 18.9 days of age. In disagreement with the current results, Morrison et al. (2008) and Collins et al. (2013) found that piglets weaned at 22 days of age consumed more feed than those weaned at 29 days of age during WP**.** The current finding on ADFI differs from values found by Morrison et al. (2008) and Collins et al. (2013) because pigs reared in the present study were fed diets that were low in crude protein (20 to 18%), whereas pigs in the study by Morrison et al. (2008) and Collins et al. (2013) were fed diets that had high crude protein (20.54 to 24.01%).

Piglets weaned at 21 days of age significantly consumed more feed than those weaned at 28 and 35 days of age which were similar during GFP (Table 2). This response is due to fact that early weaned piglets had adapted more to a solid diet compared to weaner rearing period. The current results are inconsistent with Morrison et al. (2008) who found no significant difference on ADFI between early and late weaned piglets.

Average daily feed intake was not significantly different for age groups during WFP (Table 2). The present result is in agreement with Drizt et al. (1996b) who found no significant differences in ADFI between piglets weaned at 9 and 19 days of age during wean to finish rearing period. On the contrary, Dunshea et al. (2003) found that piglets weaned at 28 days of age consumed significantly more feed than those weaned at 14 days of age during wean to finish rearing period. The differences between the current results and those of Dunshea et al. (2003) may be ascribable to weaning age ranges.

Feed conversion ratio

Feed conversion ratio was significantly high for piglets weaned at 21 days of age compared to other age groups (28 and 35 days) which were not significantly different from each other during weaner rearing period (Table 2). This suggests that piglets weaned at 21 days of age utilised feed less efficiently than those weaned at 28 and 35 days of age. Higher FCR could be associated with ability to digest solid feed that possibly resulted in low feed intake due to inappropriate diet composition for their age. In agreement with the current findings, Leviveld et al. (2013) weaned piglets at 21, 28 and 35 days and found that increasing weaning age improved FCR from weaning to 70 days. However, the current results disagreed with Bonnette et al. (1990), Baas et al. (2007) and Smith et al. (2008) who found that increasing weaning age from 15 to 35 days does not improve FCR during weaner rearing period. The disagreement could be attributed to the type of housing, breed and physical form of diet. The study by Wondra et al. (1995) showed that feeding pelleted diets improves FCR by 7% than feeding mash diets immediately postweaning as heat treatment during pelleting increases nutrient and energy digestibility by 5 to 8%.

No significant effects of weaning age on FCR during grow to finish and wean to rearing periods was observed (Table 2). These results are in agreement with Dritz et al. (1996b) and Partanen et al. (2007) who found no significant differences in FCR between early and late weaned piglets during grow to finish and wean to finish rearing periods. Mahan and Lepine (1991) weaned piglets at 21 days of age and reported higher FCR values of 2.90, 2.93 and 2.82 for piglets that weighed 4.1 to 5.0, 5.5 to 6.8 and 7.3 to 8.6 kg respectively at weaning compared to those reported in the current study. The difference in FCR between the current study and that of Mahan and Lepine (1991) is due to slaughter weight and age. In study of Mahan and Lepine (1991) pigs were slaughtered at 105 kg (165.7 to 180.8 days), whereas in this study pigs were slaughtered at 70 kg BW (130.8 to 137 days). Feed conversion ratio decreases with increasing age and weight therefore pigs in Mahan and Lepine (1991) study reached the plateau phase in the growth curve and this growth phase contributed to the higher FCR values than in the current study.

Days on test

Weaning age did not significantly affect days on test from weaning to 70 kg BW (Table 2). Piglets weaned at 21 days of age spent significantly shorter days on test than piglets weaned at 28 and 35 days of age during the grow to finish rearing period. However, days on test were not significantly different among age groups end of wean to finish rearing period. These results are consistent with Danko and Bilkei (2004) and Partanen et al. (2007) who found no significant effect on days on test between piglets weaned early and late.

Conclusion and recommendation

Body weight of piglets weaned at 21 days of age was significantly lower than piglets weaned at 28 days of age but similar to those weaned at 35 days. However, BW, ADG, ADFI, FCR and days on test did not significantly vary during wean to finish rearing period. Generally, weaning age had no effect on growth performance of piglets weaned at 21, 28 and 35 days of age. These results suggest that piglets can be weaned at 21, 28, and 35 days of age without adversely affecting their growth performance. Further studies should be conducted to evaluate the effect of weaning age on the reproductive performance of the sows and profitability of the three weaning ages.

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