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Beef Marbling: Association with carcass traits and beef tenderness

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Introduction (1)

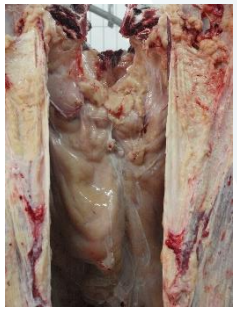
- Carcasses should be well muscled with moderate fat cover
  - Aim of carcass classification:
    conformation E, U, R
    fatness class 2, 3, (4)

- Growing animals
  - First growth of bones, second muscle growth, finally fat tissue
    - In breeds with high muscle growth potential, development of fat tissue starts late(r)

Source: Augustini 1987, Wegner et al. 1998, Warriss 2000, Pethick 2006

Introduction (2)

- 4 major fat depots
  - (1) intestinal fat (kidney fat, …)
  - (2) intermuscular fat (between muscles)
  - (3) subcutane fat (fat cover)
  - **(4) intramuscular fat (IMF) = marbling**
    - Important for palatability, tenderness, juiciness



Introduction (3)

- **Internationally beef marbling is important** (USA, Australien, Japan, …)
  - Consumers prefer higher marbled beef
- In **Europa** beef marbling **not recorded / paid for**
- Steakhouses, top gastronomy, grill events … sell well marbled beef from oversea
- In Austria some beef labels (e.g. *www.cult.beef*), butchers and direct marketing advertise with marbling

Fat in human nutrition often negative image; nevertheless demand for well marbled beef ->marketing -> **additional values for farmers, butchers, meat trade, gastronomy**

Influence factors an IMF / marbling

- **Animal specific**
  - Sex, category
  - Breed, genetics

- **Production specific**
  - Final live weight, slaughter age
  - Management, housing
  - Feeding (intensity), backgrounding
  - Feeding regime *(Park et al. 2018)*
    - Forage and concentrates (ratio, components, …)
    - …

Animals, materials und methods (1)

- **Purpose of the project: investigation of relationships between IMF/marbling and carcass traits as well as meat tenderness**

- **14 Austrian beef fattening trials** (bull, heifer, steer)
  - Approx. 800 data sets
    - 63% bulls, 20% heifers, 17% steers
    - Typically Austrian feeding rations and slaughter age/weight
    - Fleckvieh und Fleckvieh-crosses; some Wagyu-crosses, Angus, domestic breeds (Pinzgauer, Grauvieh)
  - Data on carcass traits and beef tenderness (shear force, panel)
    - IMF (Soxhlet, NIRS) of forerib (*M. long. dorsi*)
    - Meat 14 days aged

Animals, materials and methods (2)

- **Statistical analyses**
  - **(1) Covariance analysis** (**11 feeding trials** and 500 data sets): **Effect of slaughter performance** on **IMF**
  - **(2) Correlations** (Pearson, Spearman), **scatterplots** (14 trials and 800 data sets): **Relationship tenderness and IMF**

Research question (1)

- What effect have beef category, breed, slaughter age, slaughter weight and carcass fatness on IMF content?

Database 11 fattening trials (covariance analysis)

		Bull		Steer		Heifer	
Trait	Unit	mean	σ	mean	σ	mean	σ
Number animals		*314*		*73*		*128*	
Slaughter age	Tage	534	*49*	636	*68*	508	*58*
Final live weight	kg	675	*31*	635	*29*	539	*19*
Carcass weight (cw)	kg	391	*21*	348	*22*	300	*20*
Dressing percentage	%	58.0	*2.0*	55.5	*2.0*	56,1	*2,1*
Daily gains	g	1,284	*128*	1,069	*102*	1,132	*92*
Daily net gain	g	742	*71*	592	*59*	607	*64*
Carcass conformation	Pkt 1-5 (5=E)	3.81	*0.54*	3.33	*0.52*	3.67	*0.44*
Fat class	Pkt 1-5 (5=fett)	2.34	*0.41*	2.80	*0.56*	2.97	*0.57*
pH, 48 h p.m.		5.60	*0.20*	5.56	*0.14*	5.61	*0.12*
Kidney fat	% v. cw	2.38	*1.10*	3.97	*1.64*	3.84	*1.29*
IMF-content (Soxhlet/NIRS)	mg/g FM	19	*9*	34	*14*	30	*13*

Results – IMF und slaughter performance

- **Significant effects on IMF content according to model** (R^2=58%)
  - **Trial** (11 trials)
  - **Beef category** (bull, steer, heifer)
    - Bull lowest IMF content
  - **Slaughter age**
  - **Fatness class**
  - **Kidney fat**

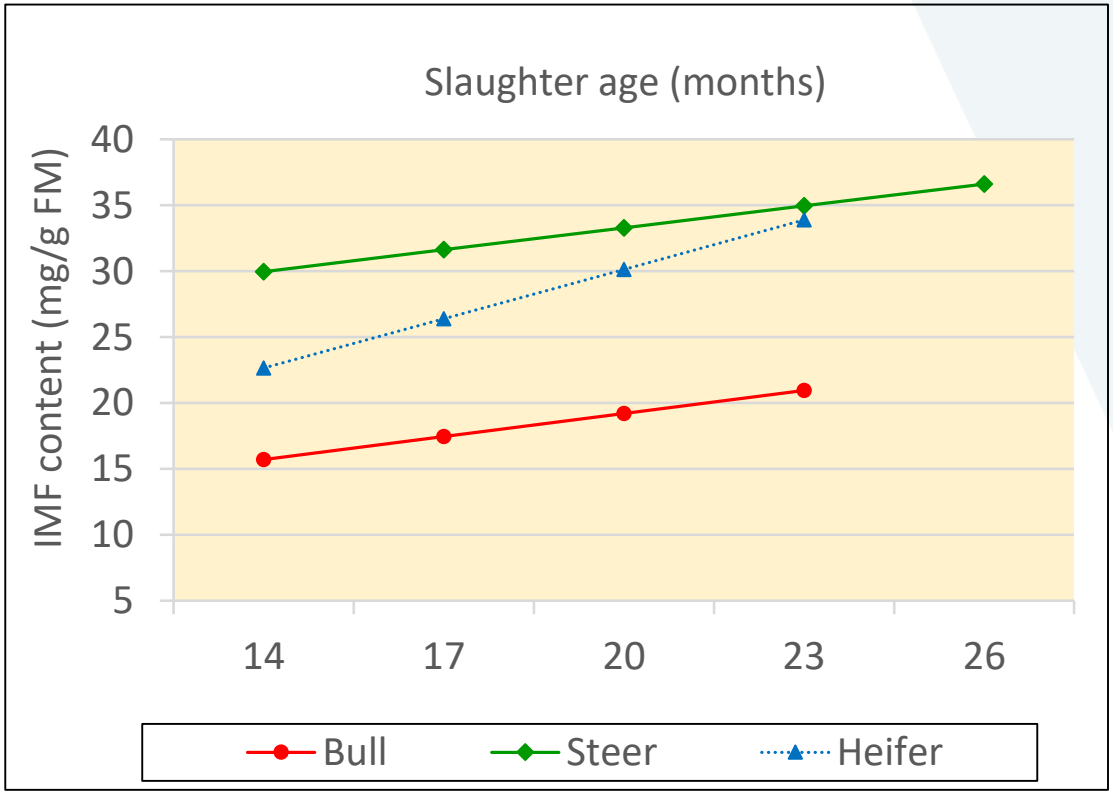
No effect according to model:

- **Breed** (FV vs. FVxLI, FVxCH)
- **Daily gains**
- **Conformation class**

- Impact of **feeding/ energy supply** could **not** be **considered** in the model, because feeding trials too different -> feeding partly in effect „trial"

Results – IMF and slaughter age (1)

- **Slaughter age** has significant **effect** (P=0.012) **on IMF**
  - Impact in literature well documented (*Wegner et al. 1998, Branscheid et al. 2007, Park et al. 2018*)



Results – IMF and slaughter age (2)

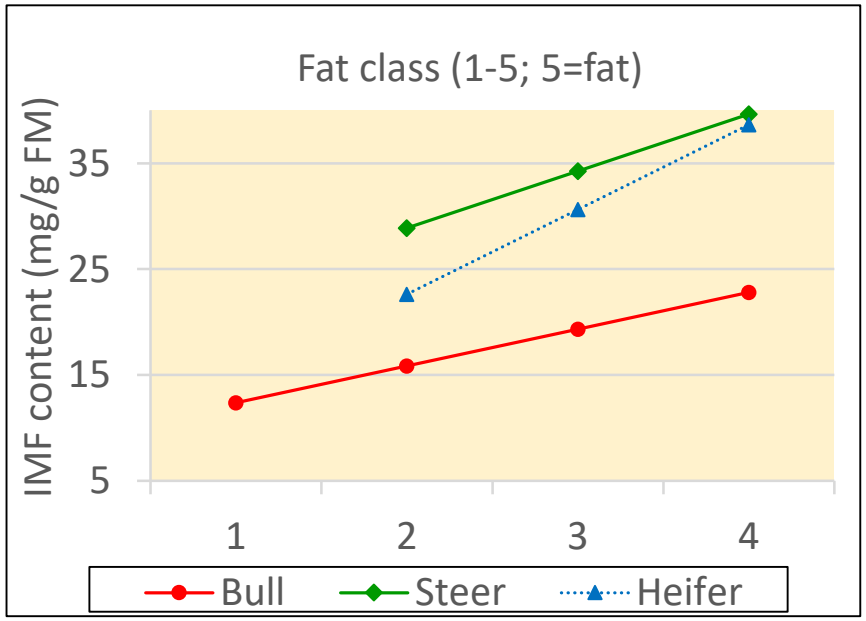
- **High slaughter age *per se*** does **not** result in **highly marbled beef**

- Necessary to put slaughter age **in connection with final live weight**
  - **Final live weight no significant effect in model**
  - However, if final slaughter weight instead of slaughter age in model, then significant (similar graph)

Augustini u. Temisan (1986): Fattening intensity has stronger impact on carcass fatness then slaughter age

Results – IMF and fatness score

- **Fat cover score has** significant effect (P=0.001) on IMF

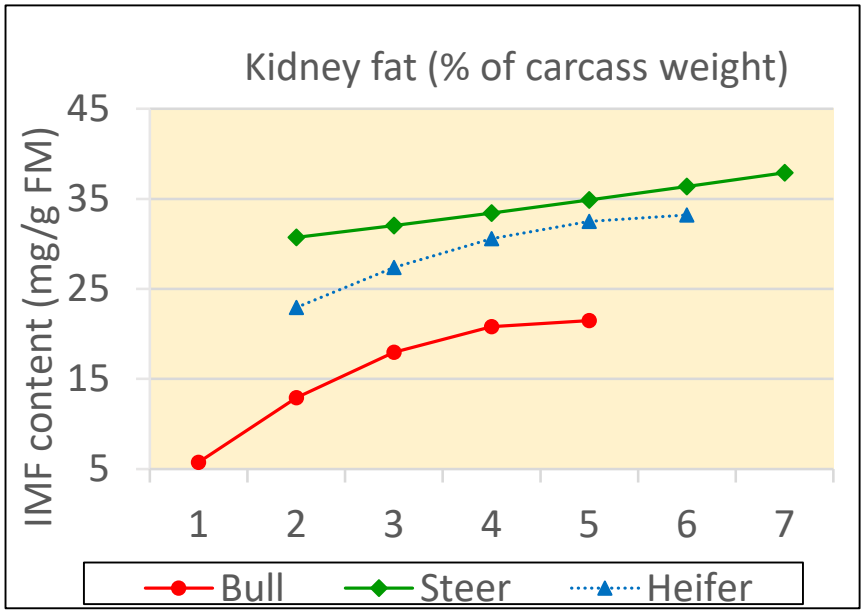


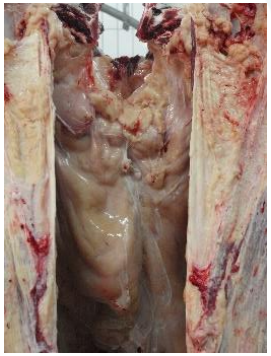
Correlation coefficient (r) = 0.18 (P<0.001) (single trials r= 0.20 – 0.74)

- Few literature, because fat class only in Europa: *Sanaa (2008)* und *Indurain (2009)* r=0.31 and 0.29, respectively

Results – IMF and kidney fat

- **Kidney fat not routinely surveyed** in slaughter houses
- Significant correlation (P=0.005) between kidney fat and IMF





Correlation coefficients (r) = 0. 50 (P<0.001) (single trials r= 0.18 – 0.77)

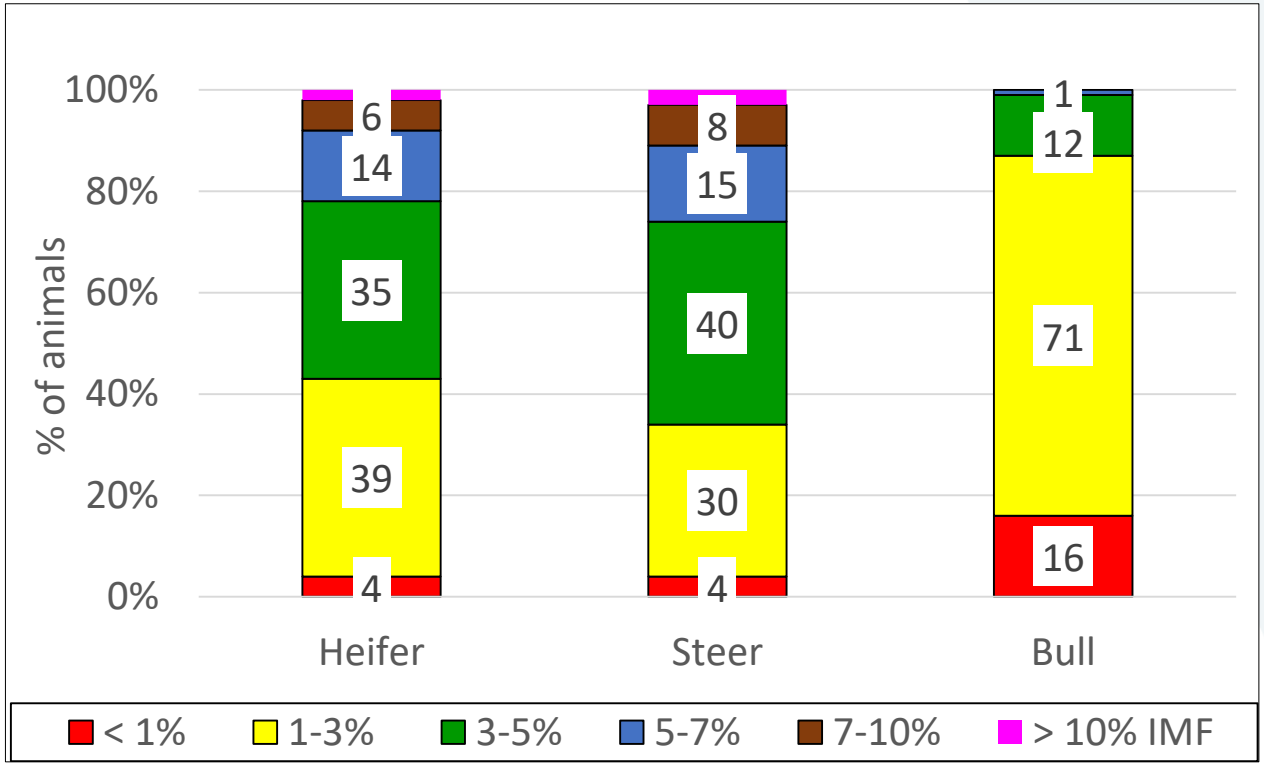
- No literature found, which compares IMF and kidney fat

Research question (2)

- Is there a connection between IMF content and tenderness of Austrian beef?

- 14 trials with different designs (… Wagyu crosses, Grauvieh steers, Angus), 14 days meat ageing

Results – IMF content of Austrian beef



Source: Velik 2020

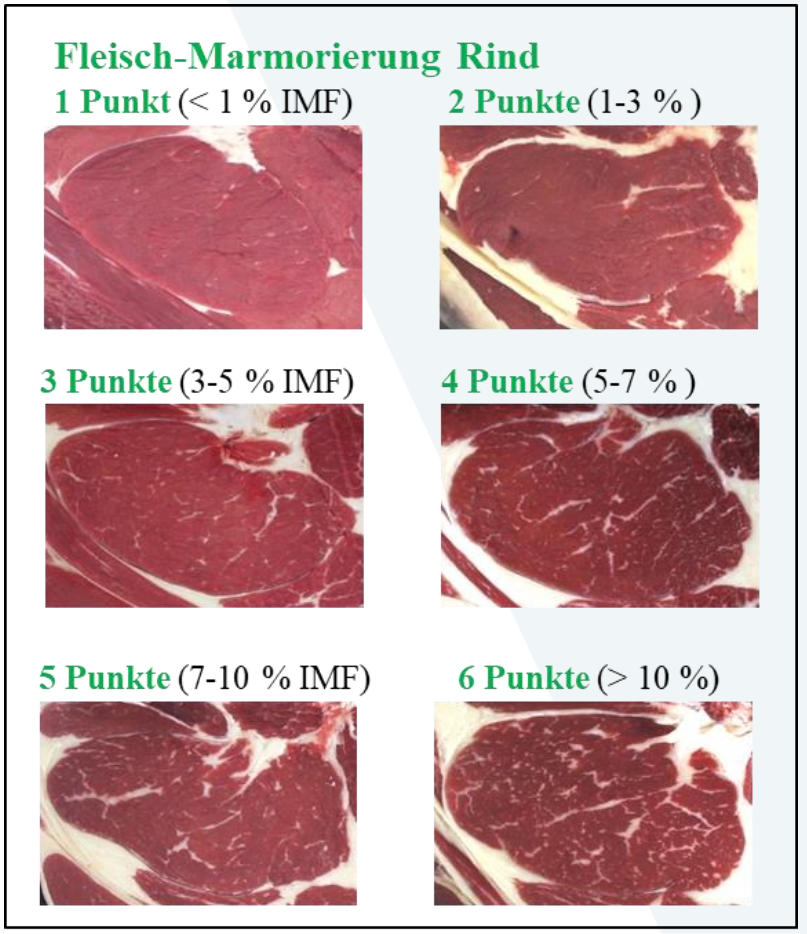
*Data bases **14 fattening trials**: 161 heifers, 137 steers, 510 bulls*

IMF content accoring to Soxhlet / NIRS; forerib

Austrian beef has **Ø 2 - 4 % intramuscular fat (IMF)**

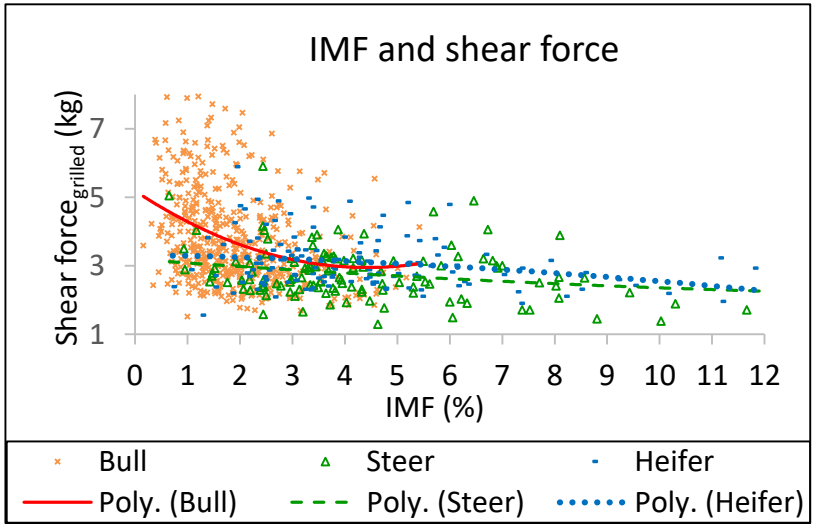
Marbling classes of Ristic (1987) and marbling fotos of Frickh et al. (2003)

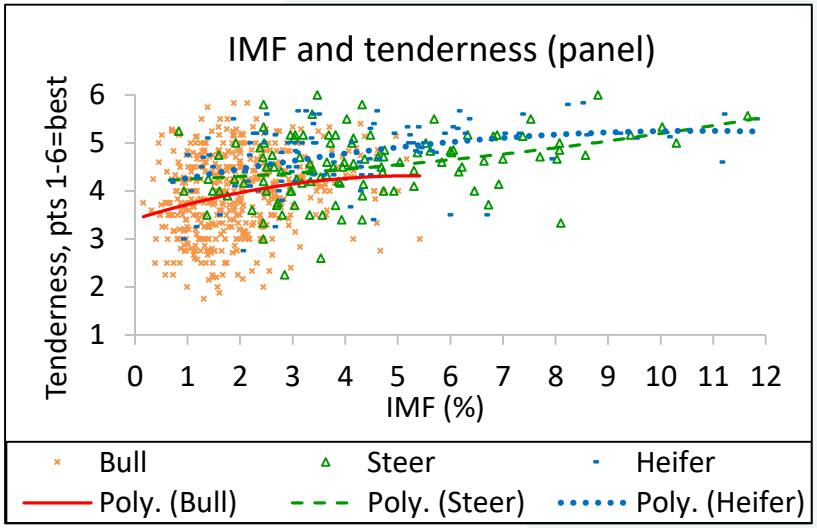
Pkte	Ausprägung	Beschreibung	IMF, %
1	keine sichtbare	blaues Fleisch	< 1
2	schwache	Existenz einiger sichtbarer Marmorierungspunkte	1-3
3	mittelmäßig	gut sichtbar eingelagertes Fett	3-5
4	stark	bereits dickere Fettfaszien	5-7
5	sehr stark	zahlreiche Fetteinlagerungen	7-10
6	zu stark	abnorme übermäßige Fetteinlagerung, Fettinfiltration	> 10



Quelle: FRICKH et al. 2003*

Results – IMF and shear force/tenderness





Correlation coefficients (r)

IMF and shear force: -0.23 (heifer), -0.24 (steer), -0.32 (bull) ($P<0.05$)

IMF and tenderness (panel): 0.41 (heifer), 0,33 (steer), 0,24 (bull) ($P<0.05$)

Further influence factors on beef tenderness: ageing, collagen content, muscle fibre type,...

....

Conclusion (1)

- **Austrian beef** has **Ø 2 - 4 %** IMF in forerib

- **Analyses of Austrian beef fattening trials**
  - **Impact factors on IMF**: trial, beef category, slaughter age
    - *Final live weight, feeding intensity*
  - **Connection** between **IMF** – **fat class** and **IMF – kidney fat, respectively**
    - Single animal: party no correlation existent
  - **Marbling of forerib** (between forequarter and hindquarter) could be easly assessed with marbling cards

Conclusion (2)

- **Loose correlation** between **IMF** and t**enderness** of Austrian beef

- Besides marbling **more factors** must be optimised for a **convincing meat quality**
  - Beef category
  - Slaughter age, final live weight
  - Feeding intensity, backgrounding
  - Perimortal handling of slaughter animals and carcasses
  - Meat ageing
  - Preparation in the kitchen
  - ….

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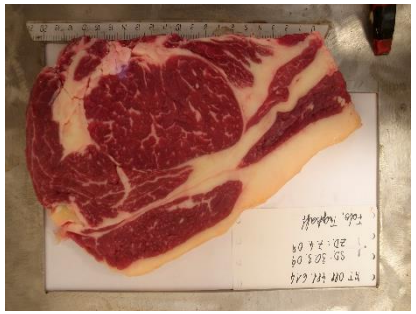
Thanks for your attention!



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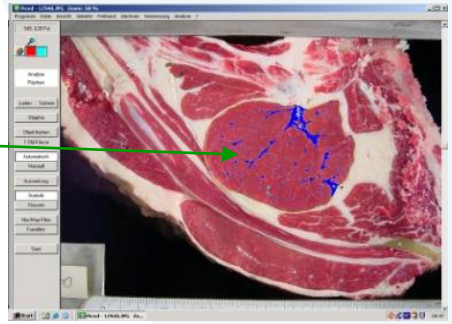
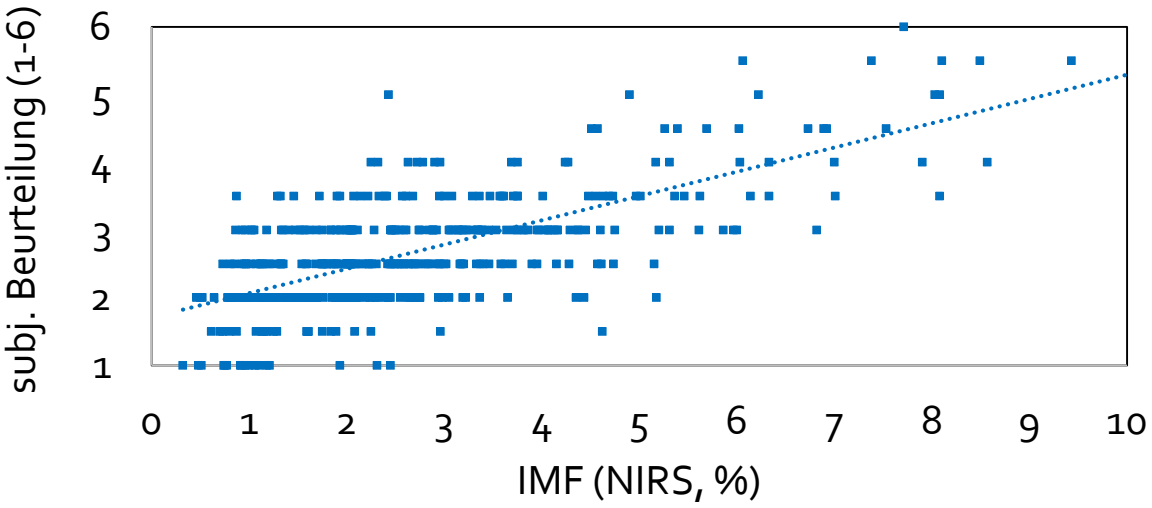
Possible slides for discussion

Beurteilung Marmorierung

- Visuelle Beurteilung
- Videobildanalyse
- Chemisch: intramuskuläres Fett (Soxhlet, NIRS, ...)
- .....
- **Zusammenhang zwischen „Beurteilungsmethoden" nicht immer ganz eng**





Datengrundlage

- 4 Versuche (BVW-Wieselburg), 416 Datensätze
- Subj. Beurteilung nach RISTIC (1987)
- Korrelation: 0,63

DIE AUSWAHLKRITERIEN IM DETAIL

Die endgültige Selektion der Schlachtkörper, die als **CULT BEEF** Selektion in Frage kommen, ist letztendlich dem geschulten Auge der Experten der Rinderbörse vorbehalten, die jedes einzelne Rind für dieses Programm auswählen. Basis für diese Wahl sind folgende Parameter: ein Maximal-Alter der Kalbinnen von 22 Monaten, ein Gewicht von max. 362,6 kg, die Herkunft aus AMA-Gütesiegel-Betrieben und die Fettklassen 3 bis 4. Denn nur eine überdurchschnittliche intramuskuläre Fettmarmorierung gewährleistet Topqualitäten. Ein wichtiges Thema ist natürlich auch die Reifung, die für die Marke **CULT BEEF** mindestens 14 Tage betragen muss.

www.cultbeef.at (besucht am 12.12.2020)

Exkurs: Fetteinlagerung und Marmorierung

- **Wenige, teilweise widersprüchliche Studien zur Fettbildung bei Mastrinder**
- Australischer Review von *Pethick et al. 2006* (andere Rassen und Mastverfahren als in Österreich)
  - (1) Rassen/Genotypen mit hohem Muskelwachstum/Bemuskelung bilden weniger IMF
  - (2) Im Schlachtgewichtsbereich 200 – 400/450 kg: linearer Anstieg des IMF
  - (3) Marmorierung hängt mit anderen Fettdepots zusammen -> kaum möglich durch Fütterung nur Marmorierung zu erhöhen
  - *(4) IMF-Einlagerung stagniert bei Erreichen des rassetypischen Endgewichts („mature weight" „mature body size")*