Investigating Opportunities Available in Genetic Selection for Healthy Beef

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Policy Environment

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Product Marketing

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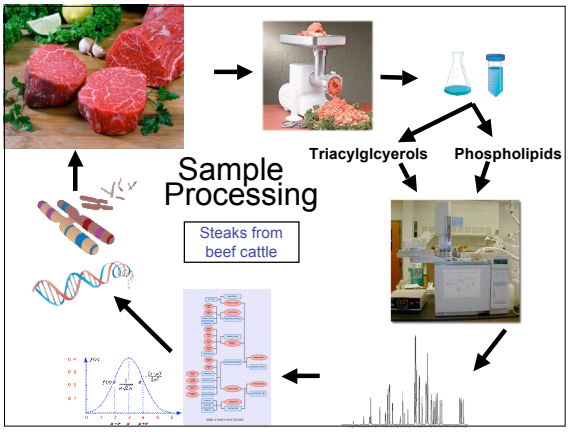
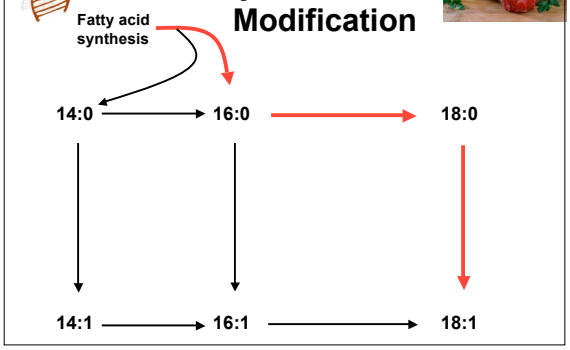
Fatty Acids

- Fatty acid concentrations determine healthfulness of the lipid
- Fatty acid concentration is influenced by:
  - Nutrition (Duckett et al., 1993)
  - Breed (Pitchford et al., 2002)

S. K. Duckett et al. 1993. J. Anim. Sci. 71:2079-2088.
W. S. Pitchford et al. 2002. J. Anim. Sci. 80:2825-2832.



Fatty Acid Synthesis and Modification



Atherogenic index

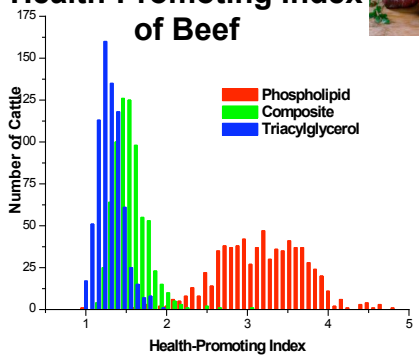
$$= \frac{12{:}0 + 4*(14{:}0) + 16{:}0}{\Sigma(\text{MUFAs}) + \Sigma(\text{PUFAs})}$$

The atherogenic index as proposed by Ulbricht and Southgate, 1991

Health Promoting Index

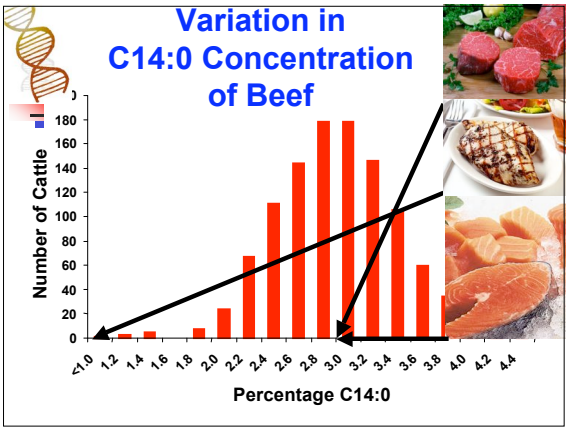
$$= \frac{\Sigma(\text{MUFAs}) + \Sigma(\text{PUFAs})}{12{:}0 + 4*(14{:}0) + 16{:}0}$$

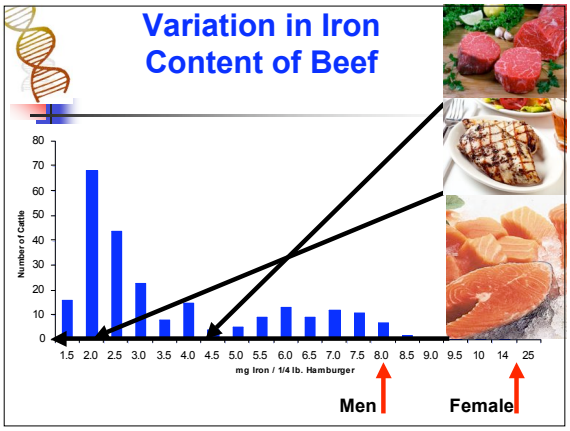
Variation in Health-Promoting Index of Beef



Health-promoting index of several foods

Food	HPI	Food	HPI
Soy oil	7.69	Beef(NLMB)	1.43
Olive oil	7.14	Beef TG(Knight)	1.27
Beef PL(Knight)	3.03	"Extreme" milk fat	1.30
Chicken	2.27	Beef(Beitz)	1.16
Pork	2.13	Tallow	1.12
Lard	1.92	"Greatest" milk	0.94
Beef(Eichhorn)	1.67	"Average" milk fat	0.44
Margarine	1.61	"Low" milk fat	0.30
Beef(Knight)	1.52	Palm kernel oil	0.15
Beef(Garret)	1.49	Coconut oil	0.06





Genetic Analysis

- Estimate h^2 of fatty acids in Angus beef:
  - 14:0, myristic acid
  - 14:1, myristoleic acid
  - 16:0, palmitic acid
  - 16:1, palmitoleic acid
  - 18:0, stearic acid
  - 18:1, oleic acid
  - 18:2, linoleic acid

Data Description

- Data collected from 2001-2004
- 916 Angus-sired bulls and steers
  - 87 sires with 1 to 41 progeny
- Calf-fed management
- Corn-based finishing rations

Data Description

- Longissimus dorsi sample

- External connective tissue was removed
- Fatty acids evaluated by gas chromatography

Data Descriptors

Fatty Acid	Mean % of lipid	SD % of lipid	Min % of lipid	Max % of lipid
14:0	2.82	0.49	1.19	4.34
14:1	0.68	0.28	0.00	1.85
16:0	26.48	1.94	16.79	32.38
16:1	3.48	0.67	0.99	5.64
18:0	12.74	1.44	8.28	17.29
18:1	41.34	3.26	23.74	54.06
18:2	7.02	2.99	1.78	29.76

Genetic Analysis

- MTDFREML
  - Sire model option
- Contemporary group definition:
  - Herd of origin
  - Sex
  - Feedlot management treatment
  - Harvest date

Genetic Analysis

- Single trait analysis
- Model:

  Y = Xb + Zu + e

  Fixed effects (b):
  - Model I: Contemporary group only
  - Model II: Cont group & lipid covariate

  Random effects (u & e):
  - Sire
  - Error

Heritability Estimates (% of lipid)

Fatty Acid	h^2 Model I	SE Model I
14:0	0.49	0.14
14:1	0.13	0.08
16:0	0.43	0.13
16:1	0.49	0.14
18:0	0.20	0.09
18:1	0.38	0.13
18:2	0.23	0.10

Heritability Estimates (% of lipid)

Fatty Acid	h^2 Model I	SE Model I	h^2 Model II	SE Model II
14:0	0.49	0.14	0.52	0.14
14:1	0.13	0.08	0.14	0.08
16:0	0.43	0.13	0.42	0.13
16:1	0.49	0.14	0.47	0.14
18:0	0.20	0.09	0.21	0.10
18:1	0.38	0.13	0.40	0.14
18:2	0.23	0.10	0.11	0.08

Heritability Estimates (% of lipid)

Fatty Acid	h^2 Model I	SE Model I	h^2 Model II	SE Model II	Δh^2 Model II - I
14:0	0.49	0.14	0.52	0.14	0.022
14:1	0.13	0.08	0.14	0.08	0.010
16:0	0.43	0.13	0.42	0.13	-0.017
16:1	0.49	0.14	0.47	0.14	-0.020
18:0	0.20	0.09	0.21	0.10	0.014
18:1	0.38	0.13	0.40	0.14	0.020
18:2	0.23	0.10	0.11	0.08	-0.119

Discussion

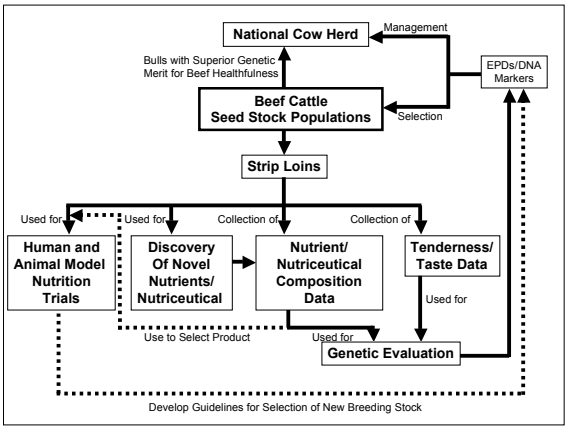
- Generally, little change in h^2 estimates with Model II
- Short-chain, saturated fatty acids are heritable
  - 14:0 (0.49)
  - 16:0 (0.43)
- Monounsaturated fatty acids are heritable
  - 16:1 (0.49)
  - 18:1 (0.38)

Genetic Correlation Estimates

Fatty Acid	HCW	12 Fat	REA	MARB	W-B Shear
14:0	-0.23	0.27	-0.10	0.32	0.31
16:0	-0.24	0.17	-0.25	0.26	-0.04
18:0	0.00	-0.54	-0.50	-0.45	-0.07
18:1	-0.14	0.18	0.01	0.83	0.12
18:2	0.43	-0.17	0.24	-0.93	-0.04

Conclusions

- Opportunities exist to select for fatty acid composition of beef
- Genetic correlations?
- Fatty acid relationships to consumer acceptability need to be investigated



Acknowledgements

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