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Response of growing hogs to the inclusion of hybrid rye in low or high energy diets

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Take home messages

- Consider increasing the NE level of the first phase diet in the grower-finisher to avoid a reduction in growth performance when feeding 40% hybrid rye.
- Overall, hogs can handle 40% hybrid rye throughout the grower-finisher very well.
- A good strategy to save money on feed costs in grower-finisher would be to reduce the dietary NE level, as long as hogs can increase their feed intake to make up for the reduced energy level.

Why look at energy level in hybrid rye diets?

Long term sustainability of the livestock industries in the Canadian Prairies is dependent on reduced reliance on grains grown primarily for human consumption and increased use of alternative feeds and by-products. One such example is rye, a cereal crop comparable to wheat. Although the rye market in Canada is small relative to other crops, new rye hybrids with improved yield potential of 25 to 30% higher than older varieties has resulted in increasing acreages planted in Saskatchewan and Alberta, making them competitive as a feed grain. The new hybrid varieties (developed by KWS in Germany) not only have increased yields but have improved grain quality and are more resistant to ergot.

Net energy (NE), standardized ileal digestible (SID) lysine content, and price of rye are intermediate to those of wheat and barley. Hybrid rye also contains large amounts of highly digestible starch and similar amounts of SID amino acids and standardized total tract digestible P as corn, suggesting that rye has the potential to be a cost-effective ingredient in swine diets. Recent research has demonstrated that the new hybrid rye varieties can replace wheat or corn in diets fed to growing hogs with minor effects on growth performance or carcass traits. Several studies observed slightly reduced feed intake for pigs fed increasing hybrid rye substituting for wheat or corn, which in turn resulted in lower average daily weight gain. Typically, the growing pig will eat to meet their energy requirements, meaning that for diets with a high energy value a lower daily feed intake is needed to maintain growth performance. The current experiment was

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designed to determine if an increased dietary energy content will compensate for reduced feed intake of pigs fed diets formulated with rye substituting for wheat.

Our objective was to determine the effects of 40% hybrid rye inclusion in diets formulated to be either low or high NE on growth, feed intake, and energy digestibility of growing hogs. We hypothesized that growing-finishing hogs fed 40% hybrid rye would perform better on the high than the low energy diets.

Photo: Grow-finish research room at PSC

Hog trial setup

A total, 80 barrows and 80 gilts (~70 kg or 154 lb) were placed into 2 rooms, 16 pens per room, 5 pigs per pen. Pens were equipped with one dry feeder and a nipple drinker located at the back of the pen. Pens were randomly allocated to be fed diets with either 0% or 40% hybrid rye replacing wheat, and with either low (2350 kcal) or high (2450 kcal) NE per kg of diet, resulting in 4 treatments and n = 8 pens per treatment. Hybrid rye fed in this trial was the variety 'KWS Bono' developed by KWS LOCHOW GMBH (Bergen, Germany) and obtained from FP Genetics Regina, SK. The low energy diets were formulated to have similar dietary inclusion levels of all major ingredients compared to the high energy diets, except for a decreased inclusion of canola oil. Test diets were fed to slaughter weight over 2 growth phases (Phase 1; 70 to 85 kg BW; Phase 2; 85 to 130 kg BW). Pigs had free access to water and the assigned test diet in pelleted form.

As part of our study design, we will followed pigs from birth to slaughter. Provided that a marked improvement on the stress resilience, performance, or welfare of the pig is seen, the treatments implemented in the study could potentially serve as functional modifications to swine housing in production settings.

What we found

The hybrid rye fed in this experiment had relatively low levels of mycotoxins, including ergot. Energy digestibility was unaffected by rye inclusion and was reduced in the low relative to the high energy diets.

For the first 8 days of the trial (Figure 1), hybrid rye inclusion resulted in decreased feed intake. The reduction in feed intake with the hybrid rye diets was greater in the low vs. the high NE diets (reduction of 0.18 vs. 0.07 g/d, respectively). Feed efficiency (G:F) was also reduced in hogs fed the low energy rye diet, resulting in less weight gain than hogs fed one of the other three diets, and lower body weight on d 8. In the next 9 days (d 8 – 17), hogs on the low energy hybrid rye diets had numerically the lowest feed intake and feed efficiency, resulting again in lower weight gain and lower body weight on d 17. For the next growth period (d 17 to 28), the opposite happened with pigs fed the low energy rye diet gaining the most weight and having the best feed efficiency. Body weight was still a bit lower for the low energy rye diets compared to other diets on d 28. There was no effect of rye inclusion or NE level on weight gain after d 28, and body weight on d 43 and d 50 was no longer different among the treatments (Figure 2).

Looking at the overall results for the entire trial (d 0 to 50; Figure 3), pigs fed the low energy rye diets gained 77 g/d less than those fed the high energy rye diet or the low energy diet without rye. Overall feed intake was not affected by hybrid rye inclusion or NE level. Net energy intake was consistently greater for pigs fed diets with rye compared to those fed diets without rye. Overall feed efficiency was reduced in pigs fed rye diets compared to those fed diets without rye, but was not affected by NE level.

What these results mean

Pigs were fed wheat-based diets before the start of the trial, so it is possible that the reduced feed intake with the rye diets in the first 8 days of the trial was due to pigs needing to adapt to hybrid rye, however, this does not explain the differential response to the high and low energy diets. The decreased feed intake may have also partially been due to the greater dietary fibre content in rye that mostly consists of complex gummy sugars, which may increase gut fill and which can hold more water in the gut. This then limits the ability of especially younger pigs to consume more feed.

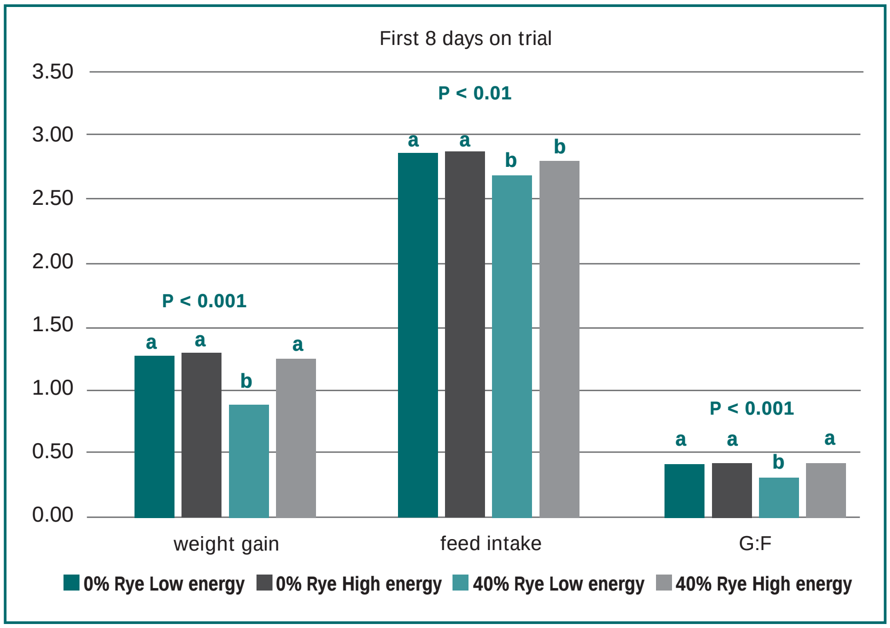

Figure 1. Growth performance in the first 8 days on trial of pigs fed 0 or 40% hybrid rye with low (2350 Mcal) or high (2450 Mcal) net energy

We had expected that hogs fed the high energy rye diets would grow better than those fed the low energy rye diets. This was indeed the case in the first 17 days of the trial. The higher NE level helped hogs on the hybrid rye diets compensate for the lower growth rate due to the rye, and daily gain was not different for pigs fed the high NE hybrid rye diet compared to pigs fed the low or high NE wheat control diets. It was interesting to see during the d 17 to 28 period that hogs fed the low NE hybrid rye diets showed the greatest weight gain and best feed efficiency of all diets, perhaps indicating compensatory gain happened. After d 28, there was no longer an effect of hybrid rye inclusion or NE level on weight gain or BW. Altogether, our data show that in younger animals the NE level of the diet may need to be considered when formulating diets including hybrid rye, but that overall, pigs can handle 40% hybrid rye throughout the grower-finisher phase very well.

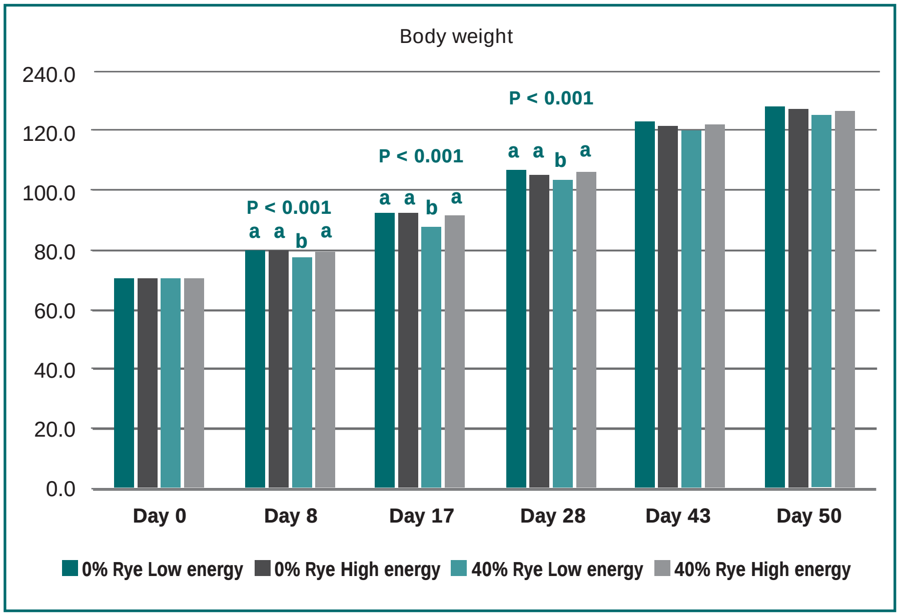

Figure 2. Body weight of pigs fed 0 or 40% hybrid rye with low (2350 Mcal) or high (2450 Mcal) net energy

Due to its lower NE value, when hybrid rye is replacing wheat in the diet the oil inclusion level needs to be increased. As a result, the price of not only wheat and hybrid rye but also of oil needs to be considered when deciding if it makes sense to feed hybrid rye. For this trial, we calculated the average cost of all ingredients between June and December 2022; wheat cost $474, hybrid rye $433, and canola oil $2,420. In this scenario, the hybrid rye containing diets were on average $7.73 per tonne cheaper than the wheat control diets for the low NE diets and $3.35 per tonne cheaper for the high NE diets. This small difference in price did not result in changes in feed cost per hog. On the other hand, feed cost per kg BW gain tended to be $0.04 higher for hogs fed hybrid rye vs. the wheat control diet, due to the lower overall feed efficiency for hogs fed the hybrid rye diets. The low NE wheat diets were on average $38.96 per tonne cheaper than the high NE wheat diets, and the low NE rye diets were on average $43.34 per tonne cheaper than the high NE rye diets. This large difference in feed cost per tonne translated to $5.22 lower feed cost per pig and $0.06 lower feed cost per kg BW gain for pigs fed low vs. high NE diets. This finding is in agreement with our previous research that has consistently shown lower feed cost per hog and per kg BW gain, as well as higher income subtracting feed cost when hogs are fed lower energy diets.

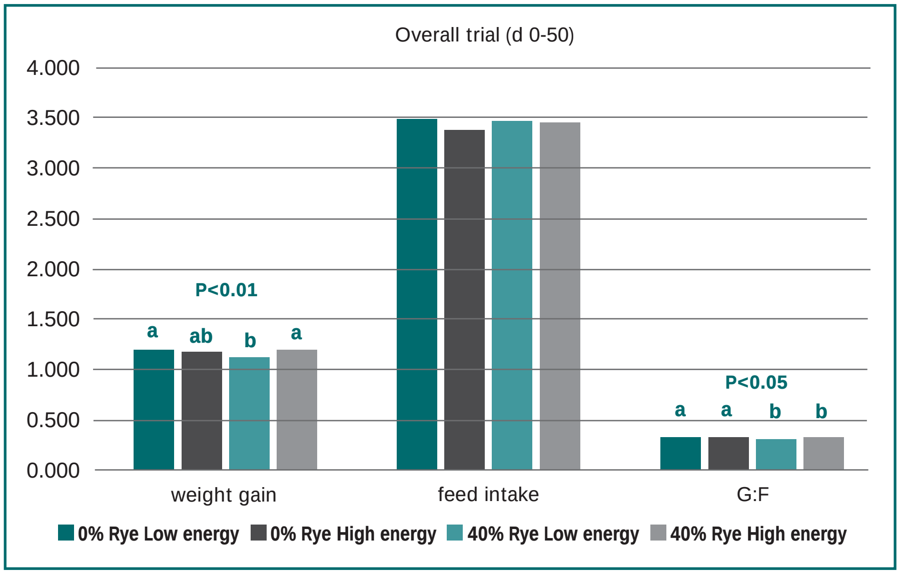

Figure 3. Overall (d 0 – 50) growth performance of pigs fed 0 or 40% hybrid rye with low (2350 Mcal) or high (2450 Mcal) net energy

Conclusion

In conclusion, it may be useful to consider increasing the NE level of the first phase diet in the grower-finisher phase to avoid a reduction in growth performance when feeding 40% hybrid rye. After the first 17 days, pigs did well on the 40% hybrid rye diets regardless of the dietary NE level, resulting in similar feed intake and final body weight as hogs fed wheat diets. A good strategy to save money on feed costs in the grower-finisher barn would be to reduce the dietary NE level, as long as hogs can increase their feed intake to make up for the reduced energy level.

Thank you

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Effects of gestation sow grouping practices on aggression and production

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In many parts of North America, the swine industry is working on the transition of gestation sow housing from individual stalls to open groups. When designing a group housing system, there are different management choices regarding group dynamics and time of mixing. Producers must decide whether to implement static (one-mixing event) or dynamic groups (multiple mixing events) and whether to mix sows soon after breeding (pre-implantation) or later in gestation (post-implantation).

One main concern with any type of group housing is the aggression performed when mixing unfamiliar sows into a group, as they compete to form a social hierarchy. Ongoing aggression is another related concern. Depending on management (i.e. grouping dynamics, feeding system, space allowance, etc.), varying levels of ongoing aggression may be experienced throughout gestation. In both cases, the aggression causes stress and has the possibility to impact sow productivity. It is therefore important to understand how different grouping practices influence sow aggression, and how to manage these systems to optimize productivity and wellbeing.

Study Design and Housing

The study was conducted at the Prairie Swine Centre (Saskatoon, SK), with financial support from Swine Innovation Porc (SIP) and Agriculture and Agrifood Canada. Three grouping treatments were compared in gestation: Control (Con): sows housed in stalls for 35 days after breeding, then moved to static groups; Static (Sta): sows mixed into static groups 1-8 days after breeding; and Dynamic (Dyn): sows mixed into dynamic groups 1-8 days after breeding with monthly mixing events (8-10 sows removed and replaced). Sows were housed in mixed parity groups, including gilts, with 25 sows per pen.

Free access stalls were used for the morning feeding after which all sows were removed from stalls and locked out in the common loafing area for the rest of the day. The loafing areas contained two nipple drinkers, two point-source enrichments and provided a space allowance of 2.08 m2/sow.

Mixing Aggression

To observe the behaviour of sows at mixing, video cameras were set to record the event, with frequency of aggression recorded in the first 30 min using scan sampling. In addition, skin lesions on the front, middle and hind regions were scored (using a scale of 0-3; where 0 indicates no lesions and 3, more than 10 lesions) before mixing and 24 hrs after mixing.

Within the first half hour of mixing, sows in the Sta groups spent more time in reciprocal, or mutual, fights than Con or Dyn sows. This suggests a greater intensity of fighting in the Sta sows compared to other treatments. However, Con sows, which were mixed later in gestation, had a more lesions in mid and hind regions and in total, in the 24 hrs following mixing. Overall, the highest number of lesions was found on the front region, reflecting reciprocal fighting, and the lowest number in the hind region.

Ongoing Aggression

Skin lesions were evaluated at three additional timepoints throughout gestation. Lesion scores later in gestation were greater in Dyn groups (Fig. 1), and Dyn sows had higher lesions overall than both Con and Sta, indicating higher levels of ongoing aggression in Dyn groups.

Lameness was also recorded during gestation (i.e. visible signs of lameness apparent in at least one leg) at the same evaluation timepoints as skin lesions. We found that Dyn sows had a higher incidence of lameness throughout gestation than Con or Sta sows (38%, 24% and 22% respectively).

Production

Body weight, backfat thickness, and body condition were measured for each sow at the beginning and end of gestation. The difference between the initial and final measurements showed no effects of grouping practices on sow body condition.

Farrowing rates, calculated as the number of sows that farrowed divided by the number of sows bred, for Con, Dyn and Sta treatments were 81%, 88% and 62%, respectively. The higher levels of aggression seen in the first half hour post-mixing may explain the reduced farrowing rate in Sta sows, but other management factors may also have contributed (e.g. seasonal effects). Because of the small herd size, sow enrollment took place over 14 months and treatments were not fully balanced for season.

In terms of litter quality, numerically, Dyn sows had fewer total born, live born, and still born piglets compared to Con and Sta sows, but it was not statistically significant. There was also an interesting correlation; sows with more lesions in the hind body region late in gestation had fewer still born piglets.

> "Dynamic mixing may serve as a viable alternative to group housing for pork producers"

Impact of Social Status

The social ranking of sows was determined in two feed competition tests during gestation. Dominant sows in the Con and Sta treatments had significantly lower lameness than subordinate sows in the same groups (Table 1). Looking across all social rankings, sows in the Dynamic groups had high incidences of lameness.

Subordinate sows in the Dyn and Sta groups tended to have lower farrowing rates than intermediate and dominant sows, while farrowing rates in the Con group were similar across all social ranks. These results suggest that a more stable group is established by mixing late in gestation with effects of social pressure more evident in groups mixed early in gestation.

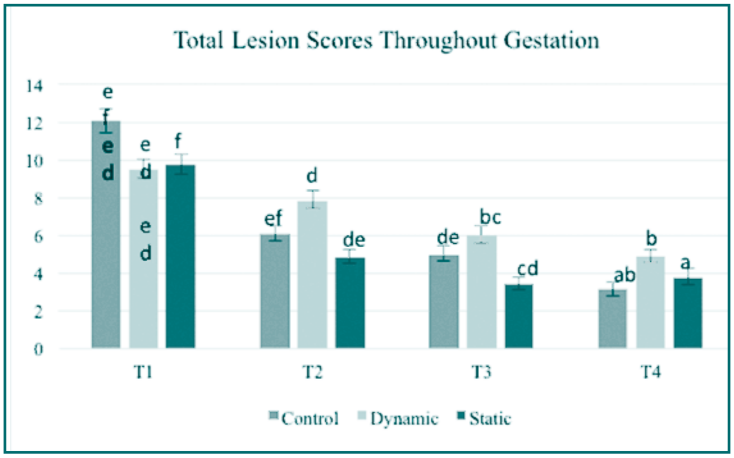

Figure 1. Total lesion scores by grouping treatment throughout gestation. Fresh lesions were scored at four different timepoints. T1: 24 hours post-mixing, T2: ~day 63 of gestation, T3: ~day 91 of gestation, T4: at movement to farrowing. Bars having different letters across timepoints (T1, T2, T3, T4) denotes a statistically significant difference (p<0.05).

Overall Conclusions

Static sows had a higher frequency of reciprocal aggression within the first 30 minutes of mixing while Control sows had higher lesions 24 hours post-mixing. Throughout gestation, Dynamic sows received more skin lesions and had a higher incidence of lameness. Thus, the initial mixing aggression was less intense in Dynamic groups but showed evidence of ongoing, or chronic, aggression. Although this did not affect farrowing rate, it suggests that the welfare of sows housed in dynamic groups may be compromised and may result in higher culling rates. Thus, dynamic mixing may serve as a viable alternative to group housing for pork producers provided that management strategies are refined to mitigate the effects of ongoing aggression.

Vehof is a graduate student at the University of Saskatchewan, Seddon is an assistant professor at the Western College of Veterinary Medicine, University of Saskatchewan, Brown is a research scientist in ethology at the Prairie Swine Centre.

Table 1. Percent (%) of sows observed with lameness and farrowing rate by grouping treatment* and social status. All P-values are chi-squared.**

Item	Control			P. Value	Dynamic			P. Value	Static			P. Value
	Sub	Int	Dom		Sub	Int	Dom		Sub	Int	Dom	
n	33	32	9		39	21	13		29	34	9	
Lameness (%)	45.45	21.88	0.00	0.013	43.59	38.10	23.08	0.420	41.38	11.76	0.00	0.004
Farrowing rate (%)	81.82	81.25	77.78	0.963	87.18	100.00	100.00	0.096	48.28	61.76	88.89	0.090

*Grouping treatments were Control: 25 sows mixed at ~35 days after breeding into static groups, Dynamic: 25 sows mixed 1-8 d after breeding into dynamic groups, Static: 25 sows mixed 1-8 d after breeding into static groups.
**Social status determined for sows in each group as Dom: dominant, Int: intermediate, or Sub: subordinate based on two feed competition tests.

New and alternative sanitization procedures for antibiotic-free swine barns

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SUMMARY

Certain barns that switched to antibiotic-free production observed increased prevalence of pathogens after a few years on the program. Developing improved sanitization and disinfection procedures is an important step to reduce the pathogen load in antibiotic-free barns, which was the goal of this study.

This project identified and screened various disinfection strategies comprised of conventional and non-conventional disinfection measures. The screening phase determined calcium oxide, peracetic acid (PAA), quaternary ammonium compounds (QACs), electrolyzed water (Slightly-acidic electrolyzed water (SAEW) and Alkaline electrolyzed water (AEW)), and silver nanoparticles as the most promising alternative measures. During laboratory-scale evaluations, the application of SAEW and PAA were identified as the most promising disinfection strategies, which were investigated further in in-barn tests.

The performance of PAA and SAEW was comparable to conventional disinfectants (Virkon) and showed longer effectivity than Virkon at 4 to 24 hours after its application. Economic analysis showed that SAEW reduces the overall cost of disinfectant used per pig while PAA costs a bit more than conventional disinfectants. This study indicates that SAEW and PAA solutions could be a better alternative to conventional disinfectants.

INTRODUCTION

Restrictions on the use of antibiotics in livestock production have been implemented in response to the increasing public concern about the development and prevalence of antimicrobial resistance (AMR) to medically important drugs, particularly antibiotics. Despite various strategies developed to keep swine herds healthy with the reduced availability or total absence of antibiotics, disease outbreaks still occur caused by the gradual increase of microbial load in barns.
Currently, the most commonly used method for controlling pathogens in swine barns is the use of disinfectants such as quaternary ammonium compound (i.e. Synergize) and potassium peroxymonosulfate (i.e. Virkon). However, some pathogens develop resistance to these chemical disinfectants decreasing their biocidal capabilities. This study aimed to develop alternative disinfection measures to control the growth and transmission of disease-causing pathogens.

EXPERIMENTAL PROCEDURES

The first phase of this study consisted of a comprehensive literature review that identified 18 potential sanitation and disinfection measures, which were evaluated based on their applicability in swine barns, intrinsic properties, and safety. The six most promising measures were then subjected to laboratory-scale evaluation where polycarbonate coupons inoculated with microbial load collected from the Prairie Swine Centre barn were used as test surfaces to mimic in-barn conditions. The coupons were treated with the selected alternative disinfectants together with commonly used barn disinfectants such as Virkon as Control, and their efficacy in reducing the microbial load was assessed and compared.

The second phase of the study investigated the two most promising disinfection strategies in in-barn tests. Rooms were pressure-washed following standard cleaning practices in commercial barns, except for the sanitizing/disinfecting step, which was part of this experiment. With Virkon as control, the selected treatments were evaluated in grow-finish, nursery and farrowing rooms and applied on various types of surfaces: concrete (flooring), metal (drinkers), plastic (penning), and wood (partitions).

The final phase of the experiment consisted of a feasibility analysis to determine the applicability of the most promising disinfection strategies in reducing microbial population levels in various production stages in a commercial pig barn. The main components of the analysis included all the costs associated with the disinfection strategies, materials and equipment required, labour, and operating costs.

RESULTS AND DISCUSSION

The screening phase yielded calcium oxide, peracetic acid (PAA), quaternary ammonium compounds (QACs), electrolyzed water (Slightly-acidic electrolyzed water (SAEW) and Alkaline electrolyzed water (AEW)), and silver nanoparticles as the most promising alternative measures. Of those, the laboratory-scale evaluation identified the application of SAEW and PAA as the most promising disinfection strategies, which were further assessed in the in-barn experiment.

High-pressure washing reduced the microbial population by approximately 99%. A further reduction in microbial population was achieved after applying the three disinfection methods (Virkon, SAEW and PAA). The performance of PAA and SAEW was comparable to conventional disinfectants (Virkon). The microbial population at 4 hrs and 24 hrs after disinfection with Virkon increased relative to the initial concentration after pressure washing, but remained almost unchanged after disinfection with SAEW or PAA (Figure 1).

(New and alternative sanitization ... cont'd on page 11)

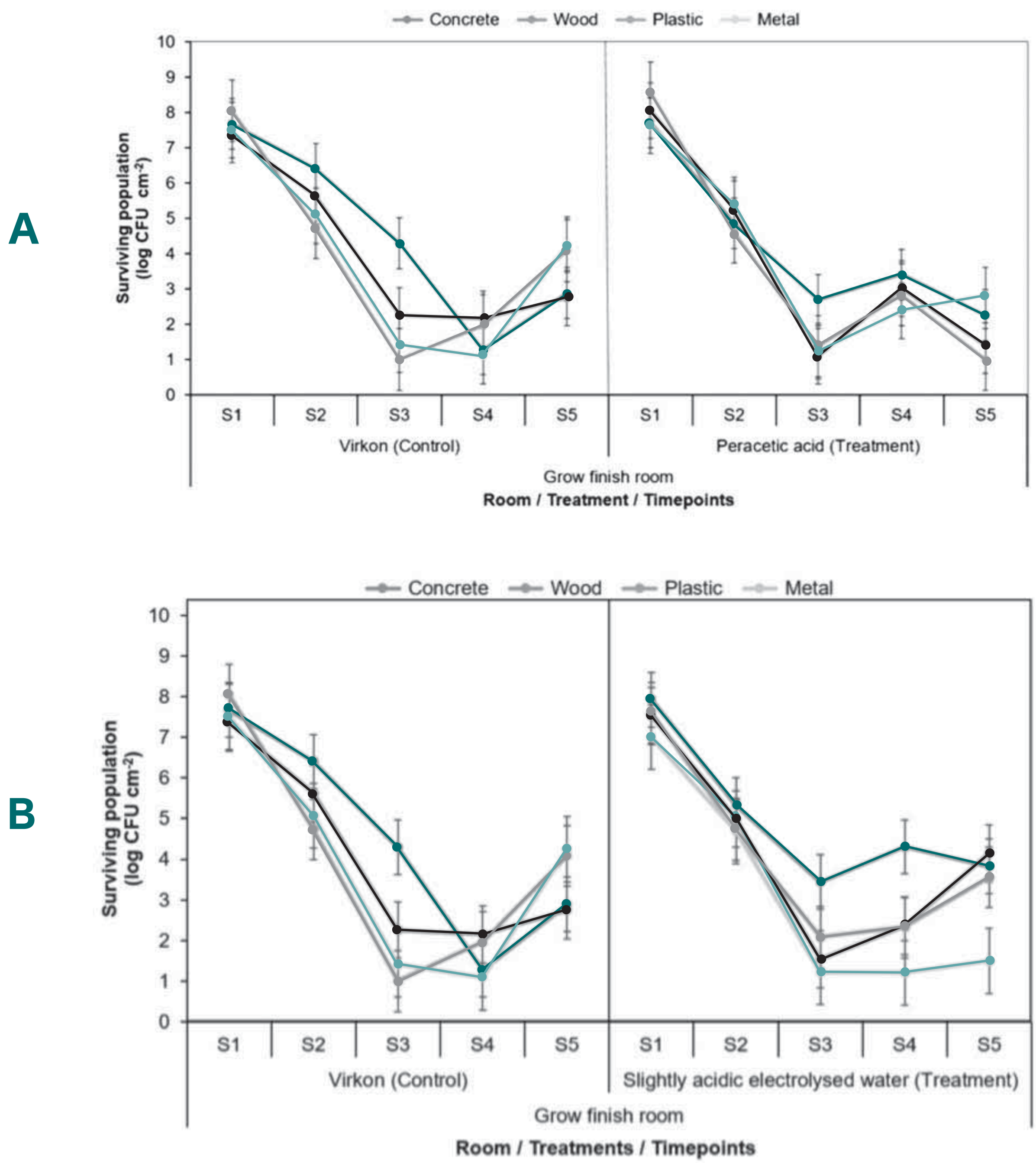

Figure 1. Mean (± SD) of log CFU cm-2 of A) Virkon (Control) and Peracetic acid (treatment) B) Virkon (Control) and Slightly acidic electrolyzed water (treatment) from different types of sampling surfaces in a grow-finish room; S1= before washing; S2 = right after washing and drying; S3 = treatments applied after washing; S4 = 4 hrs after disinfection; S5 = 24 hrs after disinfection. Performance of the control and treatment on different surfaces (from S1 to S5) are not significantly different (P>0.05).

Dietary nitrogen content affects lysine requirement and nitrogen utilization and retention in growing pigs

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Reducing protein content in diets while supplementing crystalline amino acids to meet essential amino acid requirements has become commonplace. In general, these diets have been successful at maintaining growth performance while reducing protein (i.e., nitrogen) waste into the environment. However, in some situations, for example when dietary protein is reduced by more than 3%, non-essential amino acids or total dietary protein may become limiting for maximum nitrogen retention (i.e., lean gain) and growth performance. For example, Guay et al. (2006) and Jansman et al. (2016) observed reduced growth performance in pigs fed low protein diets even though a sufficient amount of essential AA had been added. This suggests that non-essential amino acids may become essential when dietary protein is below a critical level. Nitrogen deficiency may limit essential amino acid utilization and result in changes in essential amino acid requirements.

It has been suggested that the ratio of essential amino acid-nitrogen to total nitrogen ratio (E:T) can be used as an indicator of nitrogen sufficiency in the diets. At extreme ratios, nitrogen utilization suffers due to a lack of essential amino acids (i.e., low ratios) or non-essential amino acids/nitrogen (i.e., high ratios). Heger et al. (1998) estimated an optimum ratio of 0.48 in pigs for maximum nitrogen retention, however, this ratio was calculated using total essential amino acids and only amino acid nitrogen. Advances in our understanding of nitrogen metabolism have shown that pigs are capable of utilizing sources of non-protein nitrogen (NPN; e.g., urea, ammonia) to meet amino acid requirements, especially for non-essential amino acids. Therefore, we have suggested that the E:T ratio should be calculated as the standardized ileal digestible (SID) essential amino acid nitrogen up to requirements (E) and nitrogen from all other sources (T; crude protein).

Our objectives were to:

1. Determine the effect of E:T ratio on the lysine requirement for nitrogen retention in growing pigs.
2. Determine the effect of E:T ratio and inclusion of non-protein nitrogen (i.e., ammonium phosphate) on the lysine requirement for nitrogen retention in growing pigs.
3. Determine the effect of E:T ratio, lysine content, and non-protein nitrogen inclusion on growth performance, nitrogen output, and body composition of growing pigs.

Methodology

Study 1 (Objective 1): A total of 80 growing barrows with an initial body weight of 21.5 ± 0.89 kg were randomly assigned to 1 of 10 diets (n = 8) in 8 blocks in a 2 × 5 factorial arrangement. Diets consisted of a low E:T ratio (LR; 0.33) or a high E:T ratio (HR; 0.36) with graded lysine content (0.8%, 0.9%, 1.0%, 1.1%, and 1.2% SID) fed at 2.8 × maintenance metabolizable energy requirements in 2 equal meals each day. The E:T ratio was adjusted in these diets by altering the soybean meal content in the diet while keeping the essential amino acid content constant. After a 7-d adaptation, a 4-d nitrogen-balance collection was conducted and nitrogen retention was calculated as the difference between nitrogen intake (diet) and output (urine and feces).

Study 2 (Objective 2): A total of 90 growing barrows with an initial body weight of 20.4 ± 0.46 kg were randomly assigned to 1 of 10 dietary treatments (n = 9 pigs/treatment) in 9 blocks in a 2 × 5 factorial design. Diets contained no ammonium phosphate (NAP; E:T of 0.36) or were supplemented with 1.7% ammonium phosphate (AP; E:T of 0.33) as a source of NPN with graded levels of dietary lysine [0.8%, 0.9%, 1.0%, 1.1% and 1.2% SID] fed at 2.8 × maintenance metabolizable energy requirements in 2 equal meals each day. The E:T ratio was adjusted in these diets by altering the inclusion of ammonium phosphate while keeping the essential amino acid content constant. After a 7-d adaptation, a 4-d nitrogen-balance collection was conducted and nitrogen retention was calculated as the difference between nitrogen intake (diet) and output (urine and feces).

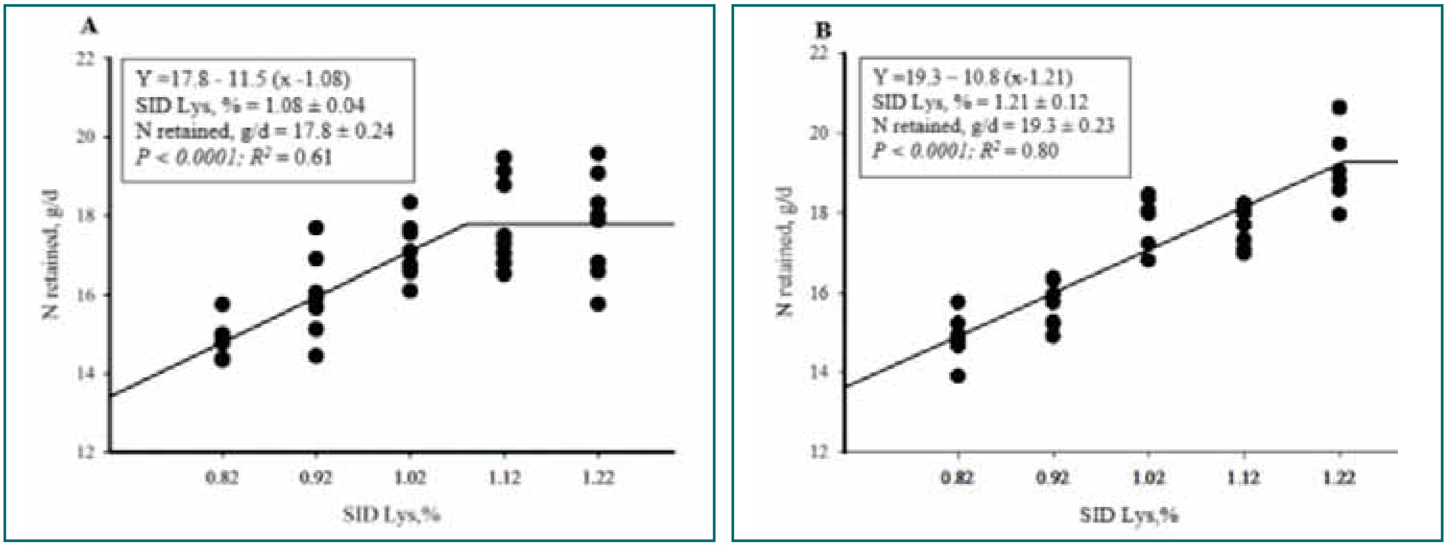

Figure 1. The linear broken-line model estimated nitrogen retention (N retention; g/d) in pigs fed high (HR; 0.36) or low (LR; 0.33) E:T ratio diet. A breakpoint was achieved at 1.08 SID Lys, % with a maximum N retention of 17.8 g/d for pigs fed the HR diets (Fig. 1A). While the breakpoint was achieved in pigs fed the LR diet at 1.21 SID Lys, % with a maximum N retention of 19.3 g/d (Fig.1B).

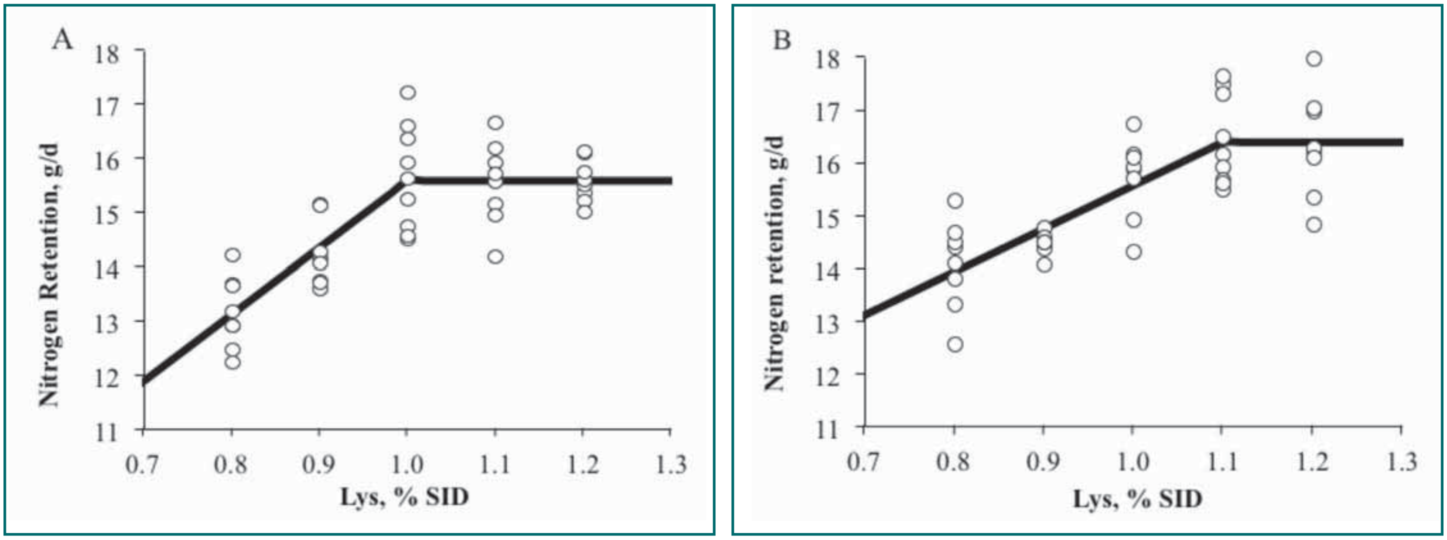

Figure 2. The two-phase breakpoint analyses estimates for nitrogen retention (NR; g/d) in pigs fed no ammonium phosphate (NAP) and ammonium phosphate (AP). The analyses indicated a breakpoint of 1.00% with maximum NR at 15.6 g/d in pigs fed the NAP diet (A). A breakpoint of 1.09% with maximum NR at 16.4 g/d was achieved in pigs fed the AP diet (B).

Study 3 (Objective 3): A total of 240 mixed-sex growing pigs with an initial body weight of 20.2 ± 2.18 kg were housed in groups of 5 pigs/pen. Pens were randomly assigned to 1 of 6 dietary treatments over 3 blocks (n = 8 pens/treatment) in a 2 × 3 factorial design, with factors of NPN inclusion (no ammonium phosphate [NAP] or ammonium phosphate inclusion at 1.7% [AP]) and dietary lysine (1.03%, 1.15% or 1.27% SID). The NAP and AP diets were formulated to have an E:T ratio of 0.35 and 0.33, respectively. Pigs had ad libitum access to feed and water for the duration of the experiment (28 d). Individual pig body weight and feed intake were measured weekly to determine average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F). Fresh fecal samples were obtained on d 15 to determine digestibility. On d 28, backfat and lean depth were measured on 2 pigs per pen via ultrasound.

Results

Study 1 (Objective 1): There was a significant interaction between E:T ratio and, where LR diets had a higher nitrogen retention than HR diets, while increasing lysine linearly increased nitrogen retention in both HR and LR diets. The marginal efficiency of utilizing SID lysine reduced with increasing lysine content, while the efficiency of utilizing N increased as lysine increased. The SID lysine required to maximize nitrogen retention of HR-fed pigs was estimated at 1.08% (R2 = 0.61) and at 1.21% (R2 = 0.80) in LR-fed pigs (Figure 1).

Study 2 (Objective 2): Lysine and nitrogen content had an effect on fecal and urinary nitrogen output, including a decrease

(Dietary nitrogen content ... cont'd on page 10)

(Dietary nitrogen content... cont'd from page 9)

in urinary nitrogen and an increase in nitrogen retention with inclusion of NPN and increasing lysine ($P < 0.01$). The marginal efficiency of nitrogen was improved with increasing lysine content, but reduced with inclusion of NPN. Marginal efficiency of lysine was decreased with increasing lysine content, but improved with NPN inclusion. The linear breakpoint model indicated NR was maximized at 1.00% SID lysine (15.6 g/d NR; R2 = 0.68) in NAP-fed pigs and at 1.09% SID lysine (16.4 g/d NR; R2 = 0.61) in AP-fed pigs (Figure 2).

Study 3 (Objective 3): Overall ADG and d 28 body weight increased with increasing lysine, but were not impacted by dietary NPN content (Table 1). Inclusion of NPN reduced feed intake and increased G:F compared to pigs fed NAP diets. Inclusion of NPN increased fecal N output. Pigs fed AP diets had increased lean depth with no effect on backfat (Table 2).

Summary

These results indicate that:

- Non-essential amino acids, or total dietary nitrogen, become limiting in diets with a high E:T ratio. This deficiency can be mitigated through supplementation with either intact protein or a source of non-protein nitrogen (i.e., ammonium phosphate)
- An increase in dietary lysine is required when diets contain sufficient nitrogen as a result of improved nitrogen retention (i.e., lean gain)
- Including a source of non-protein nitrogen improved feed efficiency while maintaining growth performance, indicating that ammonium phosphate is an appropriate source of nitrogen in swine diets.
- Nutritionists should consider the E:T in diet formulation as an indication of N sufficiency.

Table 1. Growth performance metrics for diets with and without ammonium phosphate at 1.7% inclusion with increasing SID Lys content[1]

	No ammonium phosphate			Ammonium phosphate				P-valuesDom		
Lys, % SID	1.03	1.15	1.27	1.03	1.15	1.27	SEM	N	Lys	N × Lys
Body Weight, kg										
Day 0	20.2	20.2	20.4	20.3	19.9	20.2	0.38	0.30	0.32	0.36
Day 7	25.1	25.5	25.4	25.0	24.8	25.2	0.37	0.08	0.44	0.36
Day 14	31.1	31.7	31.6	30.8	30.8	31.8	0.35	0.17	0.05	0.14
Day 21	38.1	39.1	39.1	37.4	37.7	39.3	0.47	0.02	<0.001	0.06
Day 28	45.3	46.7	46.5	44.9	45.1	46.9	0.65	0.19	0.01	0.10
Average daily gain, kg/d										
Days 0-7	0.70	0.73	0.72	0.69	0.70	0.72	0.016	0.31	0.38	0.86
Days 8-14	0.88	0.90	0.88	0.82	0.85	0.95	0.031	0.62	0.17	0.16
Days 15-21	0.99	1.06	1.07	0.95	0.99	1.02	0.032	0.02	0.03	0.83
Days 22-28	1.03	1.08	1.07	1.06	1.05	1.10	0.038	0.74	0.65	0.73
Days 0-28	0.90	0.93	0.94	0.88	0.90	0.94	0.017	0.24	0.02	0.73
Average daily feed intake, kg/d										
Days 0-7	0.70	0.73	0.72	0.69	0.70	0.72	0.017	< 0.001	0.11	0.30
Days 8-14	0.88	0.90	0.88	0.82	0.85	0.95	0.023	0.003	0.19	0.30
Days 15-21	0.99	1.06	1.07	0.95	0.99	1.02	0.039	0.01	0.14	0.77
Days 22-28	1.03	1.08	1.07	1.06	1.05	1.10	0.064	0.01	0.51	0.37
Days 0-28	0.90	0.93	0.94	0.88	0.90	0.94	0.027	< 0.001	0.27	0.51
Gain:Feed, kg/kg										
Days 0-7	0.60	0.60	0.59	0.61	0.63	0.62	0.010	0.01	0.73	0.60
Days 8-14	0.57	0.60	0.60	0.60	0.60	0.65	0.013	0.02	0.02	0.28
Days 15-21	0.60	0.63	0.62	0.60	0.62	0.62	0.014	0.85	0.32	0.97
Days 22-28	0.57	0.57	0.54	0.57	0.59	0.58	0.016	0.14	0.61	0.47
Days 0-28	0.58	0.59	0.59	0.59	0.61	0.61	0.006	0.002	0.08	0.51

ADFI, average daily feed intake; ADG, average daily gain; G:F, gain:feed; Lys, lysine; N, nitrogen; SID, standardized ileal digestible; SEM, standard error of the mean.
[1]Data presented are least-square means (n=8 pens/treatment).

Table 2. Backfat and lean depth measurements from pigs fed diets not including or including ammonium phosphate at 1.7% inclusion with increasing SID Lys content[1]

	No ammonium phosphate			Ammonium phosphate			P-values			
Lys, % SID	1.03	1.15	1.27	1.03	1.15	1.27	SEM	N	Lys	N × L
Backfat, mm	6.6	6.7	6.8	6.4	6.4	6.5	0.32	0.15	0.80	0.89
Lean, mm	36.5	37.9	37.3	38.0	40.1	38.9	1.05	0.02	0.13	0.91

Lys, lysine; N, nitrogen; SID, standardized ileal digestible; SEM, standard error of the mean.
[1]Data presented are least-square means (n=8 pens/treatment).

(New and alternative sanitization... cont'd from page 7)

The feasibility analysis showed that relative to the cost of using current conventional disinfectants (e.g., Virkon), in the long run the application of SAEW reduces the total cost of disinfectant used per pig by about 20% for grow-finish and nursery rooms and about 26% in farrowing rooms. Compared to SAEW, peracetic acid yielded higher total cost with CAD$0.24/pig for grow-finish and nursery rooms, and CAD$1.42/pig for farrowing rooms, which are slightly higher compared to the conventional disinfectant (Virkon) with CAD$0.20/pig and CAD$1.21/pig, respectively. However, this can be compensated by its better effectiveness in reducing microbial concentration to lower levels (compared to the other treatments) and longer residual effects in keeping the microbial loads down. These results suggest that the use of SAEW and PAA solutions during sanitation could be a better alternative to conventional disinfectants. Specific recommendations and guidelines for applying these potential measures in a swine barn are summarized in Table 1.

IMPLICATIONS

We would like to acknowledge the financial support for this research project from the Saskatchewan Agriculture Development Fund. The authors would also like to acknowledge the strategic program funding provided by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund. In addition, we also wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that make it possible to conduct this research.

Table 1. Specific recommendations and guidelines for the application of PAA and SAEW in commercial barns.

	Peracetic acid	Slightly acidic electrolyzed water
Preparation of the working solution	- Concentration: 400 mg L-1 - Based on the actual-in barn trials, 12 L of working solution is sufficient for a 100-head room	- Concentration: 50 mg L-1 (active chlorine concentration) - Based on the actual-in barn trials, 12 L of working solution is sufficient for a 100-head room
Additional parameters	---N/A---	Required pH: 5.0 - 6.5 Input Voltage: 20 V Electrolyte: 36 g of salt/4 L of water
Storage of disinfectants	- Store the active ingredient in refrigerator (4˚C) when not in use - Always use freshly made working solution every disinfection process	- Always use freshly made working solution every disinfection process
Application of the working solution	- Disinfectant can be sprayed on target surfaces - Apply the disinfectant following the required dosage - Apply the working solution within an hour of preparation - Longer exposure time for rough surfaces like concrete - Wear PPEs during the disinfection process	

Personal Profile

Taiwo J. Erinle, MSc.
PhD Student

Hailing from Sagamu, South-Western Nigeria. Taiwo bagged a B.Tech degree in Animal Nutrition and Biotechnology from the Ladoke Akintola University of Technology, Nigeria, in 2018. Following this, he got admitted into a master's degree program in Animal Science at Dalhousie University, where he earned his MSc degree in 2022 under Dr. Deborah Adewole. His MSc research evaluated the antibiotic replacement of potentials of grape pomace and red osier dogwood extract as sustainable solutions to combat disease incidence in broiler chickens production challenged with Salmonella Enteritidis (SE) or SE lipopolysaccharide. In addition to poultry, Taiwo's quest for well-rounded professionalism in monogastric animal nutritional research motivated his research interest in swine nutritional physiology. He is currently in his Ph.D. degree program under the supervision of Dr. Dan Columbus. After completing his Ph.D., Taiwo hopes to remain in academia as a Post-Doctoral Fellow, where he would like to conduct high-quality poultry and swine research to improve monogastric animal productivity.

Coming Events

Alberta Livestock Expo
Lethbridge, Alberta
October 11, 2023

Red Deer Swine Technology Workshop
Red Deer, Alberta
October 18, 2023

Sask Pork Symposium
Sasktoon, Saskatcheewan
November 7 – 8, 2023

Brandon Hog & Livestock Expo
Brandon, Manitoba
December 13 , 2023

The NSERC Industrial Research Chair in Swine Welfare website is here!

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