Increasing creep pellet size improves creep feed disappearance of gilt and sow progeny in lactation and enhances pig production after weaning

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Summary

Objective: To determine if feeding a larger diameter pellet increases creep feed intake and growth rate of piglets during lactation, especially that of gilt progeny (GP) compared to sow progeny (SP), and stimulates feed intake after weaning.

Materials and methods: Over two replicates, GP and SP (n = 2070) were allocated to two creep feed treatments, receiving either a 4 mm diameter × 4 mm length pellet or a 9 mm diameter × 12 mm length pellet, from 3 days of age until weaning. After weaning, pigs were split into male and female pens according to the type of pellet fed in lactation and fed a common diet. Feed disappearance was recorded before and after weaning (up until 10 weeks of age), along with piglet growth performance and all piglet mortalities and removals.

Results: Total creep feed disappearance in lactation was higher ($P < .001$) in litters offered the larger pellet, but litter weaning weight for GP was not improved (interaction, $P > .05$). Gilt progeny were weaned lighter ($P < .001$) than SP. After weaning, pigs offered the larger pellet during lactation showed a tendency to receive less medication ($P = .07$) than pigs offered the smaller pellet. Growth rate and feed intake after weaning were both stimulated ($P = .02$ and $P = .09$, respectively) in pigs offered the larger pellet during lactation irrespective of sex.

Implications: Offering a larger pellet creep feed to piglets in lactation can improve postweaning performance and reduce the postweaning medication rate.

Keywords: swine, gilt progeny, creep feed, weaning, pellet diameter.

Received: May 20, 2020
Accepted: July 20, 2020

Resumen - Aumentar el tamaño de pellet del alimento de la camada mejora la desaparición del alimento de las camadas de primerizas y de la progenie de las multíparas en la lactancia y mejora la producción porcina después del destete

Objetivo: Determinar si la alimentación con un pellet de mayor diámetro aumenta la ingesta de alimento y la tasa de crecimiento de los lechones durante la lactancia, especialmente la progenie de primerizas (GP), en comparación con la de multíparas (SP), y si estimula la ingesta de alimento después del destete.

Materiales y métodos: Durante dos repeticiones, a partir de los 3 días de edad y hasta el destete, la GP y SP (n = 2070) se asignaron a dos tratamientos de alimento de camada, un pellet de 4 mm de diámetro × 4 mm de largo o un pellet de 9 mm de diámetro × 12 mm de largo. Después del destete, los lechones se dividieron en corrales de machos y hembras según el tipo de pellet con los que se alimentaron durante la lactancia, y se les ofreció una dieta común. La desaparición del alimento se registró antes y después del destete (hasta las 10 semanas de edad), junto con el crecimiento, la mortalidad y el desecho de lechones.

Resultados: La desaparición total del alimento en la lactancia fue mayor ($P < .001$) en las camadas a las que se les ofreció el pellet más grande, pero el peso de la camada al destete para la GP no mejoró (interacción, $P > .05$). La progenie de las primerizas se destetó más ligera ($P < .001$) que la de SP. Después del destete, los cerdos a los que se les ofreció el pellet más grande durante la lactancia mostraron una tendencia a recibir menos medicación ($P = .07$) que los cerdos a los que se les ofreció el pellet más pequeño. Independientemente del sexo, tanto la tasa de crecimiento, como el consumo de alimento después del destete fueron estimulados ($P = .02$ y $P = .09$, respectivamente) en los cerdos a los que se les ofreció el pellet más grande durante la lactancia.

Implicación: Ofrecer a los lechones un alimento con pellets más grandes durante la lactancia puede mejorar el rendimiento después del destete y reducir la tasa de medicación posterior al destete.

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This article is available online at **http://www.aasv.org/shap.html**.

Craig JR, Kim JC, Brewster CJ, Smits RJ, Braden C, Pluske JR. Increasing creep pellet size improves creep feed disappearance of gilt and sow progeny in lactation and enhances pig production after weaning. *J Swine Health Prod*. 2021;29(1):10-18.

Résumé - L'augmentation de la taille des granules lors de l'alimentation à la dérobée améliore la consommation de l'aliment de démarrage par la progéniture des cochettes et des truies en lactation et augmente les performances de production après le sevrage

Objectif: Déterminer si l'alimentation avec des granules de diamètre plus gros augmente la consommation d'aliment de démarrage et le taux de croissance des porcelets durant la lactation, spécialement la progéniture des cochettes (GP) comparativement à la progéniture des truies (SP) et stimule la consommation d'aliment après le sevrage.

Matériels et méthodes: Au cours de deux réplicas, GP et SP (n = 2070) furent répartis en deux traitements de moulée de démarrage, recevant soit des granules mesurant 4 mm de diamètre × 4 mm de long ou 9 mm de diamètre × 12 mm de long, à compter de 3 jours d'âge jusqu'au moment du sevrage. Après le sevrage, les porcelets étaient séparés dans des enclos de mâles et de femelles en fonction du type de granule reçu durant la lactation et nourris avec une moulée commune. La consommation d'aliment fut notée avant et après le sevrage (jusqu'à 10 semaines d'âge), ainsi que les performances de croissance des porcelets et toutes les mortalités de porcelets et les retraits.

Résultats: La consommation totale de la moulée de démarrage durant la lactation était plus grande ($P < .001$) dans les portées recevant les granules plus gros, mais le poids de la portée au moment du sevrage pour les GP n'était pas amélioré (interaction, $P > .05$). La progéniture des cochettes était sevrée à un poids plus faible ($P < .001$) que SP. Après le sevrage, les porcs ayant reçu les granules plus gros durant la lactation avaient tendance à recevoir moins de médicaments ($P = .07$) que les porcs recevant les granules plus petits. Le taux de croissance et la consommation de nourriture après le sevrage étaient tous les deux stimulés ($P = .02$ et $P = .09$, respectivement) chez les porcs recevant les granules plus gros durant la lactation indépendamment du sexe.

Implications: Offrir une moulée de démarrage avec des granules plus gros à des porcelets durant la lactation peut améliorer les performances post sevrage et réduire le taux de médication post-sevrage.

Creep feed consumption before weaning is typically low and variable between and within litters.[1] However, supplying creep feed to piglets during lactation to familiarize them with solid feed before weaning is linked to a greater interest of pigs in their feed after weaning, improving subsequent feed intake and performance.[2,3] Surprisingly, relatively little attention is paid to physical characteristics of creep feed offered to piglets and its impacts on creep feed intake and performance before and after weaning. Commercial creep feed pellet sizes are typically ≤ 4 mm in diameter, and it is generally thought that this size allows for effective chewing and swallowing and therefore maximum intake; however, there is evidence suggesting that young pigs are adaptable to a variety of pellet diameters. For example, van den Brand et al[4] showed that offering a creep pellet with a diameter of 12 mm from day 3 or 4 of lactation encouraged creep feed intake in early lactation (before day 18), stimulated growth, and enhanced feed conversion efficiency after weaning, in comparison to piglets offered a 2 mm diameter pellet. Moreover, Middelkoop et al[5] showed that a novel offering of two different pellet sizes simultaneously improved feed intake shortly before weaning. However, neither of these studies examined the impact of dam parity on these improvements in creep feed intake.

Progeny born to primiparous sows (gilt progeny; GP) show compromised performance both before and after weaning.[6,7] Furthermore, GP exhibit higher mortality rates shortly after weaning in comparison to sow progeny (SP). This may be a result of an inability to physiologically adapt to the additional stressors at this time, which in turn may be a direct result of differences present at birth.[7] Provision of creep feed during lactation may encourage GP to consume more both before and after weaning, resulting in production improvements and greater survival. Furthermore, the sex of the pig has been shown to influence a number of physiological traits after weaning.[8] Female pigs tend to have improved mortality rates and performance compared to their male counterparts, despite generally showing heightened nervous and immune activation, increased intestinal permeability, and increased diarrhea.[8] Therefore, offering a larger pellet might be more beneficial to male pigs after weaning.

We hypothesized first, that feeding the larger creep pellet would improve creep feed disappearance and the performance of GP compared to SP in lactation; and second, that feeding a larger creep pellet would improve feed intake and growth rate after weaning, and be more beneficial to male pigs compared to their female counterparts.

Materials and methods

Experimental design

All procedures in this experiment were approved by the Rivalea Australia Animal Care and Ethics Committee (protocol No. 18N042C) and the Murdoch University Animal Ethics Committee (protocol No. R2947/17) under the Australian Code for the Care and Use of Animals for Scientific Purposes.[9]

The study was conducted at a commercial piggery in Corowa, New South Wales, Australia (Rivalea Australia Pty Ltd). Two-hundred forty F1 (Large White × Landrace; Primegro Genetics) primiparous (parity 0; n = 119) and multiparous sows (parities 1-8; mean [SE] parity was 3.1 [0.2]; n = 121) over two replicates were randomly allocated upon entry to the farrowing house according to a 2 × 2 factorial arrangement of treatments. The factors were 1) sow parity (gilts vs sows) and 2) pellet diameter (small [CON; n = 118] vs large [LRG; n = 122]). After weaning, GP and SP were mixed randomly into pens of either male or female pigs according to whether they received the CON or LRG pellet during lactation.

Diets

Piglets were supplied one of two creep diets with different pellet diameters: a 4 mm diameter short-cut (4 mm length) pellet (CON) vs a larger 9 mm diameter pellet of 12 mm length (LRG; Figure 1). The creep diets were produced at a commercial feed mill (Ridley AgriProducts Pty Ltd) and were both identical in nutrient composition (15.0 MJ/kg digestible energy [DE] and 0.87 g standardized ileal digestible lysine [SID Lys]/MJ DE, as-fed basis). Creep diets were supplied from day 3 of lactation until weaning (mean [SE] 26.3 [0.1] days of age) in creep feeders made in-house from polyvinyl chloride pipe (approximately 40 cm high, mouth of feeder 15 cm wide), installed on the wall of the pen adjacent to the creep area. Feeders were checked and filled daily, with all the feed offered being weighed and residual weighed out at weaning. Following weaning, all pigs,

Figure 1: Different creep feed pellets used in the experiment, with A) a larger creep pellet (9 mm diameter × 12 mm length; LRG) and B) a small creep pellet (4 mm diameter × 4 mm length; CON).

regardless of creep pellet diameter treatment, were fed a standard weaned pig diet (14.8 MJ/kg DE and 0.90 g SID Lys/MJ DE, as-fed basis), presented as a 4 mm diameter short-cut pellet, for the first 21 days after weaning.

Animal management

Sows and piglets were housed in individual farrowing crates. Creep areas were fitted with a creep mat and heat lamp. Each farrowing crate had a slatted floor and was fitted with drinker nipples with *ad libitum* access to water for the sow and piglets. Twenty-four hours after farrowing, minimal fostering was conducted to standardize litters, fostering within dam parity and dietary treatments wherever possible. At 3 days of age, all piglets had their tails docked and were given a 200 mg intramuscular (IM) iron injection (Gleptosil; Champion Alstoe Animal Health) and 2 mL of oral toltrazuril for control of coccidiosis (Baycox; Bayer Animal Health). They were then vaccinated against *Mycoplasma hyopneumoniae* and porcine circovirus type 2 (first replicate: Fostera Gold PCV MH; Zoetis Australia Pty Ltd; second replicate: Ingelvac CircoFLEX and MycoFLEX; Boehringer Ingelheim Pty Ltd) approximately 1 week before weaning. All litters were weighed within 24 hours of birth (after fostering) and again at weaning. Creep pellets were offered to litters (F1 × Duroc Synthetic; Primegro Genetics) on an *ad libitum* basis from day 3 of lactation to weaning, and total feed disappearance (feed delivered - residual removed) was recorded.

All piglets within replicate were weaned on the same day at a mean (SE) of 26.3 (0.1) days of age. After weaning, 2070 pigs born to gilts and sows were mixed and divided into pens of entire males and females. Pigs were moved to the commercial weaned pig facility and placed into pens of 18 pigs (n = 115) across two rooms based on the pellet diameter offered in lactation and size, for within-pen uniformity. Each pen was weighed upon entry to the room and again 21 days after weaning, with total feed intake recorded on a per pen basis. The first replicate ran from December 2018 to February 2019, and the second replicate ran from February to April 2019. All piglet mortalities were recorded for the entirety of the experiment. After weaning, all individual injectable medications and all pig removals were recorded.

Each pen in the room was fitted with one feeder with four feeder spaces, and two to three drinker nipples ensuring *ad libitum* access to water. Each pen in the barn had a solid floor area at the front where the feeder was situated, and a slatted floor in the back two thirds of the pen. Pigs that were observed to be suffering from ill thrift, lameness, or meningitis symptoms were medicated with an IM injection of both meloxicam (Recocam; Abbey Animal Health Pty Ltd) and either amoxycillin (first replicate; Moxylan; Jurox Pty Ltd), oxytetracycline, or penicillin (second replicate; Alamycin and Ultrapen, respectively; Norbrook Laboratories Australia, Pty Ltd) as per the product labels. Pigs were removed from the experiment if, in the view of the stockperson, they failed to recover or lost a large amount of body weight, body condition, or both.

Statistical analysis

Continuous variables were analyzed as linear mixed models using the MIXED procedure of SPSS (version 25; IBM). Preweaning data were analyzed as a 2 × 2 factorial comparison with creep diet (CON vs LRG) and parity group (GP vs SP) as fixed factors. Replicate was used as a blocking factor and litter as the experimental unit. Age at weaning was used as a covariate when it had a significant effect ($P < .05$) on the model, ie, for creep disappearance from day 3 to weaning and day 21 to weaning, for average piglet weight at weaning and for average daily gain (ADG) from birth to weaning. This was used to adjust for unforeseen differences in weaning age between dam parity groups in the CON group. Litter preweaning mortality rate was analyzed as a continuous variable. Postweaning data were analyzed as a 2 × 2 factorial comparison with creep diet (CON vs LRG) and sex (female vs male) as fixed factors, and replicate was used as a blocking factor and pen as the experimental unit. Random effects of barn and sow parity (nested within sow parity group) were tested as appropriate and removed from the model if not significant ($P \geq .50$). Chi-squared analysis was conducted for determining the effect of creep pellet diameter on the binomial variables postweaning mortality (died or lived), removal (removed or not), and medication rates (medicated at least once or not medicated). A P value $< .05$ was considered significant, and a P value $< .10$ was considered a trend.

Results

Litter performance at birth

Three primiparous and 6 multiparous sows were removed from the analysis due to mortality, or their udders dried up before weaning and their piglets were fostered onto another sow. Five sows (4 primiparous and 1 multiparous) had piglets fostered that were not recorded and therefore their weaning data were not included in the analysis; however, these piglets were included in the postweaning stage of the experiment. Litters from 14 sows (6 primiparous and 8 multiparous) were inadvertently mixed when separation boards between farrowing crates dislodged, and therefore their data at weaning was not included in the analysis.

There was no difference ($P \geq .05$) in number of piglets born alive or total piglets born between dietary treatments (Table 1). Multiparous sows had higher ($P = .003$) total piglets born compared to primiparous sows. Primiparous sows had lighter ($P < .001$) litters than multiparous sows after fostering with a lower ($P = .001$) mean piglet weight, but there was no difference ($P \geq .05$) between dietary treatments (Table 1).

Creep feed disappearance

There were a number of instances in the first replicate where creep feed became wet or the feeder tipped over, and therefore this replicate had a highly significant effect on all creep consumption measures ($P < .001$) and was left in the model as a blocking factor. Creep feed disappearance was lower ($P < .001$) in the second replicate, likely due to a lower rate of feed wastage as feeders were not allowed to become wet and soiled as often.

From day 3 (introduction of creep feed) to day 10 of age, piglets provided LRG pellets during lactation had a higher ($P = .004$) creep feed disappearance than piglets provided CON pellets (Figure 2A). However, there was a strong trend ($P = .06$) for an interaction between sow parity and creep feed pellet size, where higher intake was observed in GP than SP (Figure 2A). From day 11 to day 20, creep feed disappearance was again higher ($P < .001$) in the LRG group (Figure 2B); however, there was no significant interaction effect between sow parity and creep pellet size. Sow progeny (SP) had a higher ($P = .03$) creep feed disappearance than GP in this period. Higher ($P = .002$) creep feed disappearance was observed in the LRG group than in the CON group from day 21 to weaning (Figure 2C), and SP and GP had a similar ($P = .98$) creep feed disappearance. There was no creep pellet size by sow parity interaction ($P = .92$).

Over the entire creep-supplemented period (day 3 to weaning; mean [SE] 23.1 [0.1] days), both GP and SP fed the LRG diet had a greater ($P < .001$) creep feed disappearance than those fed the CON diet (2770 g vs 2111 g, respectively). There was no difference ($P = .33$) between GP and SP creep feed disappearance in the entire preweaning period.

Preweaning growth performance

There was a significant interaction ($P = .041$) between dam parity and diet for age at weaning, with GP one day younger than SP in the CON group (25.7 [0.3] vs 26.8 [0.3] days of age, respectively), whereas there was no difference in the LRG group (both 26.4 [0.3] days of age). Hence, age at weaning was used as a covariate for measures where it made a significant contribution to the model ($P < .001$ in all cases). Litter weight at weaning was similar ($P = .67$) between the CON and LRG groups (68.2 [1.4] kg vs 69.1 [1.4] kg, respectively), and multiparous sow litters were heavier ($P < .001$) than litters from primiparous sows. There was no interaction ($P = .57$) between

Table 1: Mean (SE) preweaning performance of experimental litters comprised of gilt (GP) or sow progeny (SP) provided either a small 4 mm diameter × 4 mm length creep pellet (CON) or a larger 9 mm diameter × 12 mm length pellet (LRG) from day 3 of lactation until weaning

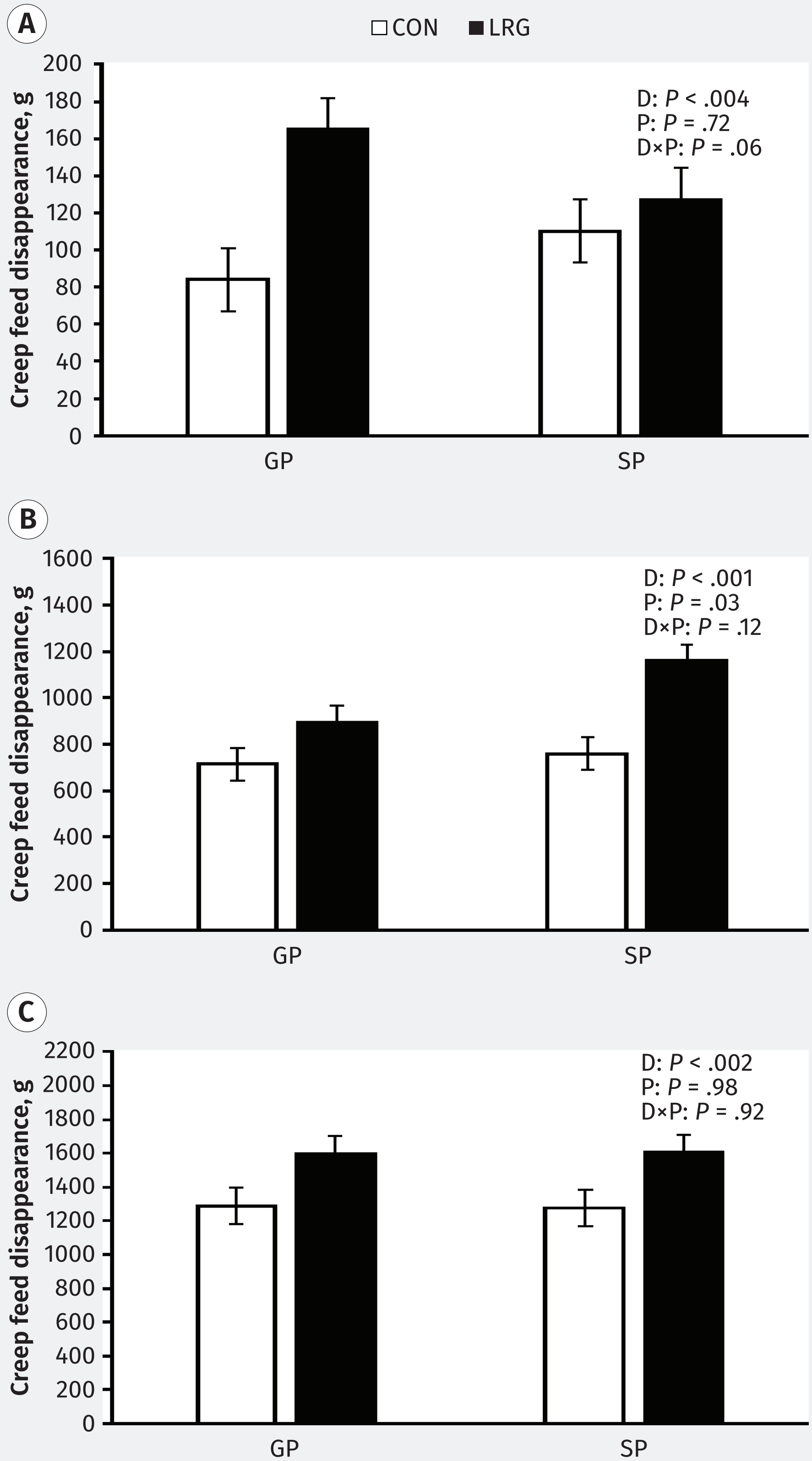
	GP		SP		*P* value		
Parameter	**CON**	**LRG**	**CON**	**LRG**	**Diet**	**Parity**	**Diet × Parity**
BA	11.9 (0.4)	11.8 (0.4)	12.4 (0.4)	12.4 (0.4)	.98	.12	.98
TB	12.5 (0.4)	13.0 (0.4)	13.8 (0.4)	14.1 (0.4)	.84	.003	.32
Day 0 (post foster)							
Litter size, No.	11.7 (0.2)	11.8 (0.2)	11.8 (0.2)	12.0 (0.2)	.88	.45	.28
LW, kg	16.5 (0.3)	16.5 (0.3)	17.8 (0.3)	17.8 (0.4)	.99	< .001	.94
Avg BW, kg*	1.42 (0.03)	1.40 (0.03)	1.52 (0.03)	1.49 (0.03)	.76	.001	.37
Weaning							
Weaning age, d	25.7 (0.3)	26.4 (0.3)	26.4 (0.3)	26.8 (0.3)	.64	.06	.04
Litter size, No.	10.0 (0.3)	10.2 (0.2)	10.3 (0.2)	10.2 (0.03)	.51	.74	.91
LW, kg†	64.7 (2.0)	64.4 (1.9)	73.7 (1.9)	71.7 (2.0)	.67	< .001	.57
Avg BW, kg*†	6.43 (0.15)	6.30 (0.14)	7.19 (0.14)	7.10 (0.15)	.87	< .001	.47
ADG D0-wean, g/d†	190 (5)	187 (5)	215 (5)	212 (5)	.91	< .001	.57
PWM, %	15.9 (2.2)	14.4 (2.2)	14.8 (2.1)	15.7 (2.2)	.58	.95	.90

* Average BW = litter weight ÷ litter size.

† Weaning age used as a covariate.

BA = number of piglets born alive; TB = total piglets born; LW = litter weight; BW = body weight; ADG = average daily gain; PWM = preweaning mortality.

Figure 2: Total creep feed disappearance in gilt progeny (GP) and sow progeny (SP) litters when fed either a small creep pellet (CON) or a larger creep pellet (LRG) from A) days 3 to 10 of lactation, B) days 11 to 20 of lactation, and C) day 21 of lactation to weaning (26.3 [0.1] days of age). The *P* values given are results of the linear mixed model analysis for the main effects of diet (D), parity group (P), and their interaction (D×P).



creep pellet size and dam parity. Litter number at weaning was similar between creep pellet size groups (*P* = .51) and dam parities (*P* = .74; Table 1). Litters in the CON and LRG groups had a similar ADG from fostering to weaning (201 [4] g/d; *P* = .91) and a similar average piglet weight at weaning (6.8 [0.1] vs 6.7 [0.1] kg, respectively; *P* = .87). Sow progeny grew faster (214 [4] vs 189 [4] g/d, respectively; *P* < .001) and were heavier (7.1 [0.1] vs 6.4 [0.1] kg, respectively; *P* < .001) than GP at weaning. There was no difference in litter preweaning mortality between the creep pellet treatments (*P* = .58) or dam parity groups (*P* = .95; data not shown). There were no interactions (*P* ≥ .05) for any of these preweaning parameters.

Postweaning performance

The creep pellet size by sex interaction was not significant for any postweaning traits (Table 2). Average weight was similar (*P* ≥ .05) at weaning and 21 days after weaning, regardless of creep pellet treatment or sex. Piglets offered the LRG pellets before weaning grew faster (*P* = .002) than those offered the CON pellets and consumed more feed (average daily feed intake [ADFI]; *P* = .009) in the first 21 days after weaning. Replicate significantly (*P* < .05) affected the postweaning ADFI and feed conversion ratio of pigs, with pigs in the first replicate consuming less feed and being more efficient than those in the second replicate (data not shown). Male pigs tended (*P* = .07) to be more efficient in the first 21 days after weaning than female pigs (1.26 [0.01] vs 1.29 [0.02] kg/kg, respectively), and although not a statistical trend, were heavier than females at weaning (by approximately 6%) and 21 days after weaning (by approximately 5%; Table 2).

Mortalities, removals, and medications of pigs are shown in Figure 3. There was a higher numerical proportion (*P* = .11) of removals after weaning in the CON group compared to the LRG group. There was a stronger tendency (*P* = .07) for a higher proportion of pigs in the CON group to be medicated after weaning compared to the LRG group. There was no difference between males and females in terms of mortality (*P* = .66), removals (*P* = .58), or medications (*P* = .76); however, within females there was a significant difference in proportion of

Table 2: Mean (SE) postweaning performance (from weaning, day 0; to 21 days post weaning, day 21) of female (F) and male (M) experimental piglets provided either a small 4 mm diameter × 4 mm length creep pellet (CON) or a larger 9 mm diameter × 12 mm length pellet (LRG) from day 3 of lactation until weaning

	CON		LRG		*P* value		
Parameter	**F**	**M**	**F**	**M**	**Diet**	**Sex**	**Diet × Sex**
BW D0, kg	6.59 (0.26)	7.07 (0.25)	6.75 (0.25)	7.09 (0.25)	.72	.10	.77
BW D21, kg	10.9 (0.4)	11.6 (0.4)	11.6 (0.3)	12.0 (0.4)	.12	.14	.74
ADG (D0-21), g/d	207 (7)	214 (7)	230 (7)	234 (7)	.002	.45	.76
ADFI, g/d	270 (9)	269 (9)	295 (9)	291 (9)	.009	.80	.87
FCR, g:g	1.30 (0.02)	1.27 (0.02)	1.28 (0.02)	1.25 (0.02)	.33	.07	.96

BW = body weight; ADG = average daily gain; ADFI = average daily feed intake; FCR = feed conversion ratio.

pigs medicated between CON and LRG pigs (5.6% vs 3.0%, respectively; $P = .04$), whereas within males there was no difference (4.2% vs 3.6%, respectively; $P = .63$).

Discussion

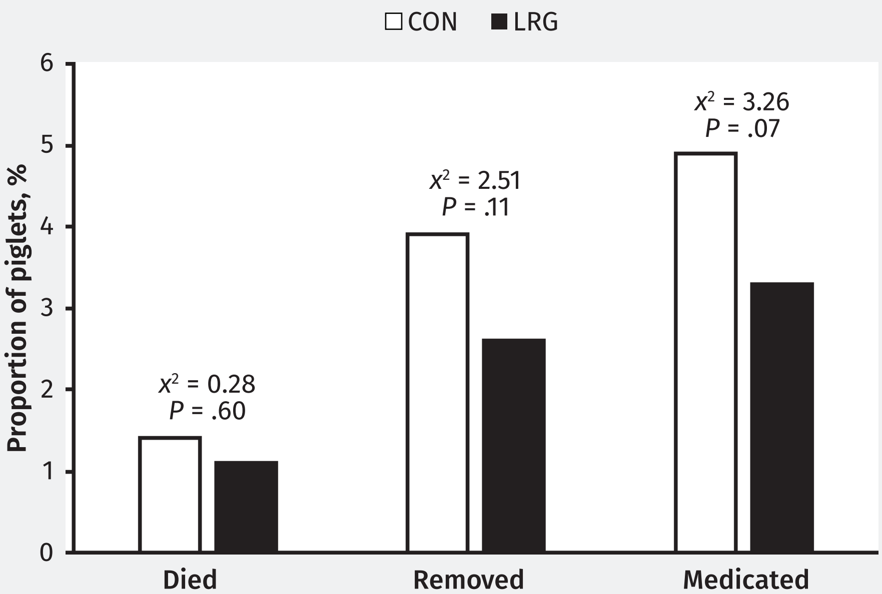
In the current study, providing a larger creep pellet increased creep feed disappearance but there were no production benefits for GP relative to SP during lactation. This partly confirms our hypothesis that providing a creep feed in a larger form would help familiarize piglets with solid feed during lactation, and in turn encourage more feed intake after weaning. The prevailing view commercially is that smaller pellets are easier for small piglets to eat and therefore will encourage more feed intake in early lactation when piglets are not familiar with solid feed.[10] However, larger particle sizes (eg, acorns, nuts, or mushrooms) are often consumed by young wild pigs in nature and in free-range conditions when a more gradual weaning occurs.[11] Providing creep feed early in lactation is thought to encourage exploration behaviors and therefore preweaning feed intake.[12,13] Larger particle sizes may actually be easier to pick up and carry for small piglets, whose teeth and jaw structure are not fully developed before weaning in a commercial production system.[14] The finding that piglets provided the larger pellets had a higher creep feed disappearance in lactation concurs with the study of van den Brand et al,[4] who found that piglets provided a larger diameter pellet (12 mm) explored the creep feeder more often, and had a significantly higher creep feed intake than piglets offered a smaller pellet (2 mm). Clark et al[15] found an increase in creep feed intake of piglets offered larger pellets (13 mm) in comparison to those offered smaller pellets (3 mm) from day 17 of lactation, and a reduction in piglet mortalities from 10 days of age until weaning.

It is unclear from previous experiments whether creep feed intake is increased with the larger pellets due to more time being spent at the feeder,[10,16] or to more feed being consumed in the same time frame (ie, in the same feeding event).[4] Edge et al[10] reported that "feed trough directed behavior" of piglets, as measured via video camera, was not highly correlated with actual feed intake. In that study, trough directed behavior was defined as any chewing, manipulating feed, placing head in the feeder, or manipulation of the feeder itself. It is probable that the larger pellets encourage 'playing' with the larger feed items away from the creep area, allowing other littermates more time at the feeder and hence encouraging higher creep feed intakes from the litter as a whole. The presentation of the smaller pellets may have allowed one dominant piglet in the litter to occupy the space at the feeder for a longer period of time, limiting the amount of interaction with the feeder for their fellow littermates.[10] Clark et al[15] found that while improving overall creep feed intake, providing larger pellets did not increase the proportion of piglets in the litter consuming creep feed. The proportion of piglets eating CON or LRG pellets was not ascertained in the current study, therefore it is not known whether offering larger pellets encouraged more creep feed to be eaten over the whole litter or by a greater proportion of piglets.

Farm staff in the current study observed that less of the larger diameter creep pellets fell between the farrowing crate slats than the smaller pellets and hence less were wasted, similar to what was observed by van den Brand et al[4] and Middelkoop et al.[5] Therefore, it may be assumed that the difference in creep disappearance between CON and LRG piglets that was attributable to actual feed intake was larger than is reported here, given that more of the CON diet may have been wasted. Furthermore, a significant effect of replicate on some of the results was observed. In the first replicate it was observed in some instances that the creep feed became wet and had to be replaced (ie, creep feed disappearance was higher overall in this replicate than in the second). Results were analyzed both as a whole, as reported above, but also separately between each replicate to account for this. Regardless of replicate, the results and conclusions were similar and hence the decision was made to analyze the data as the whole cohort, with replicate included in the model.

Daily replacement of creep feed may encourage further preweaning feed intake, as observed by Appleby et al[16] and Wattanakul et al,[1] and could be another reason for significantly higher creep feed disappearance in the large pellet group in our study, as higher feed intakes in this group would encourage more frequent feed replacement. One disadvantage of a larger pellet is that they may be less durable and produce more fine particles during the production process than smaller pellets.[4,17] While physical presence of fine particles was not recorded in the current experiment, the larger pellets were not observed to be any dustier than the smaller pellets. Furthermore, there is evidence that production of larger pellets at the feed mill may be more energy efficient than the production of smaller pellets.[17]

Figure 3: Proportion of piglets that died, were removed from the experiment, or were medicated at least once in the postweaning period. Piglets were fed either a small creep pellet (CON) or a larger creep pellet (LRG) from day 3 of lactation until weaning (26.3 [0.1] days of age). Parameters were analyzed as binomial traits using Pearson's chi-square (χ^2).



Overall, creep feed disappearance during the entire lactation was similar between GP and SP, in contrast to Edwards et al[18] who found creep feed disappearance was greater in SP (from day 19 of lactation to weaning). Potential reasons for GP and SP displaying a preference for larger sized pellets, or creep feed in general, in different stages of lactation in the current study are not easy to interpret. A possible reason might be associated with interactions between litter characteristics, for example suckling intensity and its impacts on nutrient demand and milk production of the sow,[1,19] with primiparous sow litters having less variation in body weights and lower overall litter weights in comparison to multiparous sow litters.[20] The potential effects of this on creep feed consumption differences of GP and SP warrants further investigation. Furthermore, the literature suggests that parity of the sow (birth or foster sow parity) can influence overall creep feed consumption of piglets,[18,21] but these relationships may be quite complex. In this regard, offering creep feed in lactation as early as possible appears to provide benefits,[4,22] even though significant consumption of creep feed does not occur until later in lactation.[23] Our data showed that creep feed disappearance increases throughout lactation and was much higher in the period from day 21 of lactation until weaning, supporting this proposition. Our observation that preweaning growth rates were similar between small and large pellet groups, despite higher creep feed disappearance in the large pellet group, supports this notion and agrees with the findings of Edge et al[10] and Clark et al.[15] This is not surprising given that the improvements in creep disappearance with the larger pellets would not equate to a substantial increase in individual creep feed intake, and therefore energy and nutrient intake, per piglet throughout the lactation period. It also seems that pigs, like other animal species, prefer variety[5,12] and complexity[24] in their diets. Hence, providing more than one creep feed type at a time may also stimulate feed intake before and after weaning.[5] However, results are conflicting as to whether, if given a choice, piglets will show a preference for smaller or larger pellets,[11] or not show a preference to either.[5]

Feed intake after weaning was improved in pigs offered larger diameter creep pellets before weaning, supporting our hypothesis. This agrees with previous studies[4,10,15] and caused a higher postweaning ADG, in agreement with the findings of van den Brand et al[4] and Clark et al,[15] but in contrast to those of Edge et al.[10] Voluntary feed intake of solid food after weaning is typically low and variable[25] and contributes to the postweaning growth check,[26] especially when pigs are not offered solid feed before weaning.[2,27] Supplying creep feed in lactation improves adaptation to a solid diet thereby increasing feed intake[28,29] and performance of pigs after weaning,[3,30] and concurrently may give a sense of familiarity to the pig at this stage that could reduce neophobic reactions to a new environment and ameliorate weaning stressors.[3,26,31] This is critical because even a small improvement in creep feed intake (approximately 60 g/piglet/day) can increase postweaning growth by 1 kg/piglet in the first 2 weeks after weaning.[5,12] It was also suggested by van den Brand et al[4] that chewing of larger pellets may help to further stimulate teething in young pigs, which has been shown to impact their appetite and feed intake after weaning.[32]

The greater ADFI after weaning in pigs eating larger creep pellets before weaning appeared to improve their overall health, as was reflected in the lower removal rates and reduced number of injectable medications (most of which were for ill thrift) given in these pigs. A higher level of feed intake after weaning is important for maintaining gastrointestinal tract structure and function,[33] and greater feed intake is also linked to reduced postweaning diarrhea.[34] van den Brand et al[4] found no differences in diarrhea scores between pigs receiving small or large pellets before weaning, but different conditions in diets and feeding patterns, genetics, disease status, and environmental conditions can contribute to differences between experiments. There were no significant differences in postweaning mortality rate or removal rate between pigs in the CON and LRG pellet groups; however, mortality and removal rates were lower for pigs offered the larger pellet before weaning. We also hypothesized in this study that male pigs would benefit more than female pigs in the postweaning period when offered the large diameter pellet before weaning, given they generally perform poorer.[9] However, we failed to see any production improvements in male pigs compared to their female counterparts aside from a trend for improved feed conversion efficiency, and in fact, offering larger creep pellets significantly reduced the rate of medications after weaning in females but not in males. The mechanisms of this improvement require further investigation. In this regard, postweaning performance can be heavily influenced by dam parity,[7] and unfortunately dam parity could not be controlled for in the weaner phase of this experiment due to commercial production constraints. It is likely that GP and SP may have been largely kept in separate pens after weaning, as pigs would have been sized into pens (as is commercial practice at this facility) to allow uniformity of body weight within pens as much as possible. Therefore, GP may have been overrepresented in 'light' pens, and SP in 'heavy' pens and it would be of interest to examine these effects more closely after weaning in future studies.

In conclusion, providing a larger creep pellet from day 3 of lactation until weaning may have encouraged higher creep feed intake of both GP and SP before weaning. This caused an increased feed intake after weaning irrespective of sex, and subsequently a significant improvement in ADG and ADFI in the first 21 days after weaning. Offering a larger diameter pellet also resulted in a lower proportion of pigs being medicated after weaning.

Implications

Under the conditions of this study:

- Providing large creep pellets in lactation increases creep feed disappearance.
- Larger pellets enhance postweaning feed intake, growth, and health status.
- Providing larger pellets improves both gilt and sow progeny performance.

Acknowledgments

The authors would like to acknowledge the technical staff at the Research and Innovation Unit at Rivalea Australia for their assistance with the on-farm data collection. This experiment was conducted as part of a project funded by Australian Pork Limited (project No. 2014/461).

Conflict of interest

None reported.

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