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# Substitution of conventional dried barley for MycoCURB™ ES treated barley improved lean gain and carcass grading in finishing pigs without affecting performance

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## Summary

A large commcerical trial (over 3,200 pigs) assessed the impact of substituting conventionally dried barley with high moisture barley preserved with MycoCURB ES on the performance and carcass grading of finishing pig production. Overall, pigs fed a diet with 35% treated barley:

- Had improved growth (1,011 g/day treated vs 995 g/day control) compared to those fed conventional diets, though feed efficiency was slightly redcued (2.657 treated vs 2.624 control)
- Had improved lean weight (61.2 % carcass weight treated vs 60.57 % control, $P<0.05$) and less backfat (12.29 mm treated vs 12.64 mm control, $P<0.05$) at slaughter
- Had improved carcass grading

Higher liveweight gains, improved carcass yield and lower mortality and condemnations lead to more kilograms of lean meat sold in pigs fed diets containing 35% treated barley.

## Introduction

Conventional wisdom says that the moisture content of wheat and barley must be less than 15% for prolonged storage without deterioration in quality (Hackl et al. 2010), unless kept in anaerobic conditions (Ton Nu et al., 2015). Given that unpredictable weather both throughout the growing season and at harvest can lead to moisture at harvest well in excess of 20 % moisture, processing post harvet is required. Artificial drying and treatment with an organic acids liquid preservative such as MycoCURB™ ES are commonly used. As drying is both energy intensive, costly and provides no residual protection against mould growth during storage, the energy requirement, cost and carbon footprint of grain processing can be reduced by treating grain at harvest with MycoCURB™ ES liquid. This has been a popular option in Ireland for over 20 years as it allows for rapid processing and long-term storage of grain while maintaining excellent grain quality during storage.

Barley is transported into storage by an augur/screw conveyor where MycoCURB™ ES Liquid is sprayed through nozzles at a predetermined rate, depending on its moisture content and the throughput of the augur. The augur is modified to improve its mixing action and by servicing and calibrating the liquid pumping equipment before each harvest, accurate, uniform and consistent liquid application is achieved. This process has been adopted by grain merchants in Ireland over the last 20 years to successfully store their grain, and more recently field beans, to the point where the annual tonnage treated now in Ireland is in excess of 350,000 tonnes.

The treated grain, predominately barley (some wheat and oats are also treated), is mainly used in ruminant feed in pelleted and "rolled" form as the retained moisture in the grain produces a physically excellent quality product. It is also used successfully pig feed, but to a lesser extent. As the moisture content of treated barley is higher and nutrients are diluted there is a perception that performance in the animal will be equally affected. However, previous scientific research has shown that this is not the case, with finisher pigs fed treated barley as a weight for weight substitute for dried barley at least maintaining performance. (Douglas et al, 2014).


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nutritionists have been reluctant to use it in pig feeds (due to nutrient dilution). Previous research and feeAnalysis shows that feeding acid-preserved high-moisture grains may improve margins per market pig considering costs of acidification, grinding, and savings accruing from avoiding the cost of grain drying (Sotto, 2019).
Therefore, a study was conducted to look at the effect of high moisture barley (HMB) on pig performance and carcass grading under commercial conditions.

## MATERIAL AND METHODS

A trial to assess the impact of substituting conventionally dried barley with barley treated with MycoCURB™ ES was conducted at Coolamber Pig Farm, a commercial unit of Kiernan Milling, Ireland. The trial ran in 2 consecutive cycles, starting in October 2019 and finishing in March 2020.

The unit runs an integrated birth to slaughter system, and it is of high health status. This finisher unit is dry fed using pellets as produced by Kiernan Milling (diet composition for the trial was as per Table 1), with single space feeders (wet and dry). Pens are equipped with 2 feeders per pen (28 pigs).

Pigs were weighed at the start of the trial in order to calculate initial starting weight, and then transferred to the finisher accommodation, where they were housed in 2 different houses. Each house consists of 32 pens with 28 pigs per pen. As it was not possible to record intake and FCR on a per pen basis, these parameters had 2 replicates which is the total and averages for all pigs in both houses.

All pens were weighed at the beginning of the trial and again at transfer to factory in order to accurately calculate average daily gain (ADG) across the whole period. All feed was manufactured at Kiernan Milling; feed was weighed and delivered to the experimental location prior to the trial starting. Each house is equipped with a feed bin (20 t) which was empty on commencement of the trial. Once the experimental period ends all pigs were weighed and slaughtered, and remaining feed left in the bins was removed and weighed. Therefore, calculations of average daily feed intake (ADFI) and feed conversion ratio (FCR) could be conducted. Mortality was also recorded.

A sample was taken from each new load of barley that arrived onsite for the trial. This sample was analysed in-house using NIR analysis and will be stored for reference purposes throughout the trial period. Every load of feed manufactured at Kiernan Milling and delivered to the trial location was analysed using NIR in-house and will be stored on site for reference purposes. Moisture contents were cross-checked using Brabender Oven (industry standard for Ireland).

Pigs were allocated 1st stage finisher feed for a period of 4 weeks; after this period the pigs moved onto 2nd stage finisher feed. This allocated amount of feed provided in the 4 weeks was the same for both control and treatment groups. At slaughter all pigs from the same treatment group were slaughtered together. This aided in the collection of data from the factory in relation to lean meat percentage and back fat thickness, in order to correlate it back to which treatment pigs were fed.

Slaughter data was then used to calculate the SEUROP grade of each carcass, as explained in Table 2. S is the most attractive grade and attracts the most competitive price from the slaughterhouse.

Statistical analysis was not possible on the feed intake or FCR, as these were measured per house, rather than per pen. For growth, deadweight, lean carcass weight and backfat thickness, data were analysed using the Fit Model platform of JMP 15 (SAS Institute, Cary, NC), with treatment as a fixed effect and cycle as a covariate. Differences were considered significant at $P < 0.05$.


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**Table 1**. Composition and nutritional levels of experimental diets

| | Finisher 1, 35-65 kg | | Finisher 2, 65 kg - slaughter | |
|---|---|---|---|---|
| | **Control** | **Treatment** | **Control** | **Treatment** |
| Raw Materials, % | | | | |
| Dried Barley | 35.00 | -- | 35.00 | -- |
| Treated Barley | -- | 35.00 | -- | 35.00 |
| Maize | 20.00 | 20.00 | 20.00 | 20.00 |
| 49% Hi Pro Soya | 19.81 | 19.81 | 12.00 | 12.00 |
| Wheat | 15.65 | 15.65 | 19.66 | 19.66 |
| Pollard | 2.00 | 2.00 | 5.33 | 5.33 |
| Fat Blend 310 | 1.55 | 1.55 | 0.50 | 0.50 |
| 00 Rapeseed | 1.41 | 1.41 | 3.99 | 3.99 |
| Limestone Flour | 1.05 | 1.05 | 1.17 | 1.17 |
| Molasses | 1.00 | 1.00 | 1.00 | 1.00 |
| Soya Oil | 1.00 | 1.00 | -- | -- |
| Salt | 0.46 | 0.46 | 0.46 | 0.46 |
| L-Lysine Monohydrochloride | 0.40 | 0.40 | 0.40 | 0.40 |
| HKM Grower supplement | 0.25 | 0.25 | 0.25 | 0.25 |
| Monocalcium Phosphate | 0.23 | 0.23 | 0.15 | 0.15 |
| L-Threonine 98.5% | 0.13 | 0.13 | 0.10 | 0.10 |
| Methionine | 0.05 | 0.05 | 0.00 | 0.00 |
| Calculated Chemical Composition | | | | |
| Protein, % | 17.50 | 17.50 | 15.58 | 15.58 |
| Oil B, % | 4.57 | 4.57 | 2.64 | 2.64 |
| Fibre, % | 3.50 | 3.50 | 3.91 | 3.91 |
| Ash, % | 4.72 | 4.72 | 4.66 | 4.66 |
| D:E, MJ/kg | 14.01 | 14.01 | 13.25 | 13.25 |
| N:E, MJ/kg | 10.00 | 10.00 | 9.50 | 9.50 |
| Calcium, % | 0.63 | 0.63 | 0.66 | 0.66 |
| Phosphorus, % | 0.43 | 0.43 | 0.44 | 0.44 |
| Dig. Phos, % | 0.28 | 0.28 | 0.28 | 0.28 |
| Cal/Phos | 2.25 | 2.25 | 2.37 | 2.37 |
| NaCl, % | 0.58 | 0.58 | 0.58 | 0.58 |
| Lysine, % | 1.15 | 1.15 | 1.01 | 1.01 |
| Dig Lysine, % | 1.05 | 1.05 | 0.90 | 0.90 |
| M+C/Lysine | 0.55 | 0.55 | 0.55 | 0.55 |
| Thr/Lysine | 0.65 | 0.65 | 0.64 | 0.64 |
| Starch | 41.07 | 41.07 | 44.33 | 44.33 |


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**Table 2.** Definition of SEUROP grading system, by visual description of the carcass and objective measurement of lean meat

| Grade | Description | Lean meat, % cold carcass weight[1] |
|---|---|---|
| **S** | Superior – All profiles extremely convex; exceptional muscle development with double muscles | ≥ 60% |
| **E** | Excellent – All profiles convex, exceptional muscle development | ≥ 55% |
| **U** | Very Good – Profiles on the whole convex; very good muscle development | ≥ 50% |
| **R** | Good – Profiles on the whole straight; good muscle development | ≥ 45% |
| **O** | Average – Profiles straight to concave; average muscle development | ≥ 40% |
| **P** | Poor – All profiles concave to very concave; poor muscle development | < 40% |

[1] As per AHDB, 2020

## RESULTS AND DISCUSSION

Table 3 shows the results of NIR analysis of both the dried and MycoCURB treated HMB used in the trial, and the finished diets. Finished diets contained 35 % barley. It is clear from the analysis that both dried and HM barley are broadly similar in terms of chemical composition, though (as expected) the average moisture content of the HMB is ~4 % higher than that of the dried grain.

This increase in moisture is maintained in the finished diets, where diets formulated with the HMB are ~1 % higher moisture in the first phase diets, and identical in the second phase. However, HMB-formulated diets are 0.98-1.6 3% lower in starch than those containing conventionally dried barley, though protein, fibre and fat contents are broadly similar.

For the animal trial, there was minimal difference in initial starting weights between treatments (38.07 kg control vs 39.09 kg HMB). Average days on trial was slightly longer for the control group across treatments and cycles (85.36 control vs 84.46 HMB ). Growth performance and slaughter results are presented in Table 4.

Overall, substitution of conventionally dried barley with acid preserved high moisture barley resulted in a slightly higher average daily gain (995 g/day control vs 1,011 g/day HMB). On average, average daily feed intake was 2,611 g/pig and 2,686 g/pig for control and treated pigs, respectively. This lead to a numerical reduction in FCR in pigs fed diets formulated with MycoCURB™ ES treated high moisture barley (2.624 control vs 2.657 treatment).


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**Table 3.** NIR analysis of conventionally dried and MycoCURB treated high mosture barley, and finished diets containing 35% barley

| | Ash | Fat | Fibre | Moisture | NDF | Protein | Starch |
|---|---|---|---|---|---|---|---|
| *Dried Barley, Raw Material* | | | | | | | |
| Average | 1.82 | 1.63 | 4.70 | 13.62 | 16.04 | 10.23 | 51.12 |
| Range | 1.7-2.0 | 1.2-2.1 | 4.2-5.4 | 12.8-14.7 | 13.2-19.0 | 9.4-10.7 | 49.9-52.5 |
| *Treated Barley, Raw Material* | | | | | | | |
| Average | 1.76 | 1.67 | 4.00 | 17.52 | 16.68 | 9.83 | 51.67 |
| Range | 1.4-2.0 | 1.3-2.08 | 3.2-4.6 | 16.3-19.8 | 14.5-18.1 | 9.3-10.5 | 51.3-51.9 |
| *Dried Barley, 1st Phase Finished Diet* | | | | | | | |
| Average | 3.91 | 4.08 | 2.87 | 13.0 | 10.17 | 16.36 | 44.16 |
| Range | 3.6-4.2 | 3.7-4.2 | 2.8-3.0 | 12.9-13.2 | 9.6-10.7 | 15.7-16.8 | 43.9-44.6 |
| *Treated Barley, 1st Phase Finished Diet* | | | | | | | |
| Average | 3.77 | 4.08 | 3.05 | 14.30 | 12.01 | 16.56 | 42.53 |
| Range | 3.7-3.8 | 3.9-4.2 | 2.9-3.3 | 13.4-14.7 | 10.8-12.9 | 16.2-16.8 | 41.8-43.5 |
| *Dried Barley, 2nd Phase Finished Diet* | | | | | | | |
| Average | 3.33 | 3.37 | 3.32 | 13.20 | 12.90 | 15.17 | 43.79 |
| Range | 3.1-3.6 | 2.6-3.7 | 2.8-3.6 | 13.0-13.4 | 10.9-14.2 | 14.7-15.8 | 43.1-44.8 |
| *Treated Barley, 2nd Phase Finished Diet* | | | | | | | |
| Average | 3.64 | 3.85 | 3.34 | 14.03 | 12.48 | 15.55 | 42.81 |
| Range | 3.4-3.8 | 3.6-4.5 | 3.0-3.8 | 13.0-14.5 | 10.8-14.0 | 15.0-17.0 | 41.7-43.6 |

For pigs fed the control diets, 69 pigs died or were culled during the trial. Of these, 12 were sudden deaths, 6 were lame, 6 were rupture, 2 were due to ear problems, and 43 with tail biting injuries. For pigs on the HMB diets, 59 pigs died or were culled during the trial. Of these, 12 were sudden deaths, 7 were lame, 4 were rupture, 1 was stiff, 1 was sick, 3 were due to ear problems, and 31 with tail biting injuries. This meant that 1,723 pigs were sold from the control group, and 1,733 from the HMB group. Additionally, in the control group 15 carcasses were partially condemned and 8 fully condemned by the slaughterhouse. In treated pigs, only 8 carcasses were partially condemned and 6 fully condemned.

**Table 4.** Effects of substituting conventional dried barley for acid treated high moisture barley on pig performance and carcass traits

| | ADG, g | ADFI, g | FCR | Days on trial | Deadweight, kg | Lean weight, % | P2 backfat thickness, mm |
|---|---|---|---|---|---|---|---|
| **Dried barley** | 995 | 2,611 | 2.624 | 85.36 | 97.74 | 60.57 | 12.64 |
| **MycoCURB HM barley** | 1,011 | 2,686 | 2.657 | 84.46 | 98.15 | 61.22 | 12.29 |

Pigs fed diets formulated with MycoCURB treated high moisture barley had significantly higher lean weight (as percentage of cold carcass weights) and lower backfat than those fed conventionally dried barley. Under the SERUOP system lower backfat coverage and increased lean meat percent result in higher carcass grading. In this study, therefore, the reduction in backfat lead to significantly more pigs classified as the highest “S” carcass grade, as shown in Table 5.


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**Table 5.** Carcass grades of pigs fed diets formulated with 35% dried barley or 35% MycoCURB treated high moisture barley

| | MycoCURB HM barley | | Dried barley | |
|---|---|---|---|---|
| | **Total** | **%** | **Total** | **%** |
| **S** | 1,172 | 73.25 | 1,092 | 68.12 |
| **E** | 410 | 25.63 | 489 | 30.51 |
| **U** | 17 | 1.06 | 15 | 0.94 |
| **R** | 0 | 0.00 | 4 | 0.25 |
| **O** | 0 | 0.00 | 0 | 0.00 |
| **P** | 1 | 0.06 | 3 | 0.19 |

Bowland (1972) found improved that addition of propionic acid had no influence on backfat fatty acid composition, though there were small numerical decreases in backfat thickness (approximately 0.2 mm across shoulder, back and loin) and related increases in the loin eye area. Similarly, Thacker and Bowland (1980) found significant reductions in backfat of 2.4, 5.9 and 15.3% in pigs fed propionic acid at 3, 6, 9%, respectively. As in Jiao et al. (2018), this reduction was largely attributed to lower feed intake, which is not in line with the results of the current study where pigs fed with propionic acid treated HMB had significantly lower backfat than pigs fed diets formulated with conventionally dried barley, or that of Thacker and Bowland (1981).

The combination of higher deadweight, lower mortality, better grading and fewer condemnations for the MycoCURB™ treated barley diet led to at least a comparable efficiencey of production, compared to the conventional dried barley diet. Overall summary of trial data is shown in Table 6.

**Table 6.** Effect of substituting conventionally dired barely for MycoCURB treated high moisture barley on the production profitability of finishing pigs

| | Units | Dried barley | MycoCURB HM barley | Variance |
|---|---|---|---|---|
| **Total Feed delivered** | kgs | 399,670 | 406,700 | 7,030 |
| **Barley Inclusion** | % | 35 | 35 | |
| **Total dead weight sold** | kgs | 168,406 | 170,094 | 1,688 |
| **Total lean meat sold** | kgs | 102,004 | 104,132 | 2,128 |
| **Feed per unit output** | kgs/kg DW | 2.373 | 2.391 | 0.018 |
| **Condemned carcasses** | No | 21 | 14 | - 7 |
| **Lost dead weight condemations** | kg | 2,053 | 1,374 | -678.44 |
| **Feed per unit output** *(incl. condemnations)* | kgs/kg DW | 2.403 | 2.411 | 0.008 |


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## CONCLUSIONS

This trial shows that MycoCURB™ treated high moisture barley is suitable for use in finishing pig diets, having minimal effect on growth with improvements in lean weight and carcass grading. Overall there is potential to improve profitability of production per unit of pig meat.

The concerns of some nutritionists over the nutrient diluting effects of high moisture barley are disproved by these results. Use of MycoCURB™ treated high moisture barley in formulations can also take advantage of the reduced energy requirement and associated GHG emmissions reductions of processing and storing grain which is attractive for both pig farmers and grain merchants in terms of the overall sustainability of the field to fork food chain.

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