The foetus receives more nutrients with L-Carnitine

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Supplementation of sows' diets with L-Carnitine during pregnancy results in an increase in the weights of piglets and litters at birth. The reason for this phenomenon is not yet clear.

It was recently observed that L-Carnitine increases the concentration of insulin-like growth factors (IGFs) in the blood of pregnant sows. IGFs (IGF-1 and IGF-2) are well known key factors in the development of the placenta in pregnant animals.

It was, therefore, hypothesised that L-Carnitine, mediated by an increased plasma concentration of IGFs, enhances placental development in pregnant sows.

To investigate this hypothesis, the plasma concentrations of IGF-1 and IGF-2 during late pregnancy in control sows and sows who had received L-Carnitine throughout gestation, and the weights of chorions, the foetal parts of the placenta, at parturition, were determined.

Glucose derived from maternal blood is the principle source of energy for foetal growth. To assess the placental capacity for nutrient transfer, the protein concentrations of glucose transporter-1 (GLUT-1), a transport system which limits the rate of glucose transport from maternal to foetal blood, was measured.

Materials and methods

Three experiments with crossbred sows (German Landrace x Large White) were performed. In Experiment 1, 24 sows in their third reproductive cycle with an average body weight of 211kg were divided into two groups of 12 sows each.

In Experiment 2, 40 crossbred gilts with an average body weight of 136kg were split into two groups of 20 animals each.

In Experiment 3, 12 crossbred sows in their third reproductive cycle with an average body weight of 216kg were divided into two groups of six animals each. The sows were artificially inseminated with sperm from Pietrain boars. In Experiment 1, 10 of the 12 sows in each group conceived. In Experiment 2, 19 of the 20 sows in the L-Carnitine group conceived, while 16 of the 20 sows in the control group conceived. Sows who failed to conceive were removed from the experiment.

	Control	Plus L-Carnitine
Experiment 1		
No. of litters	10	10
No. piglets born	12.2	12.3
No. piglets born alive	12.1	12.3
No. piglets stillborn	0.1	0.0
Piglet weights (kg)	1.55	1.65 (+6%)
Litter weights (kg)	17.9	20.1
Experiment 2		
No. of litters	14	15
No. piglets born	10.9	10.2
No. piglets born alive	10.1	10.1
No. piglets stillborn	0.8	0.1*
Piglet weights (kg)	1.33	1.41 (+6%)
Litter weights (kg)	12.8	13.9
Experiment 3		
No. of litters	5	6
No. piglets born	14.6	12.7
No. piglets born alive	13.4	12.5
No. piglets stillborn	1.2	0.2*
Piglet weights (kg)	1.44	1.62 (+13%)
Litter weights (kg)	19.1	19.6

**P<0.05 compared to control group.*

Table 1. Number of piglets and piglet and litter weights at birth of control sows and sows supplemented with L-Carnitine during pregnancy in Experiments 1, 2 and 3.

The sows were kept in single crates until day 30 of pregnancy. From day 30 to 110 of pregnancy, they were kept in groups of five to eight in pens measuring 45m² with fully slatted floors, nipple drinkers and electronic feeding stations. On day 110 of pregnancy, the sows were moved to single farrowing pens.

Basal commercial diets with a low energy content (9.0 MJ of metabolisable energy/kg) were provided for ad libitum consumption in all the experiments.

Nutrient concentrations conformed to recommendations for pregnant sows (National Research Council 1998). The L-Carnitine concentrations of the diets were between 10 and 20mg/kg.

The diet was available for ad libitum consumption from day one to day 110 of pregnancy. The daily feed intake of the sows was recorded by means of an electronic sow feeding station. Water was provided from nipple drinker systems.

L-Carnitine supplementation was started in the treatment group 21 days before insemination. The sows in the treatment group received a supplement of 125mg L-Carnitine per day for the 21 days prior to insemination and throughout pregnancy. The supplements were administered in tablet form.

Body weights and backfat thickness were recorded ultrasonically on days 1 and 110 of pregnancy.

Sows were bled after overnight fasting by puncturing the venous plexus of the Fossa jugularis at day 95 in Experiment 1 and at day 80 in Experiment 2, and concentrations of L-Carnitine, IGF-1 and IGF-2 were determined.

The number of piglets born (total, number born alive and number stillborn) was recorded.

The piglets were weighed individually at birth (not later than six hours after birth) using scales with an accuracy of ±10g.

In Experiment 3, each sow's chorions were collected at birth and the weight of each was recorded. Concentrations of protein, DNA and GLUT-1 protein were determined in samples of chorion tissue.

Results

● **Feed intake, body weights and backfat.** There was no difference between the feed intakes of the control sows and sows supplemented with L-Carnitine throughout pregnancy in Experiments 1 and 3.

Moreover, the two groups' body weights and backfat thicknesses did not differ either at day one or day 110. In Experiment 2, the sows receiving L-Carnitine had a higher feed intake (3.7kg/d as opposed to 3.3kg/d in control sows), but there was no difference in the body weights of both groups.

● **Number and weights of piglets.** In all three experiments, the total number of piglets and number of piglets born alive were the same in both groups (Table 1). In Experiments 2 and 3, the sows supplemented with L-Carnitine produced fewer stillborn piglets than the control sows.

Sows supplemented with L-Carnitine produced heavier litters than the control sows in Experiments 1 and 2 (Experiment 1: +12%, Experiment 2: +9%), while the litter weights were similar for both groups in Experiment 3.

Piglet weights at birth were higher in sows supplemented with L-Carnitine than in control sows in all the three experiments (Experiment 1: +6%, Experiment 2: +6%, Experiment 3: +13%).

● **Concentrations of L-Carnitine, IGF-1 and IGF-2 in the sows' plasma.** Plasma concentrations of L-Carnitine and concentrations of IGFs were measured at day 95 of pregnancy in Experiment 1 and at day 80 of pregnancy in Experiment 2.

In both experiments, the sows

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	Control	Plus L-Carnitine
Experiment 1		
No. of sows	10	10
L-Carnitine (µmol/L)	7.5	11.1+
IGF-1 (nmol/L)	4.1	5.1+
Experiment 2		
No. of sows	16	19
L-Carnitine (µmol/L)	8.0	11.0+
IGF-1 (nmol/L)	3.9	5.6*
IGF-2 (nmol/L)	10.0	24.7*

*P<0.05 compared to control group +P<0.10 compared to control group

Table 2. Concentrations of L-Carnitine, IGF-1 and IGF-2 in plasma of control sows and sows supplemented with L-Carnitine during pregnancy at day 95 (Experiment 1) and day 80 (Experiment 2) of pregnancy.

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supplemented with L-Carnitine had higher concentrations of total plasma L-Carnitine, IGF-1 and IGF-2 than the control sows (Table 2).

● **Weights of chorions, amounts of DNA and protein and concentrations of GLUT-1 in the chorions.**
Chorions were collected in Experiment 3. Sows supplemented with L-Carnitine had heavier chorions (+22%) than the control sows (Table 3).

The amounts of protein (+45%) and DNA (+38%) in the whole chorions were also greater in sows supplemented with L-Carnitine than in control sows.

Moreover, the chorions of sows supplemented with L-Carnitine had a higher concentration of GLUT-1 protein than the chorions of the control sows (+62%).

Conclusion

This study confirms that L-Carnitine supplementation of sows during pregnancy increases their L-Carnitine status and the body weights of their piglets at birth.

An important finding of this study is that sows supplemented with L-Carnitine had higher concentrations of IGF-1 and IGF-2 in plasma and larger chorions with an increased amount of protein and DNA.

IGF-1 and IGF-2 play a key role in development of the placenta and the transplacental supply of nutrients to the foetus.

It is, therefore, highly probable that L-Carnitine stimulated placenta development by increasing IGF-1 and IGF-2 secretion.

The finding that sows supplemented with L-Carnitine had higher concentrations of GLUT-1 in their chorions suggests that L-Carnitine increased the capacity for glucose transport from maternal to foetal blood. Because glucose is the most important source of energy for foetal growth, this effect may be responsible for the higher birth weights of the piglets born from sows supplemented with L-Carnitine.

L-Carnitine supplementation

The large body of evidence from scientific and real life feeding studies shows that permanent L-Carnitine supplementation produces the best response in reproducing sows.

The recommended level is 50mg of L-Carnitine per kg of feed.

Gilts should start to receive supplements when they are being introduced into the sow herd. ■

Table 3. Weights of chorions and amounts of DNA and protein and GLUT-1 protein in chorions of control sows and sows supplemented with L-Carnitine.

	Control	Plus L-Carnitine
No. of sows	5	6
Weight of chorion (g)	264	323+
DNA (mg/chorion)	3.57	4.92+
Protein (g/chorion)	11.2	16.2*
GLUT-1 concentration (relative)	1.00	1.62*

*P<0.05 compared to control group +P<0.10 compared to control group