Nutritional strategies to reduce growth of pigs during emergency situations

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Summary

Multiple feeding strategies have been shown to reduce growth in emergency situations. Feeding low protein diets decreased average daily gain (ADG) up to 71% depending on the degree of restriction and resulted in decreased carcass leanness. Feeding excess methionine decreased ADG up to 67%, with limited effects on carcass leanness. Feeding methionine in the diet above 2% may result in body weight loss. Feeding calcium chloride or ammonium chloride decreased ADG up to 98% depending on the dietary electrolyte imbalance imposed and can result in leaner carcasses and potentially poorer meat quality as measured by color, pH, and tenderness.

Keywords: swine, growing-finishing pig, growth rate, nutrition, slow down

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Resumen - Estrategias nutricionales para reducir el crecimiento de los cerdos durante situaciones de emergencia

Se ha demostrado que diferentes estrategias de alimentación reducen el crecimiento en situaciones de emergencia. Alimentar con dietas bajas en proteína disminuyó la ganancia diaria promedio (GMD) hasta en un 71% según el grado de restricción, y repercutió en una disminución del musculo de la canal. La alimentación con exceso de metionina disminuyó la GMD hasta en un 67%, y tuvo efectos limitados en la composición de músculo de la canal. Alimentar con metionina en la dieta por arriba del 2% puede provocar una pérdida de peso corporal. Alimentar con cloruro de calcio o cloruro de amonio redujo la GMD hasta en un 98% dependiendo del desequilibrio de electrolitos impuesto en la dieta, y puede dar como resultado canales más magras, y una calidad de la carne potencialmente menor medida por el color, el pH, y la suavidad.

Résumé - Stratégies nutritionnelles pour réduire la croissance des porcs durant des situations d'urgence

De nombreuses stratégies nutritionnelles ont été démontrées comme pouvant réduire la croissance lors de situations d'urgence. En nourrissant avec une diète faible en protéines, on a réduit le gain quotidien moyen (ADG) jusqu'à 71% selon le degré de restriction et obtenu une diminution de la maigreur de la carcasse. En donnant un excès de méthionine on diminua l'ADG jusqu'à 67%, avec des effets limités sur la maigreur de la carcasse. Donner plus de 2% de méthionine dans la diète pourrait résulter en une perte de poids corporel. Donner du chlorure de calcium ou du chlorure d'ammonium diminua l'ADG jusqu'à 98% selon le débalancement électrolytique alimentaire imposé et peut résulter en des carcasses plus maigres et potentiellement d'une qualité de viande inférieure telle que mesurée par la couleur, le pH, et la tendreté.

During emergency situations, such as disease outbreaks in pigs or humans, decreased harvest capacity, or when animal movement is restricted, slowing the growth rate of growing and finishing pigs through dietary formulation may be necessary. Although this is not common practice, knowing how to respond and to what degree the response will impact pig performance is important. When harvest capacity was restricted at the onset of the COVID-19 pandemic, several feeding and management recommendations were made available to swine producers to reduce the growth of pigs.[1,2] While this practice tip does not serve to replace the previous recommendations, the goal is to add to the existing information by providing expected reductions in growth that are associated with the different feeding approaches. This practice tip will also provide important insight on how these feeding strategies are expected to affect carcass characteristics. The advantages and disadvantages associated with each strategy can be found on the Iowa Pork Industry Center website.[3] The references used herein are from experiments conducted in response to the COVID-19 pandemic. However, the approaches used may serve as a tool for future situations that prevent or reduce animal movement.

Nutritional strategies

Low protein diets

Low protein diets can be achieved through the partial or complete replacement of soybean meal and feed-grade amino acids with corn. The elimination

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of soybean meal and feed-grade amino acids significantly reduces the crude protein and lysine (Lys) concentration of the diet. Across 4 recent experiments, feeding diets with 89% to 98% corn resulted in an approximately 30% to 75% reduction in standardized ileal digestible (SID) Lys levels relative to the National Research Council[4] requirement for 75 to 135 kg pigs (Table 1). Standardized ileal digestible Lys levels ranged from 0.16% to 0.50%. While this approach resulted in minimal changes in feed intake, average daily gain (ADG) decreased up to 71% depending on the SID Lys level fed and duration of feeding. Furthermore, limiting SID Lys decreased protein deposition and increased fat accretion,[5,6,8] which led to decreased carcass lean and increased backfat. Helm et al[7] also observed a decrease in loin muscle area.

Amino acid balance

Reducing the growth of finishing pigs can also be achieved by altering the amino acid pattern of the diet.[12] Helm et al[5] looked at decreasing the isoleucine (Ile):Lys ratio to 0.45% as an approach to decrease feed intake and growth. However, when compared to a standard control diet that contained an Ile:Lys ratio of 0.57%, no statistical differences in growth performance or carcass lean were observed. The lack of response may indicate that a greater reduction in Ile:Lys was needed to affect growth. When evaluating the effect of feeding either 4% methionine (Met), tryptophan (Trp), Lys, or arginine in weanling pig diets, Edmonds et al[13] observed the greatest reduction in growth when feeding excess Met. More recently, excess Met was used in two, 35-day studies, which appears to be the longest feeding period found in the literature for high levels of Met.[9] As Met in the diet increased from 0.1% to 2.0% (0.61% to 4.46% SID sulfur amino acid:Lys), ADG decreased up to 67%, whereas in some cases when Met was increased above 2.0%, pigs began to lose body weight. In contrast, limited effects of excess Met on carcass leanness were observed. Therefore, feeding high levels of Met is effective at reducing growth without causing pigs to become fat. Because pigs adapt to high levels of Met, more Met will need to be added to diets over time to achieve sustained reductions in growth. If producers are interested in long-term strategies, an 80% reduction in SID Lys in combination with a 16% Trp:Lys ratio has been shown to gradually slow the growth of growing-finishing pigs over a 119-day period.[10]

High-fiber diets

Feeding high-fiber diets is another strategy that has been evaluated to reduce finishing pig growth. For this approach to be successful, dietary energy levels need to be decreased as fiber inclusion increases. Thus, pigs will consume more feed to meet their energy requirements until maximum physical capacity for feed intake is reached due to the bulkiness of high-fiber diets. At this point, growth will be reduced because energy requirements have not been met. However, in 2 studies conducted by Helm et al[5,7] feeding 15% neutral detergent fiber (NDF) diets through the addition of soybean hulls had no effect on feed intake or growth regardless of whether pigs were housed individually or in groups. When 20% NDF was fed to group housed pigs, an 11% reduction in average daily feed intake and 19% reduction in ADG was observed, whereas when 20% or 25% NDF was fed to individually housed pigs, only a tendency for reduced growth was observed.[5,7] The discrepancies between the 2 studies are likely a result of different starting body weights or housing systems, as individually housed pigs tend to have increased feed intake compared to group housed pigs because there is no competition around the feeder.[5,7] Regardless of the growth response, a reduction in backfat was observed in both experiments when 20% or 25% NDF was fed. This is likely a result of decreased energy intake because metabolizable energy decreases as NDF levels in the diet increase. While the growth performance responses to fiber are not always consistent and are largely dependent on fiber source, it appears a high dietary fiber level (≥ 20% NDF) is necessary to reduce feed intake and subsequent gain.[5] In contrast, the negative effect of high-fiber diets on carcass yield is more easily replicated and begins to occur at 20% NDF. Increasing fiber in the diet also increases manure volume, therefore, if high-fiber diets are fed for extended periods of time, manure storage may also be affected.

Electrolyte balance

Adjusting the dietary electrolyte balance (dEB) is another approach to supress finishing pig growth. Inclusion of anhydrous calcium chloride ($CaCl_2$) in diets is the most common way for creating an imbalance in dietary electrolytes. Consuming $CaCl_2$ has been shown to increase plasma chloride concentrations which produces metabolic acidosis and leads to decreased feed intake.[14] Despite a supressed appetite, the rate of $CaCl_2$ inclusion and diet formulation method are important to affect growth. The addition of $CaCl_2$ in the diet requires a reduction in calcium from limestone to prevent excess calcium. Although not required, if there is a desire to maintain the calcium:phosphorous ratio when calculated on a standardized total tract digestible phosphorus (Ca:STTD P) or available phosphorous (Ca:aP) basis, monosodium phosphate is one ingredient that can be added to the diet to increase digestible or available phosphorous levels accordingly. In a trial conducted by Helm et al,[7] 4% $CaCl_2$ was added to the diet while maintaining a 2:1 Ca:STTD P through addition of monosodium phosphate to achieve a dEB of -404 mEq/kg. This resulted in a 49% reduction in average daily feed intake and a 77% reduction in ADG. However, no differences were observed when pigs were fed a 2% $CaCl_2$ diet with a dEB of -161 mEq/kg (2:1 Ca:STTD P maintained). These data support earlier reports that recommended feeding a dEB below -250 mEq/kg to elicit reductions in growth.[15] In a separate experiment where 3% $CaCl_2$ (dEB of -282 mEq/kg) was added to the diet but the Ca:aP ratio was not maintained (3.14 control vs 3.26 $CaCl_2$), a 93% reduction in ADG was observed.[5] This suggests that formulation strategy may impact the degree in which growth is slowed. Likewise, increased duration of feeding and heavier starting body weights could also have impacted the response observed. When $CaCl_2$ diets are fed, intake tends to be lowest during the first week of consumption as pigs acclimate to the diet. For carcass characteristics, feeding above 2% $CaCl_2$ resulted in increased carcass lean and decreased backfat as early as 14 days after the beginning of the experimental feeding period. This may reflect lighter body weights at marketing when pigs were fed $CaCl_2$. Furthermore, pigs fed 2% $CaCl_2$ exhibit decreased loin pH and tenderness, which indicates reduced eating quality.[5] Feeding ammonium chloride at 2% or 2.75% of the diet (dEB ≤ -299 mEq/kg) has also been shown to decrease growth by 39% or 98% in 25-kg pigs, respectively.[11] However, when fed at 1.25% with a dEB of -158 mEq/kg, no differences in growth were observed. This response is similar to when 2% $CaCl_2$ was fed, further emphasizing the effect of dEB on pig growth performance.

Table 1: Effect of feeding strategy on the growth and carcass leanness of growing-finishing pigs

Feeding strategy	Housing	Initial BW, kg	Days on feed	Δ ADG*, %	Δ ADFI*, %	Carcass characteristics	Reference
Low protein diets (SID Lys, %)							
0.16	Group	125	42	-47	0†	↓ loin eye area ↓ lean percent ↑ backfat depth	Helm et al, 2021[5]
0.18	Group	89	28	-23	0†	NR	Rao et al, 2021[6]
0.18	Group	89	14	-71	-12	NR	Rao et al, 2021[6]
0.18	Individual	73	28	-59	-19	↓ loin eye area	Helm et al, 2021[7]
0.21	Group	93	42	-55	-4†	↓ lean percent	Norton et al, 2020[8]
0.48	Individual	73	28	-17†	0†	↓ loin eye area	Helm et al, 2021[7]
0.50	Group	89	44	-16	-1†	↓ lean percent ↑ backfat depth	Rao et al, 2021[6]
AA balance							
0.45% Ile:Lys	Group	125	42	-10†	-4†	- †	Helm et al, 2021[5]
2.50% Sulfur AA:Lys	Group	110	35	-28	-15	- †	Edmonds et al, 2021[9]
4.46% Sulfur AA:Lys	Group	110	35	-67	-37	↓ backfat depth	Edmonds et al, 2021[9]
0.16% Trp:Lys‡	Group	32	119	-12	-4†	NR	Russi et al, 2021[10]
High fiber diets (Neutral detergent fiber, %)							
15.0	Group	125	42	+1†	+3†	- †	Helm et al, 2021[5]
15.0	Individual	73	28	+7†	+6†	- †	Helm et al, 2021[7]
20.0	Group	125	42	-19	-11	↓ backfat depth	Helm et al, 2021[5]
20.0	Individual	73	28	-6†	-1†	↓ backfat depth	Helm et al, 2021[7]
25.0	Individual	73	28	-15†	-7†	↓ backfat depth	Helm et al, 2021[7]
dEB, mEq/kg (with $CaCl_2$)							
-161§	Individual	73	28	-15†	-2†	- †	Helm et al, 2021[7]
-282¶	Group	125	42	-93	-42	↓ loin eye area ↑ lean percent ↓ backfat depth	Helm et al, 2021[5]
-404§	Individual	73	28	-77	-49	↓ loin eye area ↓ backfat depth	Helm et al, 2021[7]
dEB, mEq/kg (with NH_4Cl)							
-158¶	Individual	25	21	0	NR	NR	Kokinos et al, 2022[11]
-299¶	Individual	25	21	-39	NR	NR	Kokinos et al, 2022[11]
-439¶	Individual	25	21	-98	NR	NR	Kokinos et al, 2022[11]

* Percent changes in ADG and ADFI were calculated using the control ADG and ADFI for each experiment.

† Not statistically different, $P \geq .05$.

‡ 0.16% SID Trp:Lys was fed in a diet that contained 80% of the SID Lys requirement.

§ Calcium:standardized total tract digestible phosphorus ratio was maintained through the addition of monosodium phosphate in the diet.

¶ When dEB values were not provided, dEB was calculated using the equation dEB, mEq/kg = (Na% × 434.98) + (K% × 255.74) – (Cl% × 282.06). Na, K, and Cl% were determined using National Research Council[4] values for major ingredients.

BW = body weight; ADG = average daily gain; ADFI = average daily feed intake; SID = standardized ileal digestible; Lys = lysine; NR = data not reported; AA = amino acid; Ile = isoleucine; Trp = tryptophan; dEB = dietary electrolyte balance.

Altering the pig's electrolyte balance is a risky approach if water availability is limited. Therefore, care must be taken to ensure pigs have *ad libitum* access to fresh drinking water. Likewise, oversupplying calcium through the inclusion of $CaCl_2$ for an extended period (> 3-4 weeks) may lead to detrimental effects on bone strength.

Management strategies

In addition to nutritional strategies, there are several management opportunities for slowing the growth rate of pigs. The most recommended approaches include increasing barn temperatures through decreased ventilation, increasing stocking density, or decreasing feed access by tightening feeder settings. With each, there are precautionary measures that should be taken to ensure animal and caretaker welfare. A list of recommendations for the different management strategies can be found in several resources that were written during the COVID-19 pandemic.[1-3]

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Conflict of interest

None reported.

Disclaimer

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