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The effect of algal biomass supplementation in maternal diets on piglet survival in two housing systems

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ABSTRACT

Current developments in the pig industry pose increased challenges for piglet survival as a result of selection for increased prolificacy and welfare pressures to abolish the use of farrowing crates. The effect of supplementation of the maternal diet with algal biomass, containing the essential fatty acid docosahexaenoic acid (DHA), on the performance of sows and their piglets farrowing in two different housing conditions was studied using a 3×2 factorial experiment. A control diet was compared to 2 levels of DHA supplementation from algal biomass (0.03% and 0.3% DHA, delivered by 1.5 g/kg and 15 g/kg algal biomass) during the last 4 weeks of pregnancy and lactation, using 60 sows (mean parity 4.7 sem 0.32) in two different farrowing systems (farrowing crate and PigSAFE farrowing pen). Two-way analyses of variance showed no statistically significant interactions between dietary treatment and housing system. Piglet survival and growth did not differ between the crate and pen systems. Litter size (13.1 sem 0.42) and piglet birthweight (1.45 sem 0.047 kg) did not differ between dietary treatments, but the number of stillborn piglets per litter was reduced with increasing DHA supplementation (1.13, 0.67, 0.25, sem 0.205, $P=0.014$, with litter size covariate). This was despite an increase in farrowing duration of the sows with increased DHA supplementation (150.3, 195.2 and 216.2 sem 13.6 min, $P=0.02$). The vitality of the piglets, as described by the latency (min) of the piglets to stand (1.92, 1.44 and 1.17, sem 0.09, $P<0.001$), to reach the teat (21.55, 15.71 and 11.20, sem 1.35, $P<0.001$) and to suckle (25.66, 19.14 and 14.83, sem 1.40, $P<0.001$), was also improved with increased supplementation of DHA. Mortality of liveborn piglets in the first 3 days, and number weaned per litter (after fostering) were unaffected by treatment, as were sow weight and backfat loss in lactation. However, piglet weaning weight was reduced by DHA supplementation (by up to 12%). The mechanism for the reduction in stillbirth should be further investigated.

1. Introduction

Piglet mortality is a major problem contributing to significant financial loss in the pig industry. Most deaths occur during the early period after birth, when the newborn piglets are expelled into an extra-uterine environment which poses many challenges. The inability of the newly born piglet to surmount these challenges, such as hypothermia, teat competition and the negative energy balance arising from inadequate milk supply, eventually threatens their existence and leads to death (Lauridsen and Danielsen, 2004). The newly born piglet is physiologically immature (Tuchscherer et al., 2000) and lacks energy reserves which, when combined with hypoxia or hypothermia, results in lack of vitality and inability to survive.

The essential fatty acid supply in gestation, and in the colostrum and milk of the sow, is important for the development of vision and nervous system, and cognitive performance of the piglets (Lauritzen et al., 2001). Since pig diets contain mainly cereals, they are considered to be relatively

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low in omega-3 fatty acids yet rich in omega-6 fatty acids, a composition which has been reported to be less beneficial in the development of piglet neural tissues (Rooke et al., 2000). Docosahexanoic acid (DHA) is a long chain, omega-3 fatty acid which is essential in maternal diets and more abundant in marine oils (fish oil, marine algae) rather than cereals. DHA is a major constituent of the biomembranes of the brain and retina (Uauy et al., 2000) and is taken up and mostly used by the brain. There have been an increasing number of trials aimed at determining the effects of DHA on piglet survival. Rooke et al. (2001b) observed that piglets born to sows fed a diet supplemented throughout gestation with salmon oil (as a source of DHA) had an increase in gestation length (+0.5 days) and reduced pre-weaning mortality (−1.5% points), despite a reduced birth weight (−70 g). The reduction in birth weight was suggested to arise as a result of the high level of eicosapentaenoic acid (EPA) found in fish oils (Rooke, 2001b), which can inhibit the synthesis of arachidonic acid (AA) (Kurlak and Stephenson, 1999). AA deficiency is a known cause of reduced weight gain in human neonates (Carlson et al., 1993a, 1993b). Selection of appropriate marine algae allows the possibility of supplying DHA without an associated high level of EPA. A small study by Edwards et al. (2003) showed that inclusion of DHA Gold®, a dried algal biomass product, during the last 4 weeks of pregnancy to supply 3 g DHA/kg feed did not adversely affect birth weight, suggesting that this might be a more appropriate source of essential fatty acid for dietary supplementation designed to reduce piglet mortality.

In addition to welfare concerns about piglet survival, there is pressure arising from considerations of sow welfare to abolish use of the farrowing crate and change to alternative systems in which sows have more freedom of movement. Since the farrowing crate was introduced to reduce the risk of crushing of piglets, and to facilitate localised heating and stockperson aid for weaker piglets, alternative systems will require that piglets are more robust at birth to promote high survival. Supplementation of sow diets with DHA may be one means to achieve this outcome. Different levels of omega-3 Poly unsaturated fatty acid (PUFA) inclusion have been reported to have a positive effect in enhancing piglet postnatal survival (Baidoo et al., 2003; Farmer et al., 2009; Rooke et al., 2001a, 2001b), however the optimum amount of DHA required in maternal diets is still unknown. The level of DHA supplement shown to maximise piglet brain weight (Rooke et al., 1998) and enhance survival (Rooke et al., 2001b) is relatively high in comparison to the level recommended for human supplementation (Simopoulos, 2009). Reducing the level of DHA inclusion, providing that efficacy to improve survival is maintained, could have cost savings for farmers since the algal source of DHA is a relatively expensive feed ingredient. Therefore this study investigated the effects of varying the level of algal DHA supplementation in the diets of sows in two different types of farrowing system on piglet survival from birth to weaning.

2. Materials and methods

All practices adopted in the methods were in accordance with UK legislation and codes on pig welfare and approved by the Ethical Review Committee of Newcastle University.

2.1. Experimental design, animals, housing and management

The experiment was carried out at the pig unit at Cockle Park Farm, Newcastle University, using a total of 60 crossbred sows (Landrace × Large White) with a mean parity of 4.7 (sem 0.32). Sows were allocated according to parity, live weight and previous litter size records to one of six treatments in a 3 × 2 factorial design comparing three levels of DHA inclusion from algal biomass and two types of housing system (farrowing crate or an alternative PigSAFE loose farrowing pen). The farrowings were in batches of nine sows, with three sows allocated to each DHA level, while six sows and three sows per batch were alternately allocated between farrowing crates and PigSAFE pens. During pregnancy the sows were group-housed in kennelled, straw based accommodation with individual feeding stalls. They were fed once per day (at 07:00 h) with 3 kg of a cereal/soyabean gestation diet (Table 1), with the appropriate level of DHA supplement individually weighed and mixed with the ration of each sow prior to feeding to ensure exact dosing. The sows were moved from the gestation accommodation to the farrowing accommodation five days before the expected farrowing date. Sows that did not farrow at the expected due time were induced to farrow on day 116 of gestation by the intramuscular injection of 2 ml of prostaglandin (Planate, Intervet). Seven sows in total were not induced (four

Table 1
Dietary ingredients used in the production of gestation and lactation diets.

	Gestation	Lactation
Component		
Barley	86.0	74.0
Soya bean meal	10.0	14.0
Sunlustre full fat soya		5.0
Soya oil	1.0	2.0
Dicalcium phosphate		2.0
PS/310 SI PE[a]	3.1	
SI[b]		2.7
Algal biomass	0.0, 0.15 or 1.5	0.0, 0.15 or 1.5
Composition		
Dry matter (%)	87.67	88.25
Energy (MJ NE/kg)	9.91	10.16
Protein (%)	13.82	17.93
Oil (%)	2.47	4.43
Fibre (%)	4.39	4.22
Phosphorus (%)	2.56	2.70
Lysine (%)	0.62	0.93
Methionine (%)	0.21	0.29

[a] Vitamin A: 403,225 iu/kg, Vitamin D3: 64,516 iu/kg, Vitamin E: 1612 iu/kg (alpha-tocopherol acetate), copper: 645.16 mg/kg (cupric sulphate), Selenium: 9.68 mg/kg (sodium selenite), Phosphorus: 2.56%, sodium: 4.58%, Selenium: 1.61 mg/kg (Alkasel R379), calcium: 26.00%.

[b] Vitamin A: 462,979 iu/kg, Vitamin D3: 74,076 iu/kg, Vitamin E: 1852 iu/kg (alpha-tocopherol acetate), copper: 740.76 mg/kg (cupric sulphate), selenium: 11.11 mg/kg (sodium selenite), phosphorus: 2.70%, sodium: 5.10%, selenium: 1.85 mg/kg (Alkasel R379), calcium: 25.50%.