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EFFECTS OF DIETARY FISH OIL OR OTHER LIPIDS AND SANOVITE™ ON PIG PERFORMANCE AND PORK QUALITY

A thesis presented in partial fulfilment of the requirements for the Degree of Master of Science in Animal Science at Massey University, Palmerston North, New Zealand

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2010

ABSTRACT

In this experiment, the effects of (1) lipid type (soy bean oil, tallow and fish oil), (2) the period the fish oil was provided and (3) a dietary supplement containing conjugated linoleic acid (CLA), selenium (Se), vitamin E and vitamin C on pig performance and pork quality were studied.

Forty-eight female pigs (PIC hybrids, with a mean live weight of 16.19 kg ± 1.56 SD) were obtained from a single commercial operation in the North Island of New Zealand. The pigs were rank ordered by weight and assigned to one of six dietary treatment groups. The diet base was either a combination of animal and plant feedstuffs (AT and PTS), plant feedstuffs only (PO, POS) or plant feedstuffs combined with fish oil (PFSe and PFSl). The diets also differed depending on the presence or absence of the nutritional supplement Sanovite^{TM} and a vitamin C supplement. Sanovite^{TM} is a trademarked dietary supplement containing CLA (BASF, Auckland, New Zealand), organic Selenium (Alltech Inc., Nicholasville, KY) and vitamin E (Morel et al., 2008). Diets POS, PTS, PFSe, PFSl contained Sanovite^{TM} and a vitamin C supplement. Diets PO and POS were used to establish the effect of the supplementation with Sanovite^{TM} and the vitamin C supplement.
Pigs fed diet PFSe received plant feedstuffs and fish oil with supplement between days 1 and 35 and then diet POS up to day 84. Pigs fed diet PFSl received diet POS between days 1 and 35; plant feedstuffs and fish oil with supplement between days 36 and 56 and then diet POS up to day 84. Pigs in group PFSe and PFSl both received the same total amount of fish oil per pig (2.52 l/ 2.31 kg). Between days 1 and 56 of the experiment grower diets were fed, and finisher diets were fed between days 57 and 84 of the experiment.

The pigs were kept in pens of six, but fed individually twice daily (at approximately 8 am and 3.30 pm) according to a fixed feeding schedule. Water was available at all times. Individual feed intakes were measured daily and live weight recorded weekly.

Faeces were collected once a day during two days in week five of the trail for digestibility determination. Carcass quality characteristics determined at the abattoir included carcass weight and back fat thickness as measured at the end of the slaughter line. Meat quality assessments were performed on the Semimembranosus muscle (SM) from one of the topside cuts of each pig. Measurements of fatty acid profile (loin and backfat) and the Se content (lean meat) were conducted in Singapore by Mrs. J. Leong (MSc).

In this study plant or animal feedstuffs, lipid type, Sanovite^{TM} and vitamin C supplementation had no significant effects on growth performance and carcass quality.

There were no differences in apparent faecal digestibility characteristics for dry matter (DDM) and organic matter (DOM) in the un-supplemented animal (AT) and plant based (PO) diets.

Lipid type had a significant effect on the digestibility of ash (DA), and an increased ratio of unsaturated fatty acid to saturated fatty acid resulted in increases in DDM and DOM. DDM and DOM increased when soybean and linseed oil (POS) were used instead of tallow (PTS) or fish oil (PFS). The main differences in DDM, DOM and DA were observed between diets PO and POS. A positive effect of selenium, vitamin E and CLA supplementation is suggested.

Increased cooking temperatures reduced tenderness (higher mean, peak force, yield force and peak force – yield force) and increased cooking loss. There was a significant negative relationship between ultimate pH and relative lightness (L^*).

There were highly significant positive correlations between all three measurements of expressed juice, and there was a significant positive correlation between cooking loss at 60 and 70^oC ($P<0.01$) but correlations between expressed juice values and cooking loss were not significant.

The P-values for the contrasts for cooking loss at 70 ^0C were significant for all contrasts except for AT vs PO and PFSe vs PFSl. For all other contrasts, the P-values for cooking loss at 70 ^0C were significantly higher in group POS than for groups PO, PTS and PFSe+PFSl.

The P-value for (Peak force – Yield force) at 70°C was significantly higher in samples from group PFSe than for samples from group PFSl.

The P-value for the myofibrillar fragmentation index (MFI) was significantly higher for group AT in contrast to group PO. Group POS had a significantly higher P-value for MFI in contrast to groups PO, PTS and PFSe and PFSl.

Group POS had a lower P-value for sarcomere length in contrast to groups PFSe and PFSl. Group PFSe had a significantly higher P-value for sarcomere length in contrast to group PFSl.

Group PFSe had a significantly higher P-value for expressed juice percentage loss in weight in contrast to group PFSl.

Supplementing with Sanovite™ increased the Se content (P = 0.002) in lean meat as analysed by J. Leong (2010, personal communication).

In general it was concluded that an increase in the ratio of unsaturated fatty acid to saturated fatty acid (U/S) in the diet resulted in higher levels of unsaturated fatty acids in loin and backfat. The fatty acid profile in the diet reflected the fatty acid profile of pork. Backfat of pigs fed diets including soybean and linseed oil contained higher levels of linoleic and α-linolenic acids.

Diets PO and POS were used to establish the effect of the supplementation of CLA. The backfat of pigs fed diet POS contained higher levels of CLA (C18:2-*trans*-10, *cis*-12) and α-linolenic acid than pigs fed diet PO. The loin of pigs fed diet POS contained higher levels of palmitoleic and linoleic acid and CLA (C18:2-*cis*-9, *trans*-11) and lower levels of oleic acid than pigs fed diet PO.

The use of fish-oil as a lipid type resulted in the highest levels of eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA) and docosahexaenoic acid (DHA) in loin and backfat. The loin and backfat of pigs fed fish-oil in the second part of the grower phase (PFSl) contained higher levels of EPA, DPA and DHA than pigs fed fish-oil in the first part of the grower phase (PFSe).

By enriching the swine diet with long-chain omega-3 polyunsaturated fatty acids (LC n-3 PUFA) it was possible to increase the EPA, DPA and DHA content of pork. Enriching pork with LC n-3 PUFA will contribute to achieving standards for adequate intake (AI), but might not be suitable to reach suggested dietary targets (SDT).

In conclusion, it was possible to change the pork composition by dietary manipulation without compromising pig performance and meat quality. There were a few significant effects from treatments on meat quality characteristics, but differences reported in this study were small and relatively unimportant. A negative influence of the dietary regime on palatability and meat processing was expected, but these issues are beyond the scope of this experiment.

ACKNOWLEDGEMENTS

First of all I would like to thank my primary supervisor Associate Professor Patrick C.H. Morel from the Institute of Food Nutrition and Human Health for his valuable and friendly guidance, advice and support throughout my research. Thanks for your open-door policy and for sharing your knowledge about pigs, nutrition and statistical analysis.

I would also like to thank my secondary supervisors Associate Professor Roger W. Purchas and Dr. Brian H. P. Wilkinson from the Institute of Food Nutrition and Human Health for their valuable advice and friendly guidance throughout my research.
A special thanks to Associate Professor Roger W. Purchas for sharing his knowledge and his help with the meat quality assessments and the statistical analysis.

Special appreciation to Mrs. Jasmine Leong for sharing her results of the FA analysis of the samples and the sensory evaluation.

I am extremely grateful to Mrs Kelly Rutherfurd of the Institute of Food Nutrition and Human Health for the support she offered during the trial. Thank you very much for your advice, your optimistic views, your awesome pep talks and all the other good conversations that were totally not work related. Thanks for giving me the opportunity to learn and become more and more independent during the trial. I wouldn’t have been able to grow those pigs without you!

A special thanks to the other technicians from the Institute of Food Nutrition and Human Health. I would like to thank Miss Maggie Honeyfield-Ross for guiding me through the set-up of the trial. I would also like to thank Mr. Ed A. James for his help and advice in the feed mill and his assistance during the trial. I want to thank Miss Margreet Hekman for helping out in times of need and her dedication and enthusiasm on sample days.
Thanks to all of you for your enthusiasm, patience and sharing your knowledge. I’ve learned a lot from you.

I would like to thank Dr. Eric Neumann from the Institute of Veterinary, Animal and Biomedical Sciences for sharing his incredible knowledge and giving me the opportunity to learn. Thanks for teaching me and providing me with veterinary advice when necessary.

A special thanks to Mr. Gajen Sinnathamby for his help during the weekends. Thanks to Dr. Shay Rutherford-Hill for helping out in times of need.

Special appreciation to John Fitness and staff from Land Meat New Zealand Ltd.,Whanganui. Thanks for giving us the opportunity to take samples in the abattoir.

Special thanks to Mr. Graham Pearson for his help and sharing his knowledge on the slaughter day and during the meat processing. Thanks for your hospitality and getting up early!

Thanks to the staff of the nutrition laboratory of the Institute of Food Nutrition and Human Health for their help with the analysis of the samples.

Thanks to Mr. Garry C. Radford from the Institute of Food Nutrition and Human Health for helping out in the Food Pilot Plant and the Meat Quality lab.

I'm very grateful to Mr. Grant Skilton for providing the strong and healthy pigs that formed the most important base of my study.

Thanks to my flatmates for putting up with the pig smell, the endless pig stories and helping out when needed.

I would also like to thank my friends both in The Netherlands and New Zealand for the good times and the laughter but also for always being there for me when needed.

Last but not least, a very special thanks to my family back in The Netherlands for their unconditional love, support, encouragement and enthusiasm. Thanks for making me believe in myself. It is thanks to you that I had the courage to live my dream and study in New Zealand. I've learned more from you then any University degree could ever teach me. There are no words to describe how much you mean to me. I would like to dedicate this work to my grandmother Oma Nuijten, unfortunately she passed away before she could see the end result.

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a*	Relative redness
ADF	Acid-detergent fibre
ADFI	Average daily feed intake
ADG	Average daily gain
AI	Adequate intake
b*	Relative yellowness
BW	Body weight
CLA	Conjugated linoleic acid
CP	Crude protein
CVD	Cardio vascular disease
DA	Apparent digestibility ash
DDM	Apparent digestibility dry matter
DHA	Docosahexaenoic acid
DM	Dry matter
DOM	Apparent digestibility organic matter
DPA	Docosapentaenoic acid
EE	Ether extract
EPA	Eicosapentaenoic acid
FA	Fatty acid
FAME	Fatty acid methyl esters
FCR	Feed conversion ratio
FI	Feed intake
GE	Gross energy
He-Ne	Helium-neon
KCL	Potassium chloride
L*	Relative lightness
LC	Long-chain
LM	Longissimus muscle
LW	Live weight

MCFA	**Medium-chain fatty acid**
MFI	**Myofibrillar fragmentation index**
N	**Newton**
n-3	**Omega-3**
n-6	**Omega-6**
NaCl	**Sodium chloride**
NDF	**Neutral-detergent fibre**
NRC	**National Research Council**
OM	**Organic matter**
pHu	**Ultimate pH**
PM	**Psoas major muscle**
PUFA	**Poly-unsaturated fatty acid**
SCF	**Subcutaneous fat**
SD	**Standard deviation**
SDT	**Suggested dietary target**
Se	**Selenium**
SEM	**Standard error of the mean**
SFA	**Saturated fatty acids**
SL	**Sarcomere length**
SM	**Semimembranosus muscle**
TBA	**Thiobarbituric acid**
TBARS	**Thiobarbituric acid reactive substances**
TiO_2	**Titanium dioxide**
U/S	**Unsaturated fatty acid to saturated fatty acid ratio**
WBSF	**Warner-Bratzler shear force**
WHC	**Water-holding capacity**