EFFICIENT & ECOLOGICALLY-FRIENDLY PIG AND POULTRY PRODUCTION.

ECOFCE

A WHOLE-SYSTEMS APPROACH TO OPTIMISING FEED EFFICIENCY AND REDUCING THE ECOLOGICAL FOOTPRINT OF MONOGASTRICS.

BASIC DATA

Funding:
EU-FP7
(€ 6 million)

Start date:
1 February 2013

Duration:
48 months
(2013 to 2016)

The ECO-FCE project is funded by the European Union Seventh Framework Programme (FP7 2007/2013) under grant agreement No. 311794.

COOPERATION

ECO-FCE: Effect of early artificial rearing and milk replacer supplementation on growth of pigs (carcass and meat quality traits)

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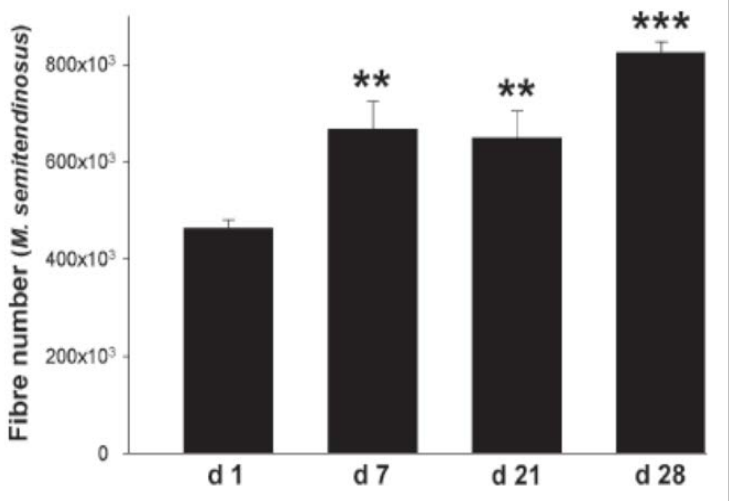
The ECO-FCE project is funded by the European Union Seventh Framework Programme (FP7 2007/2013) under grant agreement No. 311794.

Background

- Low birth weight pigs (L-BtW) are a concern in modern pig production because of:
  - Lower pre-weaning survival rate
  - Lower feed efficiency
  - Impaired carcass and meat quality

Impaired myofiber hyperplasia

feeding strategies in early life



Berard et al., 2011

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Background

- **Survival, growth and hyperplasia is impaired in L-BtW piglets**
  - Consequence of increased litter size resulting in intra-uterine growth restriction (IUGR)

- **Choice of supplementation based on previous studies**
  - L-arginine (Kim and Wu, 2004, Yao et al., 2008)
    - Promotes: Survival, growth and protein synthesis
  - L-carnitine (Lösel et al., 2009; Keller et al., 2011)
    - Promotes: Post natal myofiber hyperplasia in L-BtW piglets

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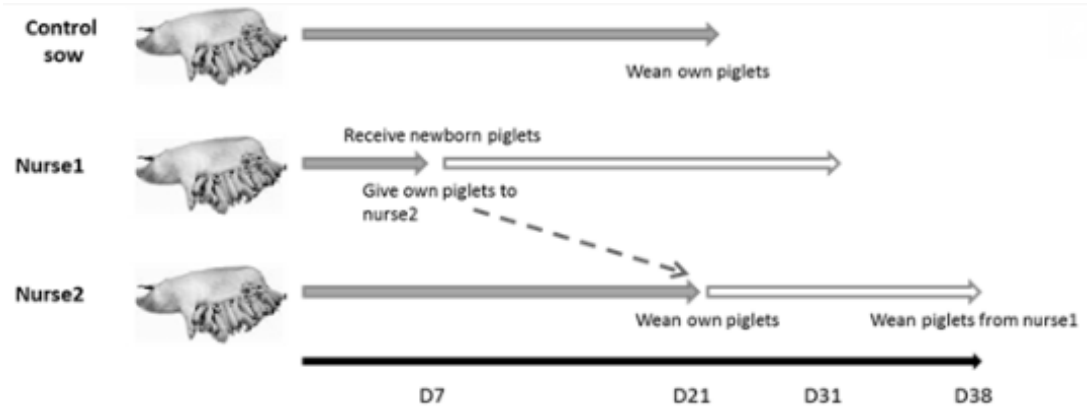
Study objectives

- **Objective**
  - Improve production efficiency by:
    - Increasing survival
    - Enhancing postnatal myofiber hyperplasia
    - Increasing growth rate

- **Alternative to conventional rearing**
  - Nursing sow strategies
  - Early artificial rearing in rescue decks
    - Large littermates, whole litter or L-BtW piglets



Modified from Amdi et al., 2015

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Materials and Methods

All piglets born from hyperprolific sows (>15 born/litter) with a BtW < 1.2 kg

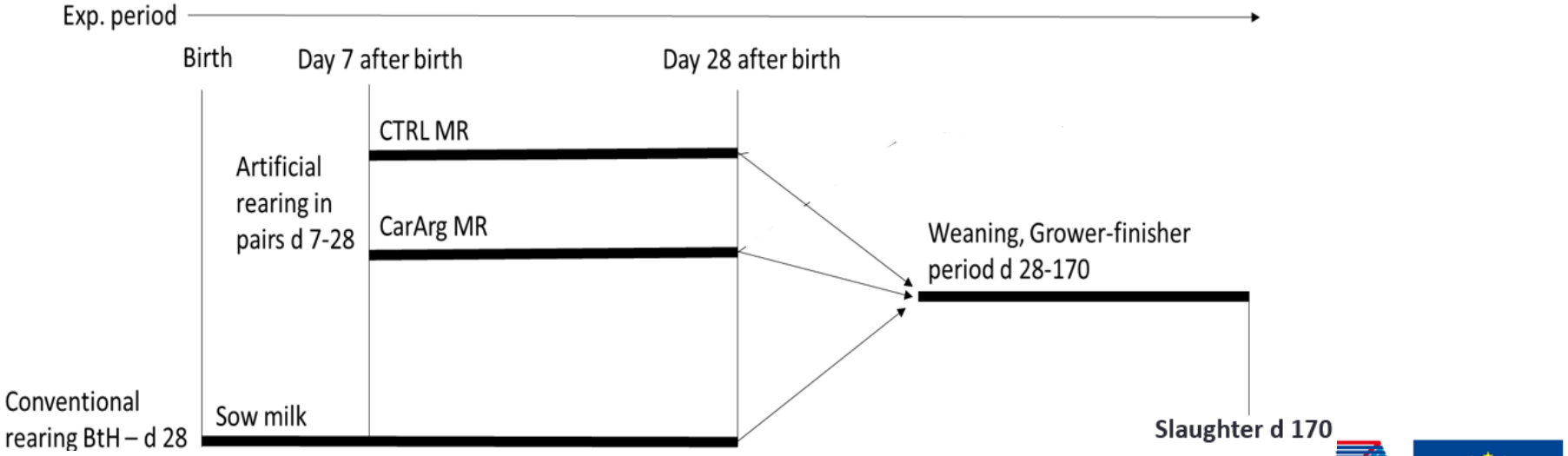
- 48 piglets were artificially reared from d 7-28 of age
- 24 piglets were conventionally reared piglets by their dam sow for 28 d (**SOW**)

Artificial rearing:

- **Ctrl**: Commercial milk replacer (20.5% protein, 9.5% fat, 18.6 GE MJ/kg DM)
- **CarArg**: Commercial milk replacer supplemented with **0.05% L-carnitine + 1.67% L-arginine**

After weaning:

- Ctrl, CarArg and SOW pigs were fed standard weaning, grower and finisher diet till slaughter at 170 d of age



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Materials and Methods

- Traits of interest:
  - Pre-weaning growth
  - Post-weaning growth
    - BW at slaughter (d 170)
    - Daily gain (ADG), feed intake (ADFI), feed efficiency (G:F)
  - Carcass traits
    - Hot and cold carcass weight
    - Lean meat percentage
  - Meat quality traits
    - Drip loss, 24h

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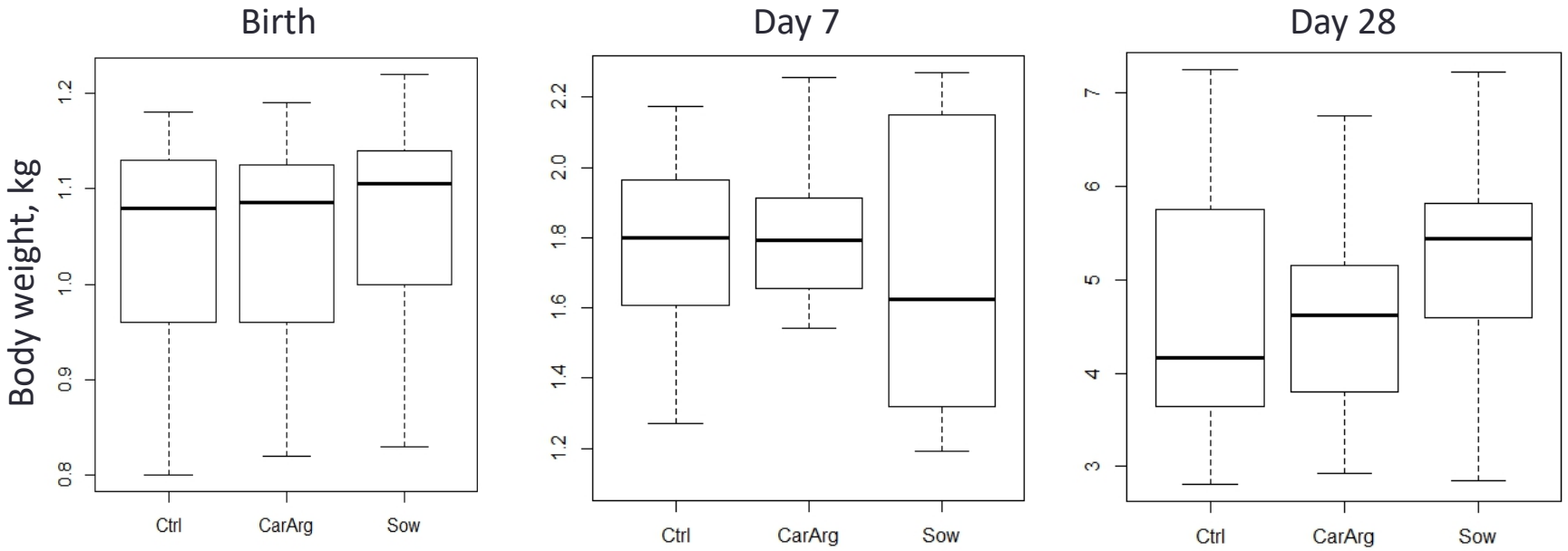
Results: Pre-weaning survival and growth



- Low weaning weight -> low DM content of milk replacer
- 0% mortality of artificially reared piglets
- 8% mortality from d 7-28 in the sow herd (loose-housed system)

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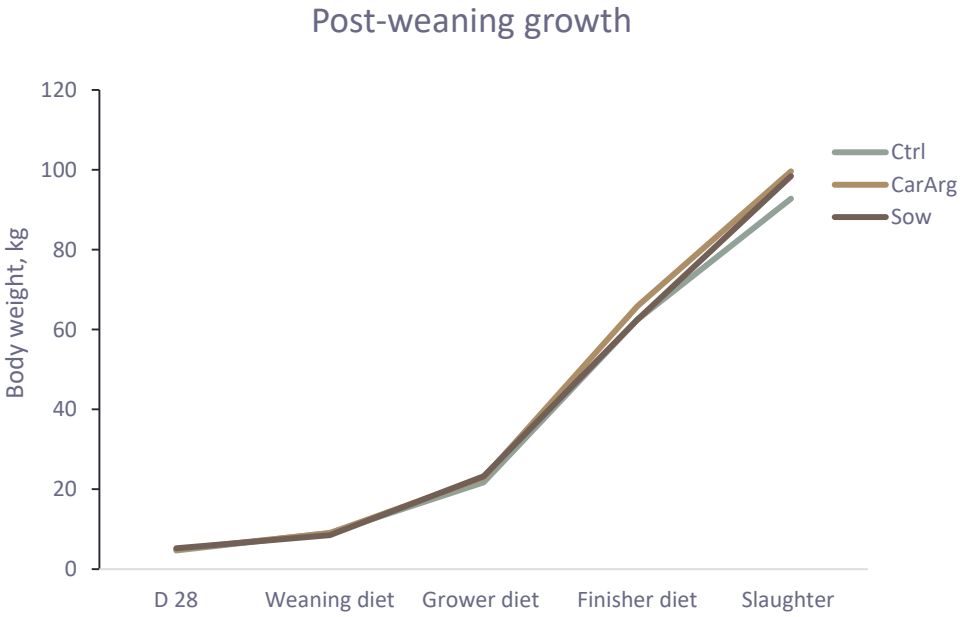
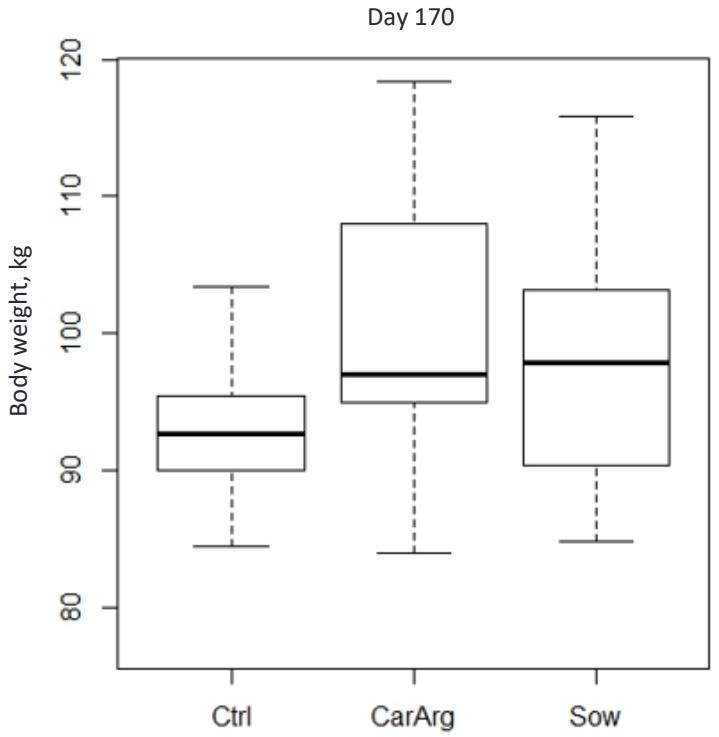
Results: Post-weaning perfomance





- No effect on slaugther weight (6 kg diffeence Ctrl vs. CarArg and Sow)
- Large variation within groups

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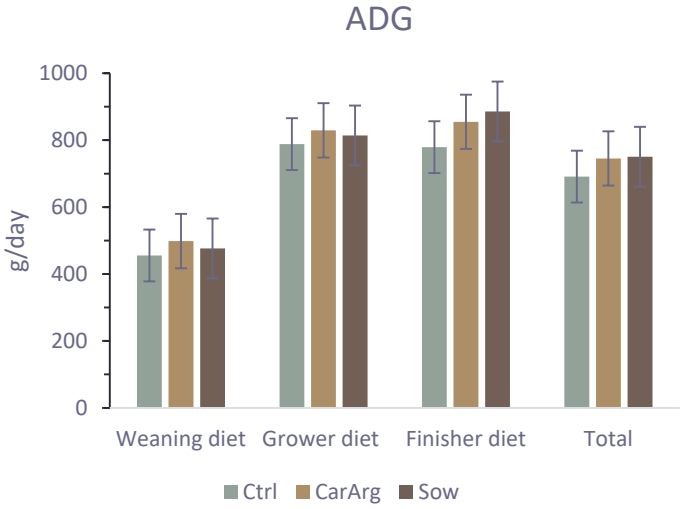
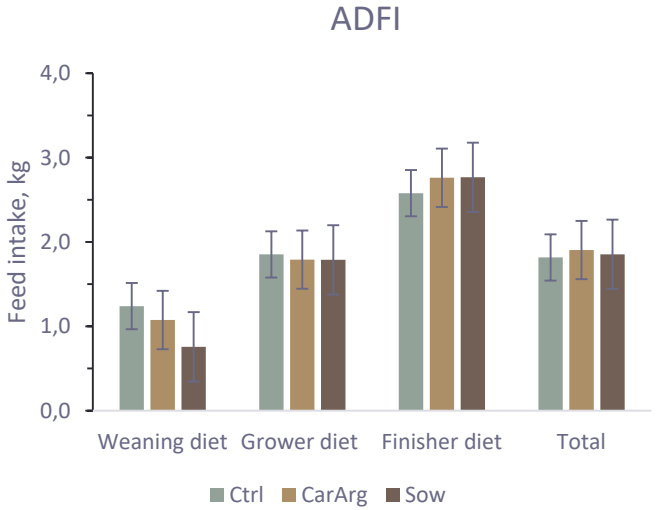
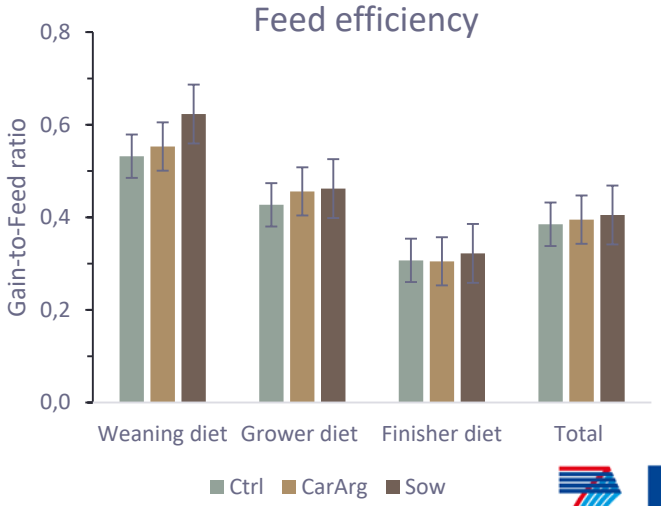
Results: Post-weaning perfomance





No difference between groups



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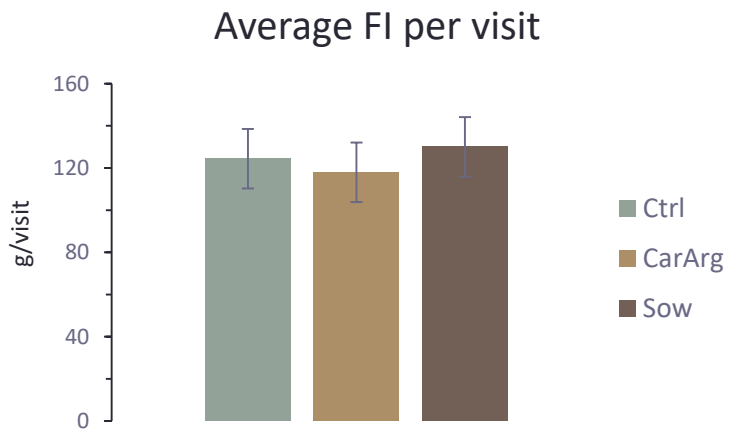
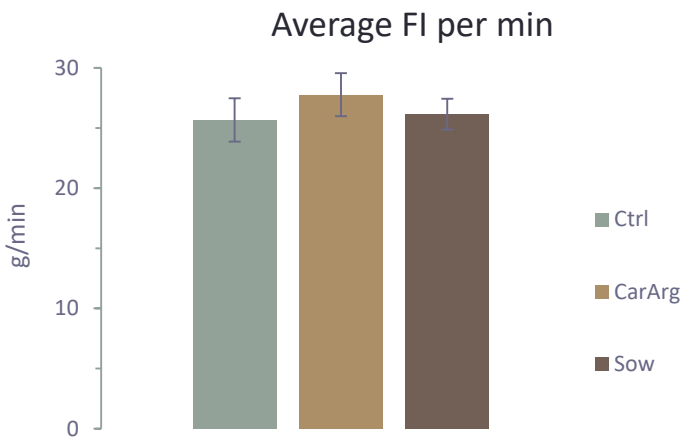
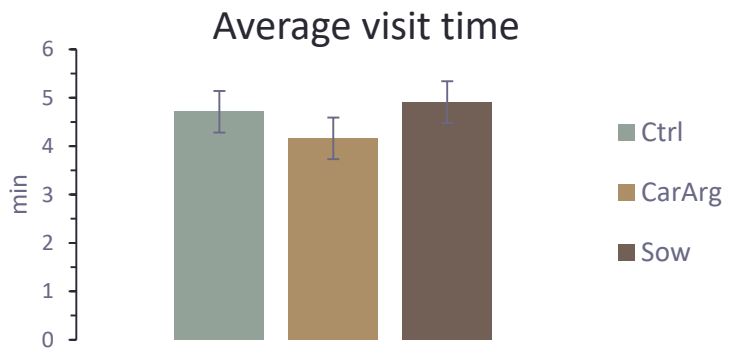
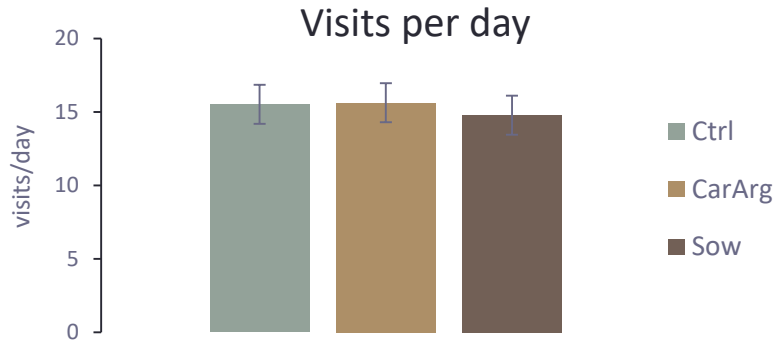
Results: Eating behavior









Eating behavior does not explain the difference in final slaughter weight

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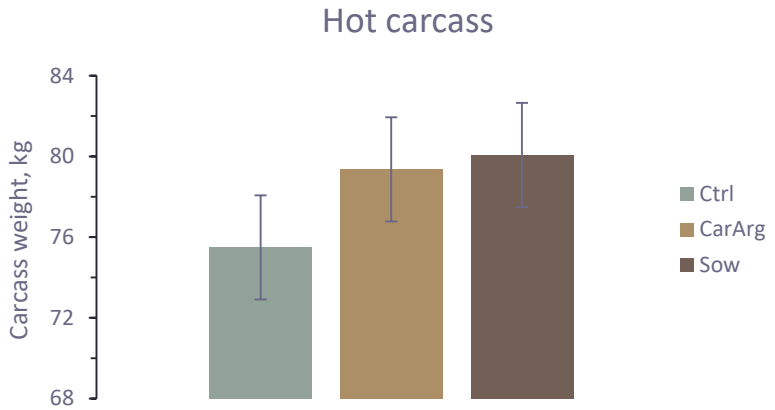
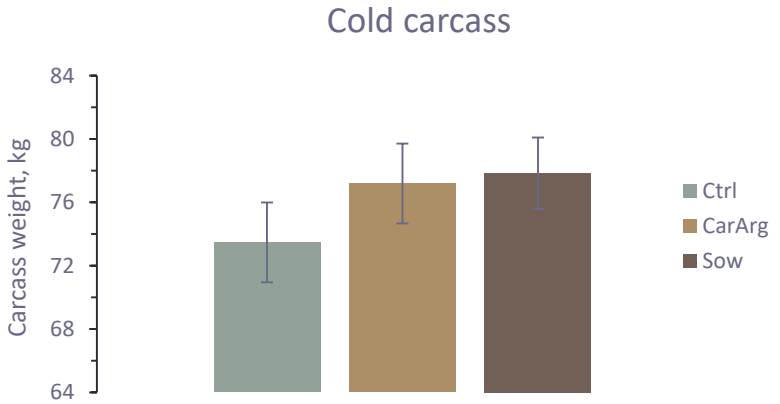
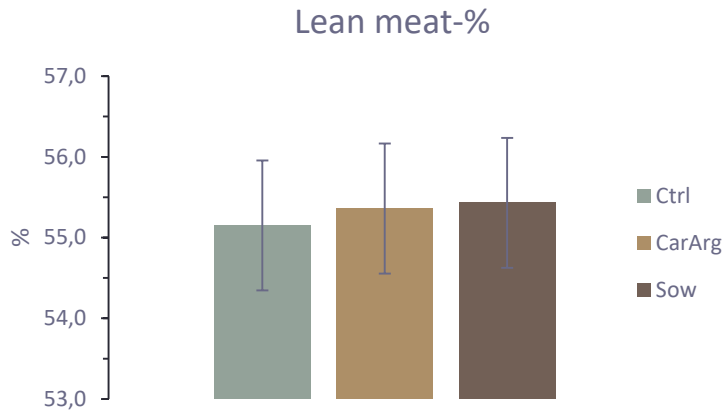
Results: Carcass traits





- No difference between groups
- Within the artificially reared groups, CarArg tended to increase carcass weight



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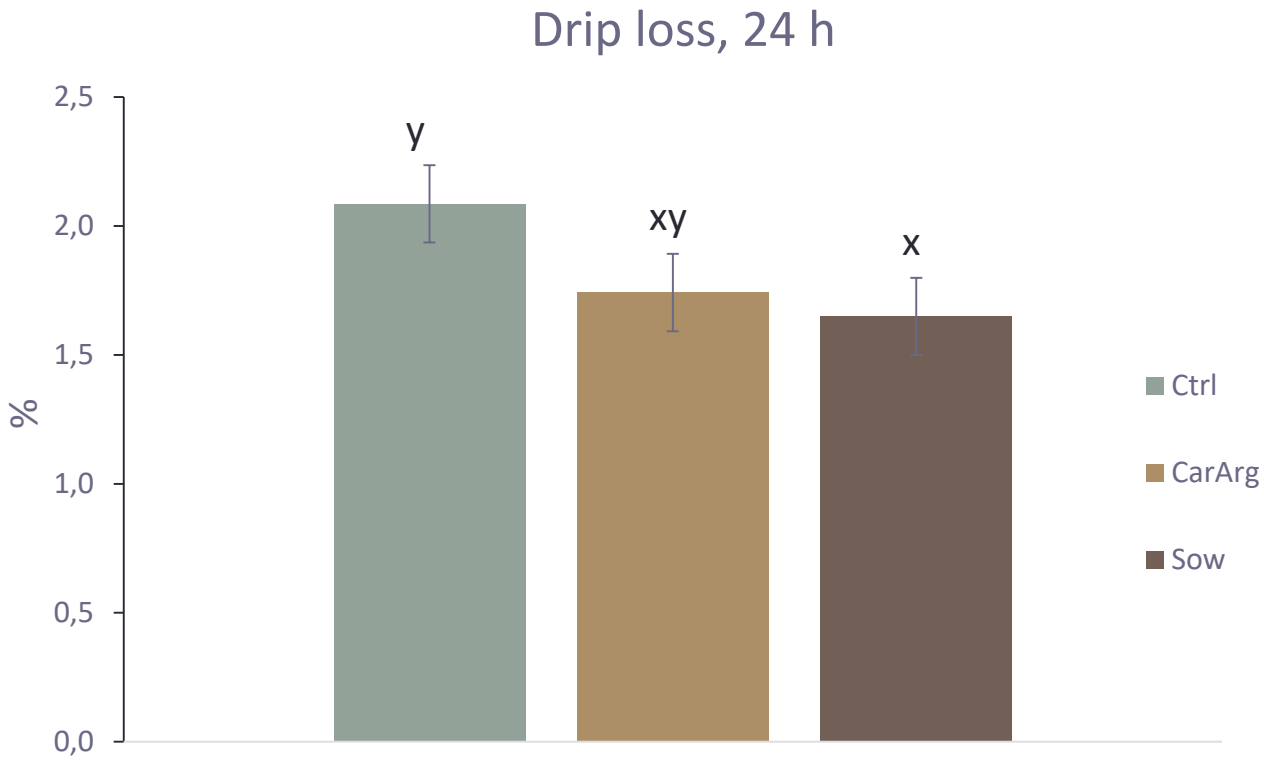
Results: Meat quality traits



Lower water holding capacity in the Ctrl group ($0.05 \leq P < 0.10$)

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Conclusions

- Improved survival rate of L-BtW piglets from d 7-28
- No clear supplemental effect on pre- and post weaning growth
- Growth performance of L-BtW is not compromised by artificial rearing
- Selected meat quality traits are not compromised in the CarArg group

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Perspectives

- **Milk replacer needs optimization**
  - Dry matter, protein and fat content, plus amino acid and fatty acid composition needs adjustment
  - Is the assumption correct that sow milk is optimal for L-BtW piglets?

- **Considering earlier artificial rearing**
  - In some countries rearing d 3 is allowed
  - Survival rate lowest first four days after farrowing
  - L-BtW piglets most vulnerable

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Thank you for your interest

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Exp. 1

- 3 week trial:
  - Restricted feeding
  - Day 7 – 28.
  - Piglets weighed weekly and feed intake measured daily.
- Slaughtered day 28:
  - Blood samples
  - Carcass composition
  - Organ weights
  - Collecting Semitendinosus muscle:
    - Myofiber number and size (histology)
    - Energy metabolism in muscle (enzym activity)
    - Gene expression analysis of myogenic- and proteasome related genes.

Ingredients, %	CTRL	CAR	ARG
Whey powder	61.6	61.6	61.6
Whole milk protein	28.0	28.0	28.0
Milk protein	6.2	6.2	6.2
L-arginine, g/kg BW · piglet^{-1} · d^{-1}	-	-	1.08
L-carnitine, g piglet · d^{-1}	-	0.40	-
Analyzed composition, % DM			
Gross energy, MJ/kg DM	17.9	17.9	17.9
Crude protein	21.1	21.1	21.1
Crude fat	7.8	7.8	7.8

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Results Exp. 1

Key enzyme for following pathways

Citric acid cycle activity
- Citrate synthase (**CS**)

Lipid oxidation
- β-hydroxyacyl-CoA dehydrogenase (**HAD**)

Glycolytic capacity
- Lactate dehydrogenase (**LDH**)

The LDH:CS and LDH:HAD = markers for muscle maturity -> reflect the relative importance of **glycolytic** compared to **oxidative** metabolism in muscle.

	Treatment		
Item[3]	C	CAR	ARG
Dark portion			
CS (× 10^{-2})	0.428^{y}	0.393^{xy}	0.357^{x}
LDH	0.930^{a}	2.088^{b}	1.617^{b}
LDH:HAD	3.63^{a}	**9.09^{b}**	**6.29^{ab}**
LDH:CS	228.84^{a}	**552.95^{b}**	**462.14^{b}**
Light portion			
CS (× 10^{-2})	0.405^{b}	0.384^{b}	0.290^{a}
LDH	1.255^{a}	1.950^{ab}	2.471^{b}
LDH:HAD	7.33^{a}	**11.56^{ab}**	**14.62^{b}**
LDH:CS	321.33^{a}	**529.38^{b}**	**904.22^{b}**

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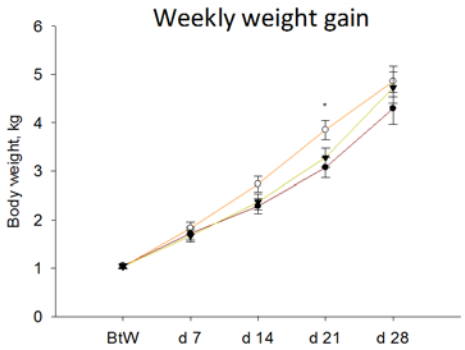
Conclusion Exp. 1 -> Changes for Exp. 2

- **Both supplements positively affect muscle maturation in early life**

- **No effects of supplements on growth performance and carcass composition**
  - Low weaning weight
    - Restricted intake?



***Ad libitum* feeding**

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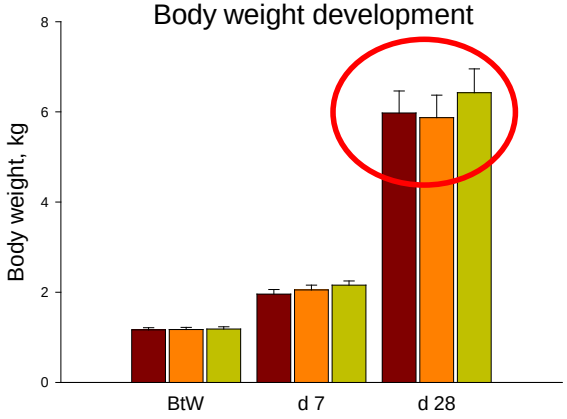
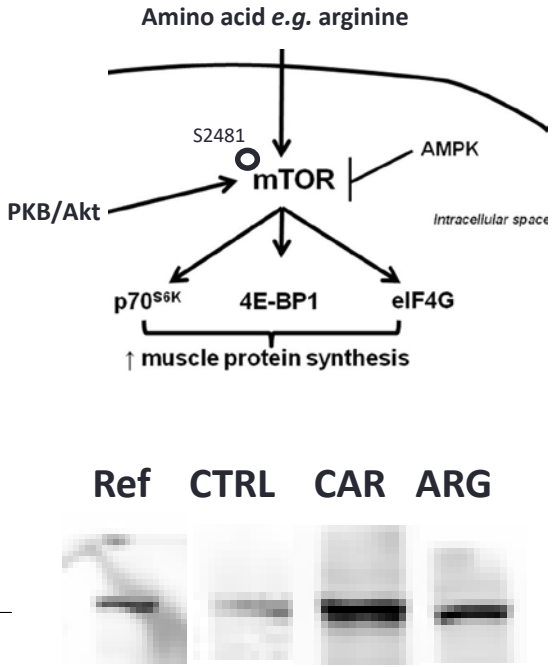
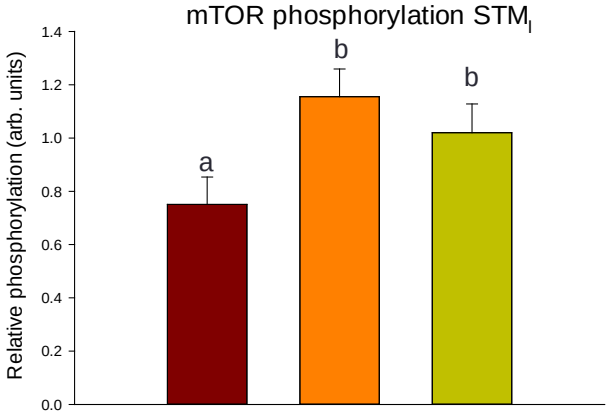
Results Exp. 2

Increase by 30%
compared to Exp. 1







Different superscripts "a" and "b" marks siginificant difference ($P < 0.05$) between bars.

Control Carnitine Arginine

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Conclusion Exp. 2

- **Compared to Exp. 1, *ad libitum* feeding improves growth and weaning weight**

- **Molecular effect of supplementation**
  - Increased activation of protein synthesis pathway.

- **No clear indication that one of the two supplements has an advantage over the other (CAR ⇔ ARG)**

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Exp. 3

- **Optimize milk replacer**

		Milk replacer	
Ingredients, %	Sow milk	Exp. 1 & 2	Optimized
Whey powder	-	61.6	-
Whole milk protein	-	28.0	-
Milk protein	-	6.2	26.5
Butter powder, 75% fat	-	-	51.0
Glucose	-	1.0	20.0
Analyzed composition, as fed			
Dry matter, %	~ 20.0	20.0	20.0
Gross energy, MJ	5.5	3.6	5.5
Crude protein	56.0	42.2	63.2
Crude fat	83.2	15.6	81.2

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Exp. 3

- **Rearing with optimized milk replacer**
  - Massive diarrhea, low growth -> experiment terminated.

- **Speculations regarding diarrhea**
  - DM, protein and/or fat content too high.

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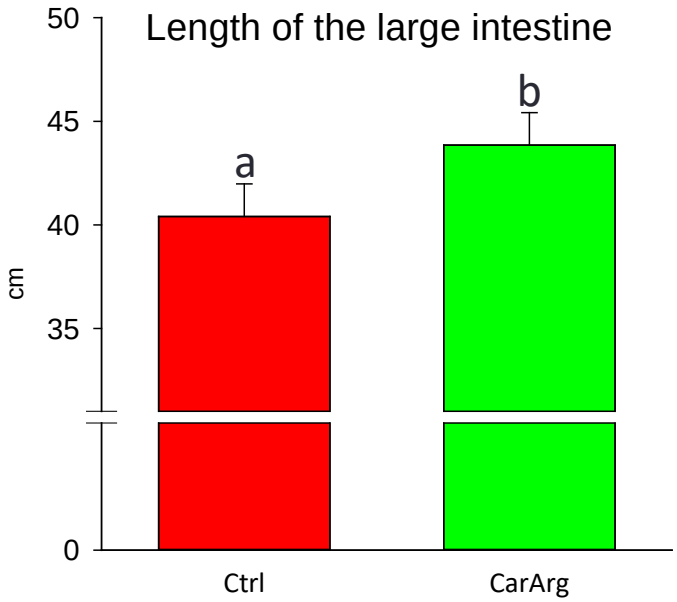
Preliminary results of Exp. 4



Pre and post weaning growth of artificially reared piglets (preliminary results)

Item	Dietary treatment	
	CTRL	CarArg
Pre weaning		
Birth weight, kg	1.037	1.042
BW day 7, kg	1.769	1.700
BW day 28, kg	4.343	4.375
ADG d 7-28, kg/d	0.123	0.128
ADFI d 7-28, kg DM/d (pair)	0.273	0.287
Post weaning (PW)		
BW 1 month PW	10.1	11.5
BW 2 month PW	24.5	24.9
ADG Weaning-2 month PW, kg/d	0.338	0.340

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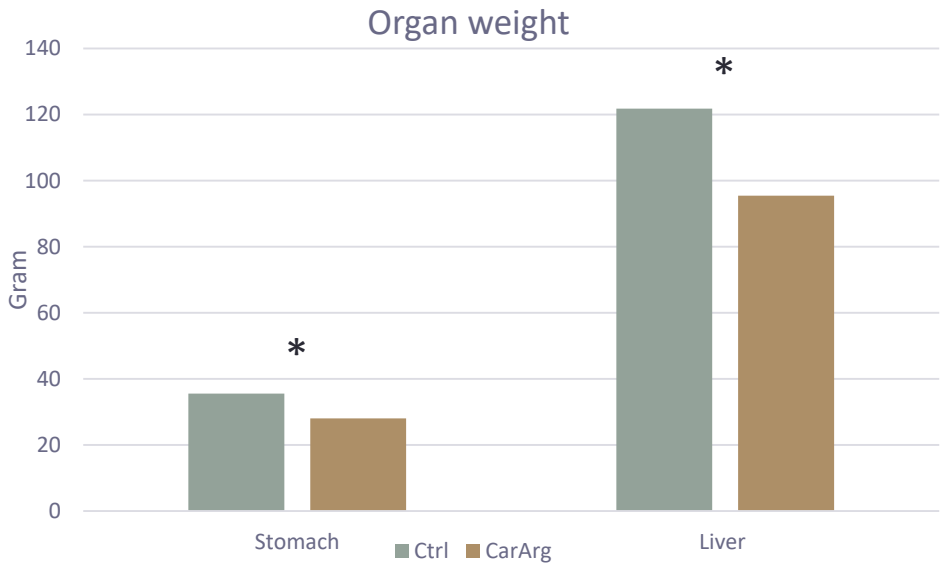
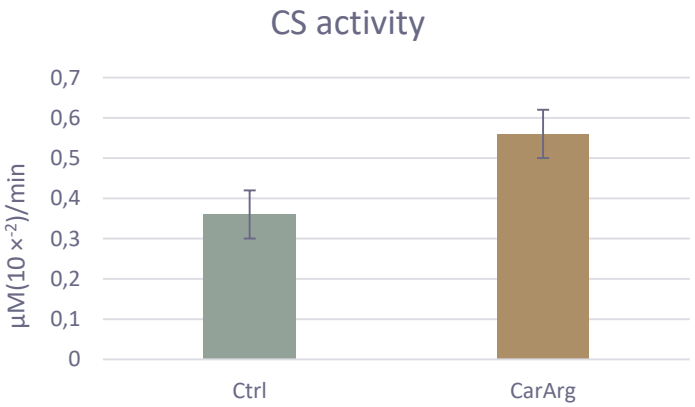
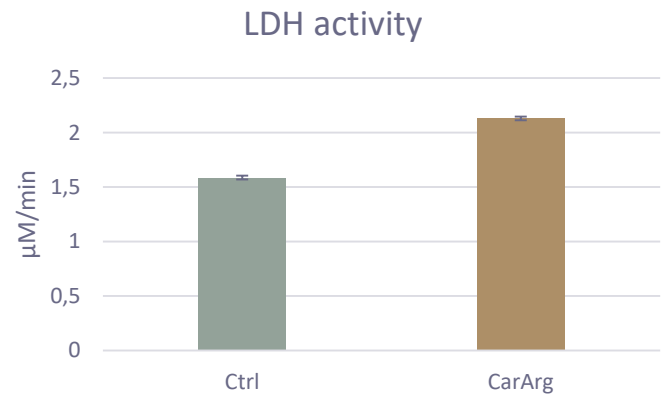
Results: Organ weights and enzyme activity d 28







- Stomach and liver weight greater in Ctrl piglets. * ($P < 0.05$).
- Greater CS and LDH activity in STM of CarArg pigs ($P < 0.05$).

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