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Compensatory feeding of gestating gilts: effects on mammary gland development and lactation

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Sows do not produce enough milk to sustain maximal piglet growth

Main factor limiting milk yield

# of secretory cells present in mammary tissue at the onset of lactation

Head et al. (1991)

How to ↑ mammary development?

- ✓ **Compensatory growth ?**
  - ➢ **in rats:** a stair-step feeding in peripuberty & gestation (Moon & Park 2002):
    - ↑ milk yield
    - ↑ mammary differentiation

  - ➢ **in pigs:** diet deprivation and over-allowance in G, F & gestation (Crenshaw 89):
    - ↑ milk yield
    - ↑ mammary casein mRNA

How to ↑ mammary development?

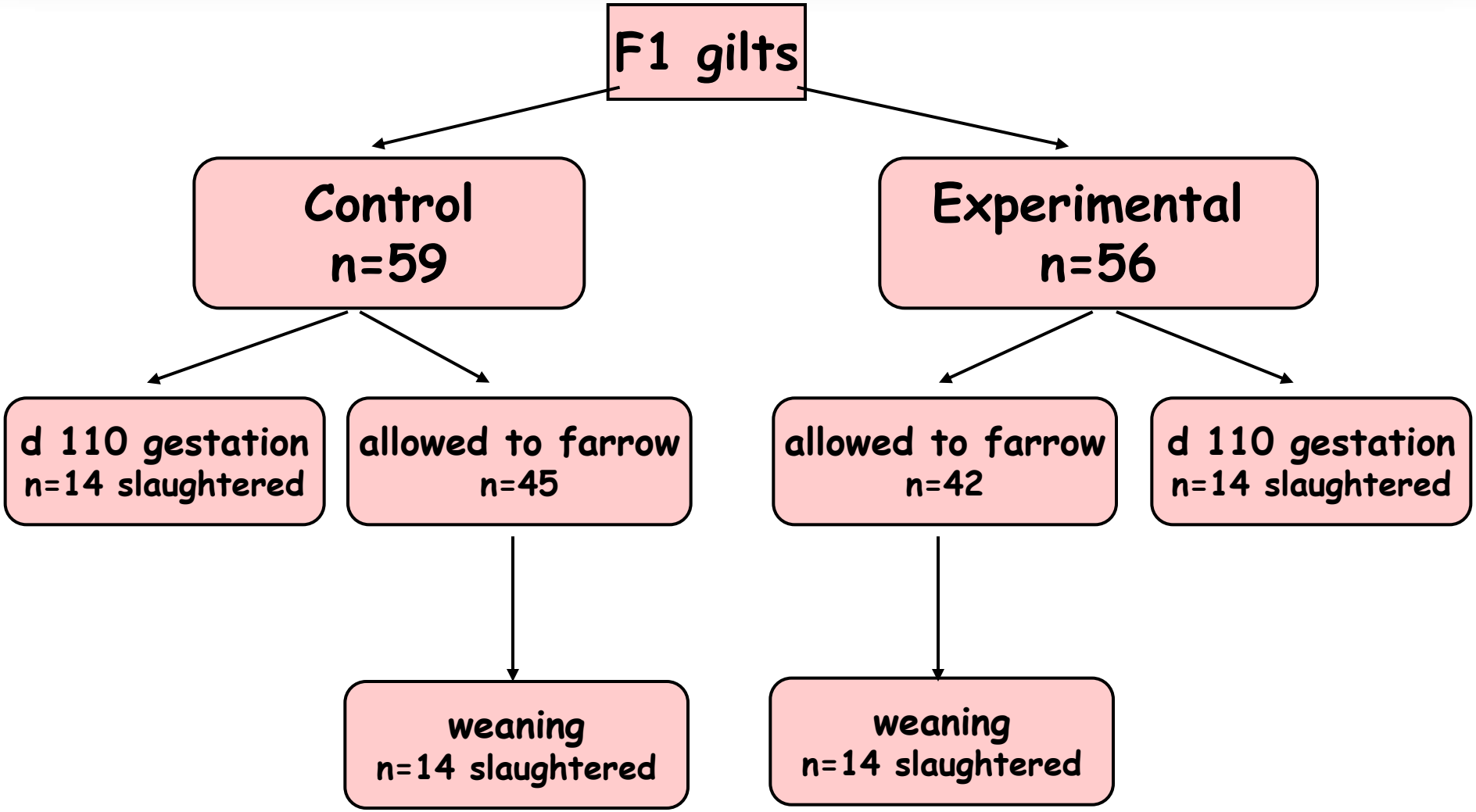
- ✓ **Compensatory growth ?**
  - ➢ **in pigs: diet deprivation and over-allowance in G-F phase (same as Crenshaw, 70% & 115%)** (Farmer et al. 2012):
    - no effect on milk yield
    - no effect on mammary parenchyma at end of gestation
    - ↑ mammary STAT5B mRNA

★ **gestation could be the most sensitive period…**

How to ⬆ mammary development?

- ✓ **Compensatory growth ?**
  - **in pigs: diet deprivation followed by over-allowance in gestation could be beneficial for:**
    - mammary development
    - mammary gene expression
    - milk yield

Materials and methods



Materials and methods

- ✓ Experimental feeding regimen:
  - ➢ weeks 1 to 10: restriction diet (70% of CP and DE of control diet)
  - ➢ weeks 11 until farrowing: compensatory diet (115% of CP and DE of control diet)
- ✓ Slaughter d 110 gestation or d 21 lactation:
  - ➢ collect mammary glands (dissection, comp., gene expression)
- ✓ Piglet growth rate:
  - ➢ litters of 11-12, weekly weights (d 21)

Materials and methods

- ✓ Sow weight and backfat thickness:
  - mating, d 70 & 108 gestation
  - d 1 & 17 lactation
- ✓ Blood samples:
  - d 70 & 108 gestation, d 3 & 17 lactation
  - measure urea, FFA, glucose, IGF-1, P4
- ✓ Milk samples:
  - d 17 lactation
  - standard comp. & protein content for casein-β, WAP

Results

Sows, BW (kg)	CTL	TRT
d 70 gestation	188.6	↓ 170.2
d 108 gestation	210.6	↓ 197.7
Gain: mating – d 70	33.5	↓ 17.1
Gain: mating – d 108	55.5	↓ 44.6
Gain: d 70 - 108	22.0	↑ 27.5
d 1 lactation	193.2	↓ 183.9
d 17 lactation	182.8	↓ 175.1
Loss: d 1- 17	10.3	8.8

Results

Sows, backfat (mm)	CTL	TRT
d 70 gestation	18.5	⇩ 16.3
d 108 gestation	17.5	⇩ 16.1
Gain: mating – d 70	1.5	⇩ -1.2
Gain: mating – d 108	0.6	⇩ -1.4
Gain: d 70 - 108	-1.0	⇧ -0.2
d 1 lactation	15.9	⇩ 14.7
d 17 lactation	13.9	13.2
Loss: d 1- 17	2.1	⇩ 1.6

Results

- Blood data:
  - no change in P4 (gestation only)
  - no change in glucose (gestation or lactation)
  - no change in urea (gestation or lactation)

Results

Blood data	CTL	TRT
FFA (µEq/L):		
d 70 gestation	180.3	↑ 327.9
d 108 gestation	416.3	↓ 258.6
lactation	NS	NS
IGF-1 (ng/mL):		
d 70 gestation	54.4	↓ 36.5
d 108 gestation	38.7	37.7
lactation	NS	NS

Results

Mammary gland-GEST	CTL	TRT
Extraparenchyma (g)	1048	883
Parenchyma (g)	1617	⇩ 1213
Parenchyma/BW (g)	7.76	⇩ 6.36
- Fat (%)	63.3	62.9
- Fat (g total)	399	297
- Protein (%)	34.1	34.6
- Protein (g total)	213	160
- DNA (mg/g)	5.76	6.17
- DNA (g total)	3.63	2.85

Results

Mammary gland-GEST	CTL	TRT
Parenchyma		
- RNA (mg/g)	7.82	8.12
- RNA (g total)	4.91	3.74
mRNA abundance*:		
- CSN2	0.15	⇧ 0.28
- IGF-1	1.16	⇩ 0.96
- ODC1	1.19	⇩ 1.02
- STAT5B	1.39	⇩ 1.15
- WAP	0.011	⇩ 0.002

*CASP3, GGT1, PRLR, STAT3, STAT5A: NS

Results

Mammary gland-LACT	CTL	TRT
Extraparenchyma (g)	1257	1155
Parenchyma (g)	2996	3135
Parenchyma/BW (g)	16.0	17.5
- Fat (%)	36.9	35.2
- Fat (g total)	230	227
- Protein (%)	52.7	54.1
- Protein (g total)	330	344
- DNA (mg/g)	11.7	12.1
- DNA (g total)	7.3	7.7

Results

Mammary gland-LACT	CTL	TRT
Parenchyma		
- RNA (mg/g)	24.3	25.4
- RNA (g total)	15.2	16.2
mRNA abundance*:		
- CASP3	0.61	⇧ 0.82
- CSN2	0.76	⇧ 2.47
- PRLR	0.57	⇧ 0.71
- WAP	2.70	⇩ 1.25

*GGT1, IGF-1, ODC1, STAT3, STAT5A, STAT5B: NS

Results

Piglets, BW (kg)	CTL	TRT
d 1	1.51	1.46
d 7	2.74	2.66
d 14	4.54	4.44
d 18	5.56	5.48
Gain: d 1 - 14	3.02	2.97

NS

Concluding remarks

- ✓ Feed deprivation & subsequent over-allowance in gestation had detrimental effects on:
  - sow BW and backfat
  - mammary development
  - mammary gene expression

- ✓ but had no effect on:
  - piglet growth

Concluding remarks

- ✓ Differences between results from Crenshaw et al. (1989) and current results could be due to:
  - ➢ differences in fiber source
    - sunflower hulls vs. soybean hulls, wheat soft & wheat middlings
    - may affect nutrient use & digestibility
  - ➢ differences in growth rate
    - growth rate ↓ by 11 kg over the whole gestation

Concluding remarks

- ✓ The ⇩ mammary parenchymal tissue mass for treated vs. control sows at the end of gestation, was no longer apparent at the end of lactation:
  - ➢ piglets were able to compensate?
    - suckling intensity (i.e. udder stimulation)?

  - ➢ alterations in mammary gene expression
    - IGF-I ⇩ end gestation but = end lactation for treated vs control sows

Concluding remarks

Still needs to be determined if compensatory gain in late gestation could have beneficial impacts on mammary development and subsequent milk yield

Thank you !

Mammary dev.: Prepubertal nutrition

- ✓ Alternating restricted & maximum growth:

  - restricted growth from 9-11 & 15-19 wks with dietary fiber addition (70% ME, 85%CP), standard diet rest of time:
    - ✓ effects on mammary development at the end of gestation

    - ❖ 43% ⇩ parenchymal mass

Lyvers-Peffer & Rozeboom (2001)

Mammary dev.: Prepubertal nutrition

- ✓ Alternating restricted & maximum growth:

Compensatory growth ?

- restricted growth from 11-13 & 17-20 wks with dietary fiber addition (70% CP, DE), compensatory (115% CP and DE) rest time:

  - ✓ NO effects on mammary development at end of gestation

Farmer et al. (2012)

Mammary dev.: Prepubertal nutrition

- ✓ Alternating restricted & maximum growth:
  - ➢ BUT: the treatment did not induce compensatory growth…
    instead there was a ⇩ in weight
    - ✓ on d 235 (puberty):
      111.1 kg for TRT vs.
      117.3 kg for CTL

Farmer et al. (2012)