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CLA IMPROVES LEAN MEAT PERCENTAGE

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Lean meat percentage increased when CLA was added to finisher feed, but FCR did not improve. CLA is currently too expensive to add to finisher feed.

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Abstract

Conjugated linoleic acid (CLA) is naturally occurring in dairy products and meat, and research has repeatedly demonstrated a positive effect of CLA on gain, feed conversion ratio (FCR) and lean meat percentage in pigs.

Results in this trial showed that lean meat percentage increased in finishers fed CLA from approx. 62 kg until slaughter at approx. 111 kg, and this effect was seen to increase when inclusion rate increased (from 0 to 0.5%). Lean meat percentage was also positively affected regardless of whether the pigs were given 0.5% CLA from an average weight of either 62 or 83 kg. FCR remained the same regardless of inclusion rate and duration. Daily gain dropped, and therefore the improvement in lean meat percentage was not reflected in an increase in production value per place unit/year when using identical feed prices per feed unit (FUgp). There were no financial benefits in adding CLA to pig feed regardless of inclusion and duration.

Analyses revealed a linear correlation showing that a 0.1% increase in CLA significantly reduced daily feed intake by 0.02 FUgp a day and improved lean meat percentage by 0.02 percentage units when pigs were fed CLA from averagely 62 kg. Lean meat percentage was positively affected by 0.7 percentage units when pigs were fed 0.5% CLA regardless of starting point (62 or 83 kg).

With the current payment for lean meat percentage, it is not profitable to add CLA to finisher feed regardless of inclusion rate and duration.

The finishers in this trial were given CLA (Lutalin™ with 60% CLA) in increasing inclusion rates from an average weight of 62 kg. The trial, conducted on one farm, comprised five different inclusion rates of CLA: 0; 0.125; 0.25; 0.375; and 0.5% CLA. Inclusion of 0.5% CLA from an average weight of 83 was also investigated.

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Background

Several trials have demonstrated that lean meat percentage in finishers improves when CLA is added to the feed [2], [3], [4], [5], [9], [10], while others also found a positive effect on gain and/or FCR [1], [2], [3], [4]. Other trials revealed adverse or no effect of CLA on gain, feed intake and FCR [9], [10], [11], [12].

Naturally occurring in dairy products and meat, CLA is a group of isomers of linoleic acid called conjugated for having a double bound after a single bound. There are a total of 28 different CLA isomers distinguished by different locations of the double bounds on the chain or by the chain turning differently around the double bond. Cis-9-trans-11 and trans-10-cis-12 are the two most interesting isomers as they are believed to have a positive effect on the immune response, daily gain, FCR and carcass fat content. They are also the two primary isomers in the CLA products sold and used for trial purposes today.

Results of a Danish trial in which control pigs were compared with trial pigs fed 0.5% CLA and 1% CLA for the entire duration of the finisher period demonstrated that the addition of CLA significantly improved the production value due to an increase in lean meat of approx. 1 percentage unit [6]. However, CLA is expensive and is unrealistic to add for the entire finisher period. Subsequent trial results revealed that the addition of 0.5% CLA the final four weeks of the finisher period did improve FCR by averagely 0.1 FUgp per kg gain with the largest effect seen among castrates [7]. Furthermore, lean meat percentage increased among female pigs and castrates, and carcass fat was more saturated (iodine number increased).

Lutalin™ from BASF is the CLA product currently available. BASF recommends adding 0.5% CLA in the form of Lutalin™ to feed the final 4 weeks before slaughter. Lutalin™ is a methyl ester of

conjugated linoleic acid $C_{18}H_{35}O_2$ and contains 60% CLA. Lutalin™ contains 30% of each of the two isomers cis-9-trans-11 and trans-10-cis-12.

Even when added in the final part of the finisher period only, it is not profitable to add high inclusion rates. To make up for the difference in productivity, results of the above trial showed that when 0.5% CLA was added in the final 4 weeks before slaughter, the price per 100 FUgp may increase by DKK 10, which corresponds to a max price of CLA of DKK 20 per kg [7]. As CLA costs more than DKK 20 per kg, it is relevant to investigate the lowest inclusion rate required to obtain an effect on productivity and still be profitable.

The aim of this trial was to establish the lowest inclusion rate of CLA in feed and/or the shortest period of use required to obtain a positive effect on FCR and lean meat percentage while also being profitable to add to the feed.

Material and method

The trial was conducted at Pig Research Centre's experimental station Grønhøj. The trial pigs weighed av. 32 kg at trial start and were slaughtered at approx. 111 kg. They were fed dry feed ad libitum. The trial comprised 45-48 blocks (replicates) with 404-432 pigs/group. The initial trial design said 48 blocks in each group, but due to recording errors a number of blocks were excluded from the data analysis, which explains the variations in number. The diets used are described in Appendix 1. Each pen had one feeder and one nipple drinker/drinking bowl, and feeding was managed via a computerised feeding system.

The trial design is shown in Table 1. The trial comprised six groups: the pigs in group 1 were fed control feed, and the pigs in groups 2-5 were fed increasing inclusion rates of CLA (Lutalin™ with 60% CLA) from an average weight of 60 kg. The pigs in group 6 were fed 0.5% CLA from av. 80 kg. All pigs were fed control feed until 60 or 80 kg, respectively. The pigs were sorted according to sex (female and castrates), and the number of blocks with female pigs and with castrates was identical in as far as possible.

Table 1. Trial design.

Group	1	2	3	4	5	6
Treatment	Control	From 60 kg				From 80 kg
% CLA	0	0.125	0.25	0.375	0.5	0.5

All diets complied with the current standards for pig diets (30-105 kg) and all were nearly identical in ingredient composition with the exception of the addition of CLA. The feed for the control group contained palm oil. The energy content of CLA was equal to that of palm oil and CLA replaced a

corresponding amount of palm oil in these diets. CLA in the form of liquid Lutalin™ with a CLA content of 60% was added directly in the mixer with a pump that was calibrated before trial start. The feed was heat-treated and pelleted at min. 81 °C.

All diets were formulated with a calculated content of lysine, methionine, cystine, threonine and tryptophan 5% above the current standard, and for phosphorus and calcium 10% above the standard as a safety against variations in the nutrient content of the ingredients. It would be unfortunate for the trial outcome to be attributed to deficiency of amino acids or minerals.

Recordings

Daily gain, feed intake and lean meat percentage were recorded at pen level from transfer to the finisher section until slaughter. The production value was recorded as the primary parameter on the basis of these figures. Daily gain and feed intake were recorded before and after intermediate weighing at approx. 60 kg and 80 kg. All pigs (groups 1-6) were weighed batch-wise at the point when they were expected to weigh 60 and 80 kg, respectively, regardless of weeks after transfer. Treatments for disease and mortality rates were recorded as secondary parameters.

Feed analyses

A representative sample of each diet was collected according to the TOS principles (Theory of Sampling) [8] during each production round and analysed for FUgp and crude protein content. Every other sample was also analysed for lysine, methionine, cystine and threonine, and for calcium, phosphorus and phytase. Analysed feed units were used for calculating feed conversion ratio. BASF handled all analyses of CLA.

Production value

On the basis of daily gain, FCR and lean meat percentage, the production value (PV per place unit/year) was calculated based on an average of the last 5 years' prices of pigs and feed (September 2006 – September 2011). When 5 years' prices are used for the calculation, PV becomes an expression of the pigs' biological response to the treatment as price trends are neutralized.

The production value was calculated as:
PV per pig = sales price ÷ purchase price ÷ feed costs ÷ various costs.
PV per place unit/year = PV per pig × (365 days/productive days per pig) × utilization of housing unit.

The calculation of the production value included:

- Price of a 30 kg pig: DKK 331 per pig
- Kg adjustment: DKK ÷5.72 (25-30 kg) + DKK 5.41/kg (30-40 kg)
- Price a finisher, incl. bonus payment: DKK 9.60 per kg
- Finisher feed: DKK 1.50 per FUgp

- Various costs: DKK 20 per pig
- Utilization of housing unit: 95%

Statistical analyses

The production value was analysed as primary parameter. Recordings of disease treatments and mortality rates were analysed as secondary parameters. Data was subject to analysis in a generalised linear model with proc MIXED in SAS.

The effect on PV of increasing CLA inclusion and the duration of CLA inclusion was calculated for the entire period from transfer until slaughter and corrected for weight at transfer (32 kg). Increasing CLA inclusion was subject to linear regression.

The effect of increasing CLA inclusion on daily gain, feed intake, FCR and lean meat percentage, which form the basis of PV, was subject to statistical analysis for the period intermediate weighing to slaughter with weight at intermediate weighing as covariable (62 kg). Production results were subject to linear regression. The level of significance (P value) was corrected with 4 according to Bonferroni as the production results are not independent of each other (daily gain, feed intake, FCR and lean meat percentage). The effect on the individual production results of the duration of CLA inclusion was subject to statistical analysis for the entire finisher period. Trial groups 5 and 6 were compared with control and Bonferroni correction was performed for 2 comparisons in pairs (2 groups compared with control). Results are shown as an average for each group, and significant differences are stated at 5% level. The statistical model included weight at transfer and gender as systematic effects, and batch as random effect. The model with increasing inclusion comprised CLA inclusion as continuous variable, and the model with the duration of inclusion comprised group and gender constituted class variables.

Results and discussion

Feed

Feed analyses demonstrated agreement between analysed and declared content (cf. Appendix 2). However, in the feed for group 3, energy content was 2 FUgp lower than expected vs 1 FUgp lower for the other groups compared with declared. This did not affect the conclusion of the trial, though.

Contrary to expectations, CLA was detected in the control diet, albeit in very low concentrations. The variation in dosage between each group was identical, though, and the conclusion of the trial was therefore unaffected by this variation (cf. Appendix 3). In the feed for group 2, CLA content was 20 percentage units higher than expected, whereas the content in the remaining diets was as expected. However, analysis results did vary between the groups, but analyses of CLA generally did not indicate

any loss during pelleting. CLA was added directly into the mixer with a pump, and analyses confirm that dosage was as expected.

Health

Mortality averaged 1.8% and the sum of dead pigs and pigs moved to a hospital pen averaged 6.0% for the entire trial period. Results showed no differences between the six groups.

Production results

The production results shown in Table 2 for increasing CLA inclusion were calculated from intermediate weighing at 62 kg until slaughter. The production results for the duration of CLA inclusion were calculated from trial start at 32 kg until slaughter (cf. Table 4). Production value was also calculated for the entire finisher period and is shown in Tables 3 and 5. Start weight, weight at intermediate weighing and weight at the end of the trial did not differ significantly between the groups.

A linear correlation was observed for increasing inclusion of CLA in feed revealing that for each 0.1% increase in CLA inclusion from av. 62 kg, a significantly linear drop in daily feed intake of 0.02 FUgp a day ($P<0.01$) and a 0.2 percentage units ($P<0.01$) improvement in lean meat percentage were observed. No linear correlation was observed between inclusion rate and FCR and inclusion rate and gain.

Results found that the more CLA, the lower the feed intake, which may indicate that CLA reduced the taste of the feed and thereby affected pigs' appetite and consequently their feed intake. Results of another trial also revealed feed intake tended to drop when CLA was added in high inclusion rates [2].

Lean meat percentage improved when CLA inclusion increased, but as feed intake at the same time dropped significantly and gain dropped numerically, production value per place unit/year (identical feed price per FUgp) did not significantly improve.

These results do not support results from a previous trial demonstrating that pigs fed 0.5% CLA from av. 60 kg had a significantly higher production value than the control group [7]. Results from that trial revealed improvements in daily gain, FCR and lean meat percentage. However, other trials have demonstrated a positive effect on lean meat percentage when adding CLA without observing any effects on daily gain, feed intake or FCR [9], [10].

Table 2. Production results – increasing inclusion of CLA from av. 62 kg.

Group	1	2	3	4	5
% CLA inclusion	**0**	**0.125**	**0.25**	**0.375**	**0.5**
Blocks	48	45	45	47	46
Pigs	432	404	404	422	413
Before change of diets					
Start weight, kg	32.2	32.2	32.1	32.2	32.4
Daily gain, g/day	904	863	885	886	875
Feed intake, FUgp/day	2.09	2.05	2.09	2.08	2.06
FCR, FUgp/kg gain	2.32	2.38	2.38	2.35	2.38
After change of diets (intermediate weighing)					
Weight at intermediate weighing, kg	62.2	61.3	62.2	62.1	62.1
Daily gain, g/day	1,090	1,081	1,076	1,099	1,051
Feed intake, FUgp /day	3.26	3.26	3.20	3.22	3.17
FCR, FUgp/kg gain	3.00	3.02	2.99	2.93	3.03
Entire trial period (32.2-110.9 kg)					
Weight at pick-up for slaughter, kg	111.5	110.4	111.1	111.2	110.4
Daily gain, g/day	1,008	985	990	1,003	973
Feed intake, FUgp /day	2.76	2.73	2.71	2.71	2.69
FCR, FUgp/kg gain	2.74	2.78	2.74	2.71	2.77
Lean meat %	60.2	60.6	60.7	61.0	60.9

Table 3. Production value (32-111 kg) – increasing inclusion of CLA from av. 62 kg.

Group	1	2	3	4	5
% CLA inclusion	**0**	**0.125**	**0.25**	**0.375**	**0.5**
Production value, DKK/place unit/year	540	515	548	579	524
Production value, index	100	95	102	107	97

The addition of 0.5% CLA to feed for pigs from 62 kg and 83 kg, respectively, significantly improved lean meat percentage by 0.7 percentage units compared with control ($P<0.001$) (cf. Table 4). However, daily gain dropped ($P<0.05$) and the increased lean meat percentage did not improve production value per place unit/year when PV is calculated with identical prices per FUgp (Table 5). Feed conversion ratio did not differ significantly from control regardless of whether the pigs were given CLA from averagely 62 or 83 kg.

Put differently, lean meat percentage was positively affected regardless of whether CLA was added for a short or a long period before slaughter. However, results still revealed no overall financial benefit. The pigs were fed CLA for av. 45 days when CLA was added from approx. 62 kg vs 27 days when added from approx. 83 kg. It may be that the overall financial benefit could be increased by adding

CLA for even fewer days in the finisher period provided the increase in lean meat percentage translates into a higher pig price.

Table 4. Production results - 0.5% CLA in different periods (av. figures).

Group	1	5	6
Weight at CLA inclusion	**No inclusion**	**From 62 kg**	**From 83 kg**
Blocks	48	46	45
Pigs	432	413	404
Entire trial period (32.2-111.1 kg)			
Weight at pick-up for slaughter, kg	111.5	110.4	111.4
Daily gain, g/day	1,008	973	990
Feed intake, FUgp/day	2.76	2.69	2.70
FCR, FUgp/kg gain	2.74	2.77	2.73
Lean meat %	60.2	60.9	60.9

Table 5. Production value - 0.5% CLA in different periods (av. figures).

Gruppe	1	5	6
Weight at CLA inclusion	**No inclusion**	**From 62 kg**	**From 83 kg**
Production value, DKK/place unit/year	540	524	558
Production value, index[1]	100	97	104

1) Minimum 5 index points are required between control and trial in order for the difference to be significant.

Castrates had a significantly higher feed intake, a poorer feed conversion and a lower lean meat percentage than female pigs, but the effect of CLA was the same regardless of gender (results not shown). Parameters were neither affected by inclusion rate nor by the duration of CLA inclusion for each gender. This demonstrates that, contrary to previous findings [7], castrates do not benefit more from CLA inclusion in finisher feed than female pigs.

The group given 0.375% CLA had a numerically better feed conversion and a higher production value than the other groups. There is no biological explanation for this as there are no indications that this particular inclusion rate is better than others and the analysed nutrient content did not differ in this group.

In the period leading up to CLA inclusion, the pigs in the control group had a numerically higher daily gain and feed conversion than the trial pigs. Despite this difference, the pigs weighed almost the same at intermediate weighing at approx. 62 kg, which was attributed to the short period from transfer at 32 kg to intermediate weighing. This period did thereby not affect the conclusion for the entire period (production value). Only the period from intermediate weighing at 62 kg until slaughter is included for each parameter.

Conclusion

Overall, results demonstrated that the addition of CLA to pig feed has a positive effect on lean meat percentage. However, this is not reflected in an increase in production value per place unit/year when using identical feed prices per FUgp as daily gain dropped. Consequently, no financial benefit was observed when adding CLA regardless of rate and duration of the inclusion under the current pig price in terms of lean meat percentage. It may, however, be attractive to use CLA in specialised productions where approval and pig prices depend on lean meat percentage, but that will ultimately depend on the price of CLA and the increased price that can be obtained for a higher lean meat percentage.

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Appendix 1

Ingredients of diets, %

Ingredient	Group 1	Group 2	Group 3	Group 4	Groups 5 & 6
Wheat	37.02	37.01	37.01	37.01	36.98
Barley	33.25	33.25	33.25	33.25	33.25
Wheat bran	2.56	2.57	2.57	2.57	2.66
Soybean meal, dehulled	17.08	17.08	17.08	17.08	17.07
Sunflower meal, dehulled	4.00	4.00	4.00	4.00	4.00
Molasses	1.00	1.00	1.00	1.00	1.00
Palm oil	2.00	1.87	1.75	1.62	1.5
Lutalin™ (CLA)	-	0.13	0.25	0.38	0.5
Mono calcium phosphate	0.80	0.80	0.80	0.80	0.80
Calcium carbonate	1.29	1.29	1.29	1.29	1.29
Salt	0.40	0.40	0.40	0.40	0.40
HCL Lysine	0.23	0.23	0.23	0.23	0.23
DL Methionine	0.04	0.04	0.04	0.04	0.04
Threonine	0.06	0.06	0.06	0.06	0.06
DA vitamin SL/US	0.21	0.21	0.21	0.21	0.21
Phyzyme XP	0.01	0.01	0.01	0.01	0.01
Microgrits	0.05	0.05	0.05	0.05	-

Appendix 2

Analysed (An.) and declared (Decl.) nutrient content

	Group 1		Group 2		Group 3		Group 4		Groups 5 & 6	
	Decl.	An.	Decl.	An.	Decl.	An.	Decl.	An.	Decl.	An.
FUgp per 100 kg[1]	108	107	108	108	108	106	108	107	108	108
Crude protein, % [1]	16.7	16.9	16.7	16.8	16.7	17.0	16.7	16.9	16.7	16.8
Crude fat[1]	4.0	4.4	4.0	4.3	4.0	4.4	4.0	4.4	4.0	4.2
Ash[1]	5.2	4.7	5.2	4.7	5.2	4.7	5.2	4.7	5.2	4.7
Lysine, g/kg[2]	9.6	9.9	9.6	10.3	9.6	9.8	9.6	9.9	9.6	9.2
Methionine, g/kg[2]	2.9	3.0	2.9	3.0	2.9	3.0	2.9	3.0	2.9	2.9
Cystine, g/kg[2]	3.0	3.1	3.0	3.1	3.0	3.1	3.0	3.1	3.0	3.1
Threonine, g/kg[2]	6.5	6.6	6.5	6.8	6.5	6.6	6.5	6.7	6.5	6.5
Calcium, g/kg[2]	7.7	7.1	7.7	7.3	7.7	7.5	7.7	7.3	7,7	7.1
Phosphorus, g/kg[2]	5.6	5.6	5.6	5.7	5.6	5.9	5.6	5.8	5.6	5.6
Phytase, FTU/kg[2]	500	755	500	839	500	746	500	878	500	905

1) Analysed content based on 6 analyses.

2) Analysed content based on 3 analyses.

Appendix 3

Expected and analysed CLA content in pelleted feed (average of 6 analyses)

Group	1	2	3	4	5 & 6
CLA, % Lutalin™	0	0.125	0.250	0.375	0.500
Expected CLA inclusion, %	0	0.075	0.150	0.225	0.300
Analysed CLA inclusion, %	0.030	0.090	0.150	0.220	0.290