Producing DHA enriched pork to improve human nutrition

The transfer of essential nutrients from animal products to human consumers is important as diets and the raw materials used in animal production continue to change.

by D. Jules Taylor-Pickard,
Alltech, Ireland.
www.alltech.com

The use of fish products has recently decreased due to concerns regarding the conservation of important fish stocks as the human population continues to grow to nine billion. Fish products are an important source of essential omega-3 oils that are required in human food, especially docosahexaenoic acid (DHA).

DHA: A critical component for development

DHA is required by animals and humans for multiple purposes, especially in the formation and protection of membranes. As such, it is important for fertility, sperm production, brain and eye development, heart health, cognitive function (especially regarding dementia), and behaviour and emotional stability.

In cardiovascular disease studies, DHA has been shown to reduce platelet aggregation, decrease triglycerides by 26%, control inflammation and increase high-density lipoproteins by 9%.

Insufficient DHA intake is related to low reading ages and behavioural issues like ADHD in children, poor emotional stability and heightened anxiety, and depressive mental disorders.

In older people, low DHA has been shown to increase brain shrinkage in old age, which is a main symptom associated with dementia problems such as Alzheimer's disease. This is because DHA makes up 30-40% of the fatty acids in brain membranes.

Despite the awareness of the importance of DHA in the diet, it is known that intake in Western diets has been declining for some time. For a 3-year-old child, the recommended daily intake (RDI) is 150mg/d, whereas the actual average is only 19mg/d. Adults require 220mg/d, but most only consume 60-80mg/d, which is less than half the requirement.

DHA is typically obtained from eating fish and seafood, which consume algae rich in DHA and concentrate it in tissues and oils within their bodies. Supplying fish oil to children used to be very common, although consumption is now low.

However, where such intake is limited, new research has shown that growing specific types of algae and using them in animal feed can provide good transfer rates in human food, increasing daily intake for consumers.

Alltech has developed such a product through its extensive development of specific algae production systems, the product of which is then spray dried into a stable form suitable for use in animal feeds. The final product, All-G Rich, contains 67% fat, 16% DHA and 0.3% sodium.

Pig meat is popular in many regions of the world, and All-G Rich has been trialled in all ages of pigs to discern its benefits in the pigs themselves as well as the expression of higher levels of DHA in the resulting meat for human consumption.

In addition, using organic forms of minerals in conjunction with algae have also

Table 1. Effects of feeding All-G Rich to sows on piglet litter sizes and characteristics.

All-G Rich	0g/d	3.5g/d	7g/d	14g/d	28g/d
Sow numbers	10	12	11	12	10
Litter size (kg)	13.1	12.8	15.4	14.6	14.6
Litter live weight (kg)	17.12	16.25	18.98	19.05	20.26
Average piglet birthweight	1.31^{ab}	1.27^{b}	1.23^{b}	1.31^{ab}	1.39^{a}

Means in a row not sharing a letter differ significantly P<0.05

Carcase parameter	Control	All-G Rich (5kg/t feed)
Carcase hot weight (kg)	93.5	93.7
Belly weight (kg)	6.95	6.59
DHA backfat (%)	0.026	0.109
DHA belly (%)	0.015	0.047
DHA loin (%)	0.002	0.004

Table 2. Impact of feeding All-G Rich on DHA expression in the pork carcase.

been trialled, as these minerals can also increase the nutritional profile of the end product for consumers by adding valuable antioxidant minerals to human diets.

Several trials in sows and the effects on their piglets, as well as in nursery pigs, have been conducted using All-G Rich in feeds.

DHA is important for reproduction in mammals, not only in maximising sperm production and protecting gamete membranes, but also in the development of gestating young.

To examine the effects of feeding higher levels of DHA from All-G Rich on pig breeding, feeding trials have shown that sows supplemented with the product have heavier live litter weights with fewer lightweight piglets born (Table 1).

The trials fed either an unsupplemented control diet or 3.5, 7, 14 or 28g of the algae product per day to the gestating sow. The highest average piglet birth weights and live litter weights were seen with the sows fed 28g/d of All-G Rich.

In a trial with young pigs, a combination of All-G Rich, Bioplex chelated minerals (selenium, copper, iron, zinc and manganese) and nucleotides for gut development and maintenance was supplemented at a level of 0.5%, 1% or 2% in feed for 42 days after weaning.

Daily gain and feed intake were significantly improved from seven to 21 days after weaning in diets containing the 0.5 or 1% levels, although the 2% level showed issues due to the oversupply of nutrients in the piglets. It was concluded that such a combined product worked best in the first week after weaning at a maximum level of 1%.

In a more recent trial, 2% or 4% All-G Rich in feed was compared to an unsupplemented control diet in young pigs to see where such performance benefits originated.

A faecal digestibility trial showed that piglets receiving 4% All-G Rich obtained an extra 35 kcal/kg energy from feed compared to the control group.

This would account for the higher performance and also reduced negative response to an oversupply of nutrients in combined product trials.

This can be used to the specific diets for the starter phase, which reduces feed costs without sacrificing growth or feed efficiency.

Such trials in sows and young piglets after weaning demonstrate that feeding this specialised algae supplement can help in both breeding more viable young and also in the healthy growth of piglets after weaning.

Focusing on fatty acids for more nutritional pork

When producing pork with an aim to increase human nutritional intake of specific compounds such as DHA, feeding trials need to focus on the impact such supplements have on the expression of fatty acids in the carcase, especially the popular meat components.

Early trials fed 28 gilts 5kg/t (0.5%) All-G Rich for the last 28 days of production. Although performance was not significantly different between the treated group and the unsupplemented control, average daily gain was higher in the All-G Rich-fed pigs (2.30kg versus 2.16kg for the control group) and feed conversion was better (2.89 versus 3.13 for the control group). The weight of the carcase and belly meat, as well as the DHA concentrations in the belly and loin cuts, were compared (Table 2).

Levels of DHA in the meat portions were four times higher in the backfat, more than twice as high in the belly cuts and twice as high in the leaner loin meat from pigs fed the supplemented diets.

Other trials have investigated such responses in more depth. Feeding experiments run by Moran et al. (2014) included two levels of supplementation with All-G Rich, 2.5kg/t or 5kg/t, in a study lasting 112 days using grower-finisher pigs.

The researchers examined the transfer of DHA into meat cuts and also looked at the fatty acid profile in carcase fat and the ratio of omega-3 to omega-6 oils.

The results showed that the uniformity of carcases was improved in the supplemented group of pigs at the 5kg/t inclusion rate. Levels of DHA increased in line with supplementation rates for the loin cut.

Including the algae product at 5kg/t in feed increased the omega-3 to omega-6 ratio in the loin meat of both castrated males and female pigs, with males in the control group having a ratio of 0.1384 versus 0.1666 for the supplemented males, and 0.1453 versus 0.1812 for the control and supplemented females, respectively.

Significant differences were seen between pigs fed the control and the two levels of All-G Rich in DHA levels of the carcase, especially backfat (Table 3).

The increases in transfer are more evident in backfat due to the accumulation of DHA in fats and oils within body tissues.

Later trials (Moran et al., 2015) with grower-finisher pigs fed the same levels of All-G Rich compared to a control for 117 days showed similar responses. Whilst there were no performance effects at this later stage of production, significant increases in DHA expression in carcase and backfat were reported.

DHA was increased in the carcase in line with supplementation levels, with the control group carcases averaging 0.01g/100g carcase fat versus 0.02g and 0.03g/100g for the 2.5kg/t and 5kg/t inclusion levels.

In backfat, DHA significantly increased from 0.07g/100g to 0.22g and 0.3g for the 1.5kg/t and 5kg/t-supplemented groups, respectively.

In a further feeding experiment where grower pigs were fed for 0-56 days and finishers from 56-112 days of the trial (average body weight 28kg at the start of the trial), loin and backfat DHA was

Continued on page 10

Table 3. Influence of feeding two levels of All-G Rich on DHA levels in pig carcase and backfat fatty acid profiles.

Parameter (g/100g)	Control	All-G Rich (2.5kg/t feed)	All-G Rich (5kg/t feed)
DHA males carcase	0.006[a]	0.02[b]	0.03[c]
DHA females carcase	0.005[a]	0.02[b]	0.024[c]
Backfat average DHA	0.047[a]	0.187[b]	0.307[c]
Omega-3:6 ratio	0.065[a]	0.08[b]	0.09[c]

Means in a row not sharing a letter differ significantly P<0.05

Continued from page 9
significantly increased with All-G Rich inclusion.

DHA levels in the loin rose from 0.006% for carcases from the control group to 0.018% for those fed 2.5 kg/t and 0.027% for the highest supplementation. Backfat levels responded in a similar fashion, at 0.047%, 0.19% and 0.31% for the control, 2.5kg/t and 5kg/t All-G Rich groups, respectively.

Meat cut	Parameter	Control	All-G Rich (10kg/t)
Ham	DHA (mg/100g)	Not detectable	17.2
	Ratio omega-6:3	29:1	12.8:1
Belly pork	DHA (mg/100g)	31.9	175.0
	Ratio omega-6:3	16.3	11.6

Table 4. Feeding All-G Rich to finisher pigs significantly increases DHA in ham and belly pork in commercial production conditions.

Reaping the nutritional rewards of DHA on-farm

Whilst research trials are relevant for proving the efficacy of a zootechnical feed ingredient, the effect under farm conditions also needs to be established, as these animals face different housing, management, feeding and health conditions.

Commercial trials conducted in Thailand using 10kg/t All-G Rich in feed examined the DHA levels in hams and belly meat cuts (Table 4).

The results showed major improvements in omega-6:3 ratios (due to the increased omega-3 consumption) as well as an increase in DHA specifically within the meat cuts.

From the trials conducted, not only does DHA supplementation from specialist algae-derived products, such as All-G Rich, have an impact on breeding performance in sows, birth weights and liveability of piglets, and early nursery pig performance, it is important in producing pork with a better nutrient profile for human consumers.

The major reduction in DHA intake in humans, especially when compared to RDI for western populations, and the very low levels consumed by children, is a particular focus for dieticians.

Providing a source of popular meat cuts that contribute to DHA intake on a daily basis is key to not only preventing developmental and mental health disorders, but also as a carry-over into diseases experienced by people as they age.

Providing DHA from pork meat that is attractive to children is paramount in ensuring they are willing to eat such sources.

Algae-based products provide an effective and sustainable form of DHA that is well-expressed in animal food products and is easily incorporated into feed at relevant inclusion levels, which contribute to reducing feed costs in young animals.

The DHA-enriched meat offers producers and retailers an opportunity for promoting value-added meat, which has defined benefits for consumers. ■

References are available from the author on request.