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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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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 \pm 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 PFSI). The diets also differed depending on the presence or absence of the nutritional supplement Sanovite™ and a vitamin C supplement. Sanovite™ 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, PFSI contained Sanovite™ and a vitamin C supplement. Diets PO and POS were used to establish the effect of the supplementation with Sanovite™ 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 PFSI 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 PFSI 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 trial 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™ 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°C ($P < 0.01$) but correlations between expressed juice values and cooking loss were not significant.

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

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

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 PFSI.

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

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

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.

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LIST OF ABBREVIATIONS

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
TiO₂	Titanium dioxide
U/S	Unsaturated fatty acid to saturated fatty acid ratio
WBSF	Warner-Bratzler shear force
WHC	Water-holding capacity