IRON BIOAVAILABILITY IN PIGLETS

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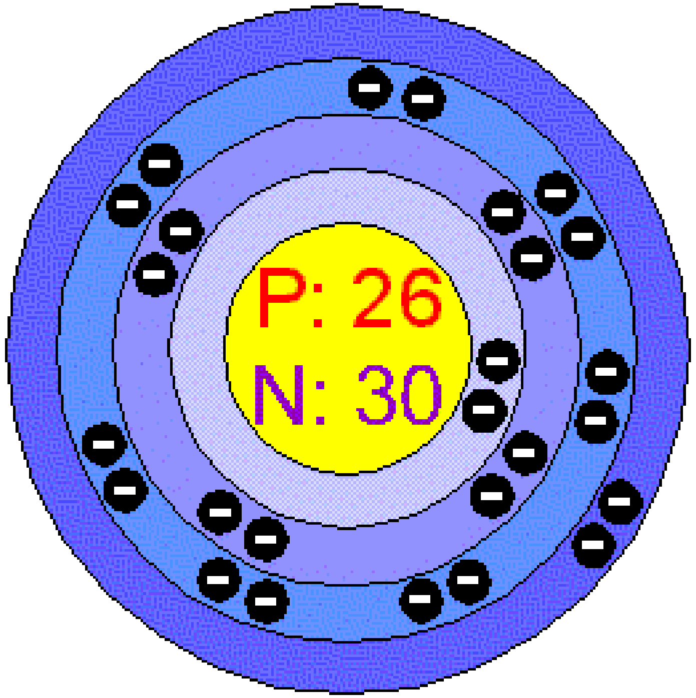
Iron as a Nutrient



Bentor (2008)

- Most abundant trace element in the body (Himmelfarb, 2007)
- Integral component of hemoglobin and myoglobin (Ganz, 2007)

Forms of Iron (Latunde Dada et al., 2006; Miret et al., 2003; Lopez & Martos, 2004; Samman, 2007)

- **Heme**
  - Meat/fish
  - Blood
- **Non-heme**
  - Vegetables/cereals
  - Animal sources

Iron Deficiency (Anemia)

Global nutritional disorder of utmost concern

- Tetens et al (2007)

Depression of bone marrow production of red blood cells

- Carlson (2009)

Iron Deficiency (Anemia) in Piglets

(Radostits et al., 2007)

- Inadequate access to soil
- Iron requirement is high
- Iron content of dam's milk is low

Piglet as Model in Nutritional Research (Patterson et al., 2008)

Elucidate mechanisms in dietary effects on mineral absorption

Easy manipulation of iron status of piglets from birth

Nutritional Study on Iron Bioavailability (Rapisura-Flores, 2009)

Validate effectiveness of meat and meat extract in enhancing iron absorption

Histological parameters

Mineral intake and retention

Nutritional Study on Iron Bioavailability

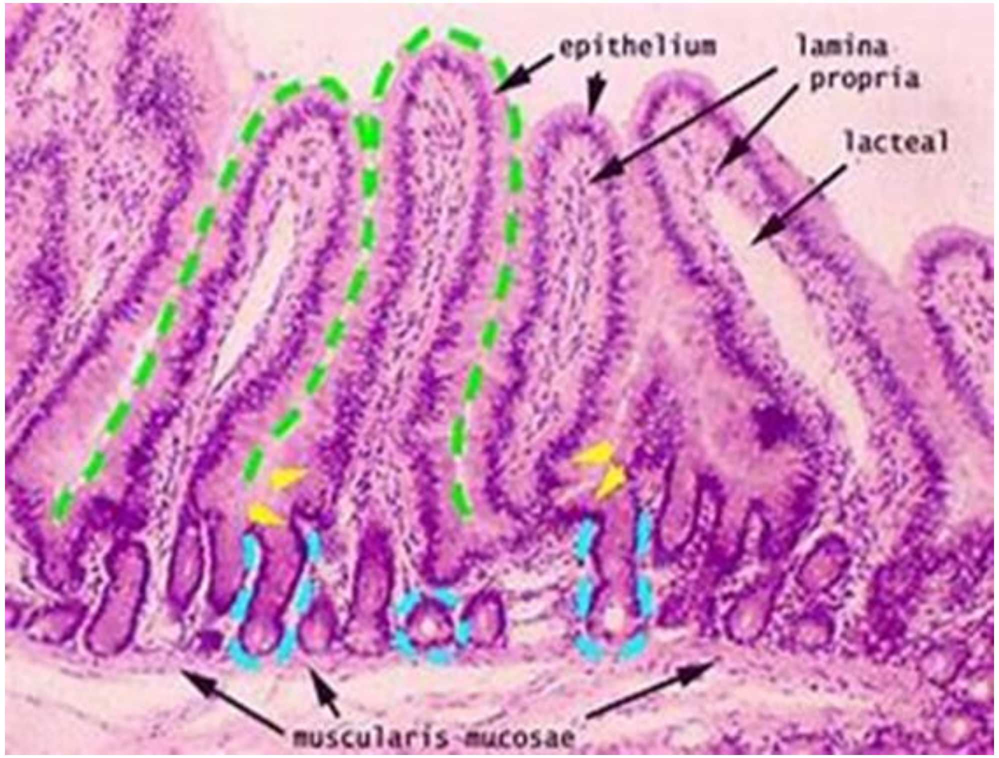
24 piglets in metabolism crates

1 week acclimatization & 4 weeks trial

6 piglets allocated to 1 of treatment groups

- Non-meat diet (control)
- Non-meat diet plus lactoferrin
- Meat diet
- Non-meat diet plus meat extract

Intestinal Histology (Rapisura-Flores et al., 2019; Laudadio et al., 2012)



https://www.bing.com (March 11, 2019)

Slides examined & images shot

Parameters measured (Sigma scan software)

Goblet cells counted

Histological Parameters

Significance levels after 4 weeks of the experiment for the height of the villi (µm), depth of the crypt (µm), mucosal thickness (µm) and goblet cells/100 µm in the small intestine of piglets given the control, lactoferrin, meat and meat extract diets

Parameters	Diet	Pig (Diet)	Location	Diet*Location	R^2
Height	ns	*	**	***	0.31
Depth	ns	***	ns	ns	0.41
Mucosal Thickness	ns	**	***	***	0.37
Goblets/100µm	**	**	**	**	0.39

ns: P > 0.05, * P < 0.05, ** P < 0.01, *** P < 0.001

Histological Parameters

Non-significant interaction between diets and locations in crypt depths:

Indication of intestinal crypts dysfunction

Formation of undifferentiated crypts

Sudden changes in feeding

Post-weaning stress (Pluske et. al., 2007)

Undifferentiated enterocytes

Least squares means after 4 weeks of the experiment for the height of the villi (µm), crypt depth (µm), mucosal thickness (µm) and goblet cells/100 µm in the duodenum, jejunum and ileum of piglets given the control, lactoferrin, meat and meat extract diets

Parameters	Control	Lactoferrin	Meat	Meat Extract	SE
Duodenum					
Villi height (µm)	419.[a]	449[a]	379[b]	322[c]	22.6
Crypt depth (µm)	130[a]	153[a]	102[b]	76[b]	11.5
Mucosal thickness (µm)	682[a]	719[a]	588[b]	515[c]	24.5
Goblet cells/100 µm	0.016[b]	0.013[b]	0.023[a]	0.019[a]	0.001
Jejunum					
Villi height (µm)	396[ab]	436[a]	410[ab]	373[b]	18.3
Crypt depth (µm)	128[a]	116[a]	104[a]	117[a]	10.1
Mucosal thickness (µm)	620[a]	624[a]	610[a]	590[a]	25.9
Goblet cells/100 µm	0.016[b]	0.020[a]	0.022[a]	0.022[a]	0.002
Ileum					
Villi height (µm)	293[c]	365[b]	399[a]	383[a]	17.4
Crypt depth (µm)	85[b]	128[a]	110[ab]	83[b]	14.4
Mucosal thickness (µm)	484[b]	553[a]	567[a]	560[a]	23.2
Goblet cells/100 µm	0.018[c]	0.019[c]	0.022[b]	0.027[a]	0.001

[a,b,c] Means within the same row with common superscripts or with no superscripts do not differ significantly (i.e. $P > 0.05$)

Histological Parameters

Number of goblet cells/100 μm significantly increased in the ileum for meat extract and meat groups

- Goblet cells are more numerous in the ileum than in duodenum (Eurell & Frappier, 2006)

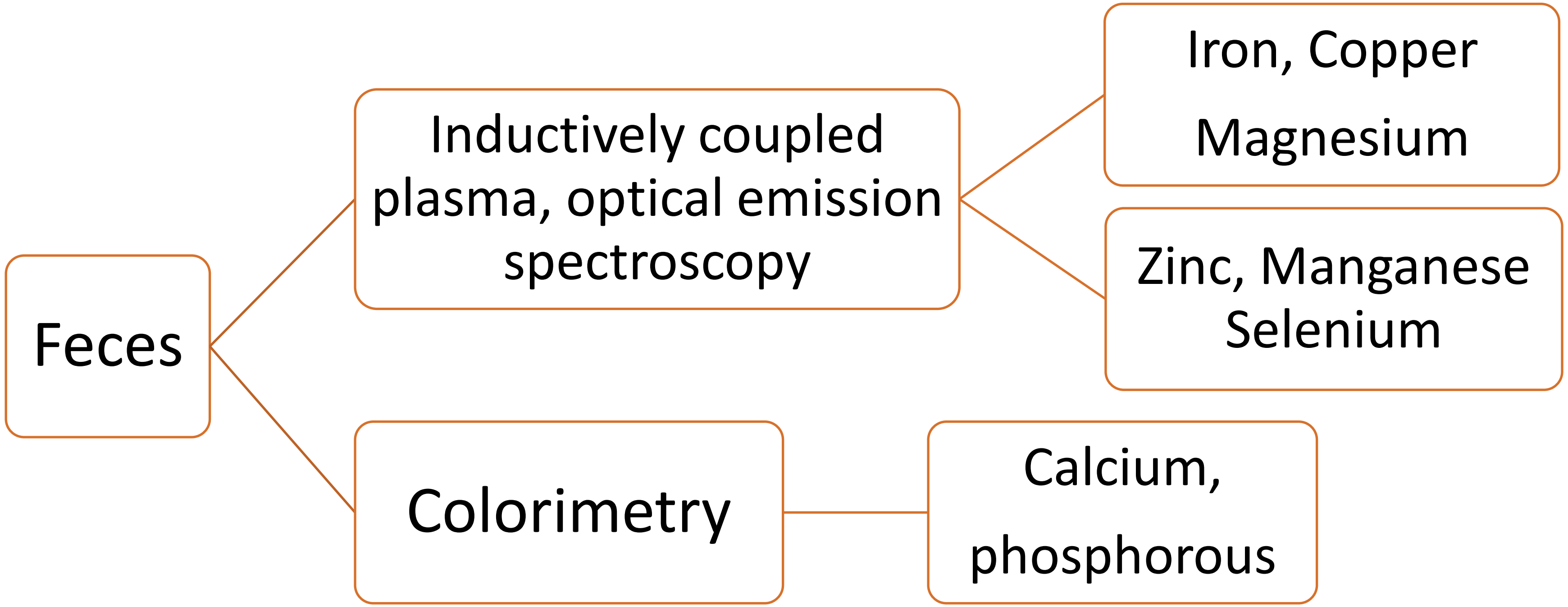
Goblet cells produce mucin (Argenzio, 2004)

- Binding of mucin to iron in acidic pH maintains iron solubility (Conrad & Umbreit, 2006)

Histological Parameters

Meat extract and meat diets → ↑ Number of goblet cells/100µm → Mucin secretion stimulation

Mineral Intake and Retention
(Rapisura-Flores, 2009)



Least squares means and significance levels for daily mineral intake (mg) and daily mineral retention (mg) of piglets given the control, lactoferrin, meat and meat extract diets on days 24 to 28 of the experiment

Parameters	Control	Lactoferrin	Meat	Meat Extract	SE	P
Intake (mg/day)						
Calcium	4234[d]	4468[c]	7551[a]	4751[b]	33.3	***
Magnesium	70[d]	83[c]	162[a]	108[b]	0.55	***
Phosphorous	3327[d]	3511[c]	3776[b]	4319[a]	26.2	***
Copper	2.5[d]	2.6[c]	3.0[b]	3.7[a]	0.02	***
Iron	30[c]	46[a]	39[b]	40[b]	0.29	***
Manganese	6.7[d]	8.0[c]	8.7[b]	24.2[a]	0.05	***
Selenium	0.33[d]	0.38[c]	0.42[a]	0.39[b]	0.003	***
Zinc	39[d]	41[c]	57[a]	52[b]	0.31	***
Retention (mg/day)						
Calcium	3522[c]	3951[b]	5951[a]	4466[b]	193	***
Magnesium	57[d]	74[c]	133[a]	96[b]	2.6	***
Phosphorous	2403[bc]	2847[b]	2381[c]	3705[a]	155	***
Copper	0.897[b]	0.762[b]	0.526[b]	1.74[a]	0.27	*
Iron	7.3[b]	29.9[a]	15.5[ab]	19.0[ab]	6.06	ns
Manganese	1.8[c]	3.4[b]	3.4[b]	19.5[a]	0.38	***
Selenium	0.133[b]	0.194[a]	0.230[a]	0.209[a]	0.02	**
Zinc	1.7	4.3	1.1	11.6	4.58	ns

[a,b,c,d] Means within the same row with common superscripts or with no superscripts do not differ significantly (i.e. P > 0.05)

ns: P > 0.05, *P <0.05, **P <0.01, ***P <0.001

Mineral Antagonisms

↑ Consumption and retention of calcium, phosphorous, copper and zinc

- ↓ Iron absorption (Patterson et al., 2008)

Zinc, calcium and magnesium

- ↓ Iron bioavailability (Zhu et al., 2009)

Mineral Antagonisms

Retentions of calcium, phosphorous, magnesium and manganese (meat and meat extract groups)

Iron absorption thus limiting iron bioavailability

THANK YOU!