"Compensatory body protein gain in newly weaned pigs"

Adam Totafurno
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Hannah Golightly

Good afternoon and thank you for joining us for the fourth presentation in a multi-part webinar series by The Ontario Swine Research Network.
My name is Hannah Golightly, and I'm a second-year veterinary student here at the Ontario Veterinary College, who has been assisting with the OSRN activities.
For those of you who haven't participated in a previous webinar in the series, the OSRN has been formed by faculty at the University of Guelph and representatives from Ontario Pork, OMAFRA and the Swine Veterinary Community. The goal of the network is to enhance and improve the timeliness and accuracy of the U of G swine research results and activities to end-users.

We also aim to highlight the on-going collaborative work taking place with other institutions and research partners in order to capture the provincial, national, and international impact of the U of G Swine Research Program. We intend to provide a platform where producers, veterinarians, industry, students and others can go for current and archived research results. We have now launched our website, www.uoguelph.ca/osrn where recordings of the webinars will be posted.
Before I introduce our speaker, I would like to inform you of some of the features of Adobe Connect, our webinar platform. You may enter a comment under the chat window, which should be at the bottom right hand side of your screen. To keep the webinar flowing, we'll be taking questions at the end.

So this afternoon I am pleased to introduce today's speaker, Adam Totafurno. To give you a bit of background, Adam completed his B.Sc in Animal Science at the University of Guelph in April 2015 and is currently pursuing a Masters in swine nutrition in the Department of Animal Biosciences here at the University of Guelph as well. Following the completion of his Masters, Adam plans on entering the swine industry.

With that, I will turn it over to Adam to take you through his presentation entitled, Compensatory Body Protein Gain in Newly-Weaned pigs.

Adam Totafurno

Thank you very much for that introduction, Hannah; and thank you everyone for joining in today to listen to me talk about my research in compensatory body protein gain in newly-weaned pigs.

So to start off, I'll start off with explaining what exactly is compensatory growth, then I'll move into my research that focuses on the effects of reducing lysine in their diet, and

the effects that they have on growth performance and carcass composition, and finally I'll finish off with future research and implications.

So feed costs are the single largest expense in pork production, and of the nutrients protein commonly is the second most expensive nutrient in the diet. So, by reducing protein in the diet, we can substantially reduce feed costs. However, what are the effects on growth performance and body composition?
Well there's two things I'd like to point out first. Firstly, protein in the diet can be utilised towards lean mass in the pig. And secondly, in general, producers are paid based off the amount of lean mass that their pigs have. So by reducing protein in their diet, they may reduce the amount of lean mass in the pig, and therefore the amount of money that the producers receive. So obviously this is not a very attractive option. However, what if this decrease is only temporary? Well, this brings up the concept of compensatory growth.

Compensatory growth can be defined as a physiological process whereby an animal accelerates its growth following a period of nutrient restriction compared to controls. Compensatory growth can be broken down into two phases. The first phase is what we refer to as the restriction phase, and this is when pigs are fed a low protein diet for a temporary period of time. And because of this low protein diet, we'll see a decrease in protein gain and an increase in fat gain compared to controls, and this is because the energy that could have been utilised towards protein has instead been utilised towards fat.

Following this we have what's referred to as the recovery phase and this is when we provide pigs with a high protein diet. And because of this high protein diet, we will see an acceleration in protein deposition and these pigs will attain the same body composition and body weight in the same time compared to the unrestricted controls, and potentially decrease feed costs. And this is especially important during the nursery phase, as diets in this phase are often highly expensive. And that simply put is what compensatory growth is.

Now to go a little bit more in depth about compensatory growth; compensatory body protein gain is driven by the minimum lipid to protein ratio, or the minimum amount of fat that the pig must have in its body to protein. We also refer to this as the target L:P or the target body composition that pigs try to achieve. To visualise this, I have a graph here which depicts the lipid to protein ratio directly following a dietary lysine restriction, and following into the recovery phase, when all pigs are provided with a diet which meets their requirements. The blue line represents the control group. And the red and yellow line represent the lipid to protein ratio of pigs which previously had a 15% and 13% dietary lysine restriction respectively. We see that directly following restriction the restricted pigs have a greater lipid to protein ratio, or in other words, are fatter than the controls, as energy has been partitioned mainly into fat instead of protein. However, at the end of this recovery phase, we see that the restricted pigs have essentially the same lipid to protein ratio, or in other words, the same body composition, and have potentially achieved compensatory growth.

Secondly, compensatory body protein gain is constrained by the pig's lean tissue growth potential, or Pdmax. Pdmax can be defined as the genetic maximum protein deposition that can occur in a pig per day. As well, compensatory body protein gain may be constrained by amino acid intake during the recovery phase. I understand that this may be a little bit confusing, so I thought I'd like to show a graph of what compensatory growth looks like.

Here a have a graph of a typical protein deposition curve of a control pig. Now typically energy intake is insufficient to express Pdmax and the associated minL:P, or in other words, most pigs are constrained by this minimum and are unable to achieve their Pdmax during the production period. However, what would happen if, for a period of time, we fed an amino acid deficient diet? As I mentioned earlier, protein deposition would decrease, lipid deposition would increase, and the actual lipid to protein ratio would be greater than the minimum lipid to protein ratio. Or in other words, these restricted pigs would be fatter than this minimum.

Now what would happen if we provide pigs with amino acids that are no longer limiting? Well firstly, the requirement for min L:P is met as the pigs are fatter than this minimum and therefore energy partitioning can be focussed towards protein deposition, and since these pigs are not constrained by this minimum, can potentially accelerate their growth beyond that of controls and potentially achieving a Pdmax. And that's kind of the key point with compensatory growth is that these pigs must be able to accelerate their growth beyond that - the restricted pigs must be able to accelerate their growth beyond that of the control pigs. And in order for compensatory growth to occur, the protein that was lost during the restriction phase must be gained back during the recovery phase.
So hopefully I haven't confused too many people. So moving onto my experiment now; the objective was to further understand compensatory growth and how it affects newly-weaned pigs. We hypothesised that pigs receiving a low lysine diet will have a reduced body weight, average daily gain, and protein deposition during the restriction phase compared to control where pigs are fed to meet the lysine requirements. However, following the restrictions, pigs will achieve full compensatory growth when given a high protein diet.

For this experiment, we used a total number of 144 pigs. These pigs were an F1 Duroc Cross with an initial body weight of 6.9 kilos. And additional eight pigs were slaughtered at the beginning of the experiment for initial body composition analysis. There was a total number of three treatments, which I'll get into in just a second, and there were a total number of six pens per treatment, and eight pigs per pen which was split into four barrows and four gilts. For this experiment, SID Lysine was used to formulate the diets. All you see here is just a summary of the percentage of lysine in the diet that was fed across the experiment in the various treatments.

Phase 1 and 2 is what we refer to as the restriction phase, and this was for a total period of three weeks; pigs were fed directly at weaning, either a control diet which was 10% above NRC requirements for SID Lysine, or 20% or 40% below NRC requirements

for SID Lysine. Following this we had what's referred to as the recovery phase and this was for a total period of six weeks. During this period, all pigs were fed common diets which were 20% above NRC requirements for SID Lysine. What you see here is just a summary of the main ingredients that were used in the diets; of course there are other ingredients, however they were made relatively constant across treatments. The main thing I'm trying to get across here is that the main ingredients that changed were corn and soybean meal, and I'd also like to point out the high quality protein sources that were used in this diet.

Now moving onto observations; growth performance observations were taken on a weekly basis. Feed intake was done per pen for average daily feed intake. Body weight was done per pig for average daily gain, and feed efficiency was gain to feed. Of course Serial Slaughter Observations occurred; serial slaughters occurred at week three, or at the end of the restriction; week six, or at the middle of recovery; and at week nine, or at the end of the recovery or at the end of the experiment. At each point, two pigs, one barrow and one gilt per pen, were utilised and analysed for carcass protein and lipid content. And all data was analysed using the PROC MIXED function of SAS.

Now moving onto results and, in particular, growth performance. When we look at body weight we see that at the end of the restriction body weight decreased linearly with decreasing lysine levels. However, at the end of the recovery, we see no significant differences in body weight across treatments and this suggests that compensatory growth has occurred.

Now to explain these variations in body weight, when we look at the average daily gain, we see that for the restriction period, average daily gain decreased linearly with decreasing lysine levels. However, during the recovery, we see that there's an increasing linear trend in average daily gain with decreasing lysine levels, and overall there is no significant differences in average daily gain across treatments, suggesting that compensatory growth has occurred.

Now when we look at daily average feed intake, average daily feed intake did not - was not different at any point during the experiment across treatments. Moving on to gain to feed; we see that during the restriction gain to feed decreased linearly with decreasing lysine levels, however during the recovery, gain to feed increased linearly with decreasing lysine levels and, in fact, overall, gain to feed did increase - or decrease, sorry, linearly with decreasing lysine levels.

Now that I've shown you these growth performance results, which suggest that compensatory growth has occurred, in order to validate this we need to look at the carcass composition. I just want to remind you that serial slaughters occurred at week three, or at the end of the restriction; week six or at the middle of the recovery; or week nine at the end of the recovery or at the end of trial. For the purpose of this presentation I have not included the week six data as, at this point, it did not appear that these pigs had achieved compensatory growth.

And when we look at carcass, we see that at the end of the restriction, carcass weight decreased linearly with decreasing lysine levels. However, at the end of the recovery there was no significant difference across treatments in carcass weights, suggesting that compensatory growth has occurred. Now when we break the carcass down into its total carcass protein and total carcass fat pools, in particular at the end of the restriction, we see that for protein - protein decreased linearly with decreasing lysine levels. However, the exact opposite occurred for fat and what we saw was that fat increased linearly with decreasing lysine levels.

When we look at calculated protein deposition and lipid depositions during the restriction phase, we see that protein deposition decreased linearly with decreasing lysine levels and lipid deposition increased linearly with decreasing lysine levels. And this is because, as I said before, because of this amino acid restriction, the energy that could have been utilised towards protein deposition had instead gone towards fat.
Now when we look at the total carcass protein and total carcass fat at the end of the recovery, we see that for both protein and fat there's no significant differences in these pools across treatments, and this shows that compensatory growth has occurred. When we look at calculated Pd and Ld for the recovery phase, we do not see any significant differences in protein deposition or lipid deposition across treatments. However, overall, protein deposition and lipid deposition - there are no significant differences across treatments showing us that protein deposition that was lost during the restriction has been gained back during the recovery.

And finally, to kind of summarise up what I was saying, and I mentioned the lipid to protein ratio earlier, what we saw during the restriction was the lipid to protein ratio increased linearly with decreasing lysine levels. Or, in other words, these restricted pigs are much fatter than the controls. However, at the end of the recovery, we saw no significant differences in the lipid to protein ratio, showing that these pigs have essentially identical body composition.

So in conclusion, Lysine negative 40 pigs, and Lysine negative 20 pigs achieved both compensatory growth six weeks post restriction. Better understanding of compensatory growth can benefit producers by potentially reducing costs of production without compromising performance and carcass composition.

And finally, there is a subsequent study that Jess finished about a month ago - it was very similar to this trial, however, this one is focussing primarily on carcass and meat quality. With that, I'd like to thank Dr. Kees de Lange, Dr. Ira Mandell, the De Lange Lab Group, Arkell Barn Staff, and of course thank you for financial support from NSERC, Wallenstein Feed Company, OMAFRA, Evonik and Ontario Park.

With that, I'll be happy to take any questions, thank you.

Karen Richardson

Thank you very much, Adam - that was really interesting. If anybody has any questions or comments, you can type them in now and I will let Adam know what they are. While

we're waiting, Adam, was there any differences between the gilts and the barrows that you noticed substantially?

Adam Totafurno
At this point, I haven't looked into that.

Karen Richardson
You haven't, yeah.

Adam Totafurno
I guess one question that people often have a lot of the time is that why do we feed them 20% above requirements during the recovery phase? And kind of the rationale for that is that, because these restricted pigs we assume can achieve a higher potential, we wanted to ensure that they were in fact restricted during the recovery phase.

Karen Richardson
Excellent. So we have a question here from Grand Valley Fortifiers; do you anticipate getting the same results for animals that are immune compromised?

Adam Totafurno
That's a very good question, and there has been some research that has focussed more on that. I guess with my research, we're kind of like assuming that all the energy and protein will go towards essentially lean growth. However we've seen - in research I've seen that, when there is an immune issue, we don't get the same results, in fact pigs may not achieve compensatory growth.

Karen Richardson
Okay, it looks like that's the end of the questions, so Hannah will sign off.

Hannah Golightly
All right, I just wanted to say thank you to Adam for giving us that great presentation. And thank you to everyone for joining in today and bearing with us through those technical difficulties - thank you for your patience. So that concludes today's webinar. And please watch your inboxes for information on our next webinar taking place in May. Thanks everyone, and have a great afternoon.