Drip, tenderness, electrical stimulation and meat quality

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- **We will go over the role of water in meat and reveal some surprising things**
- **Water changes are central to tenderisation**
- **This means old concepts need to be revised**

http://www.hortresearch.co.nz

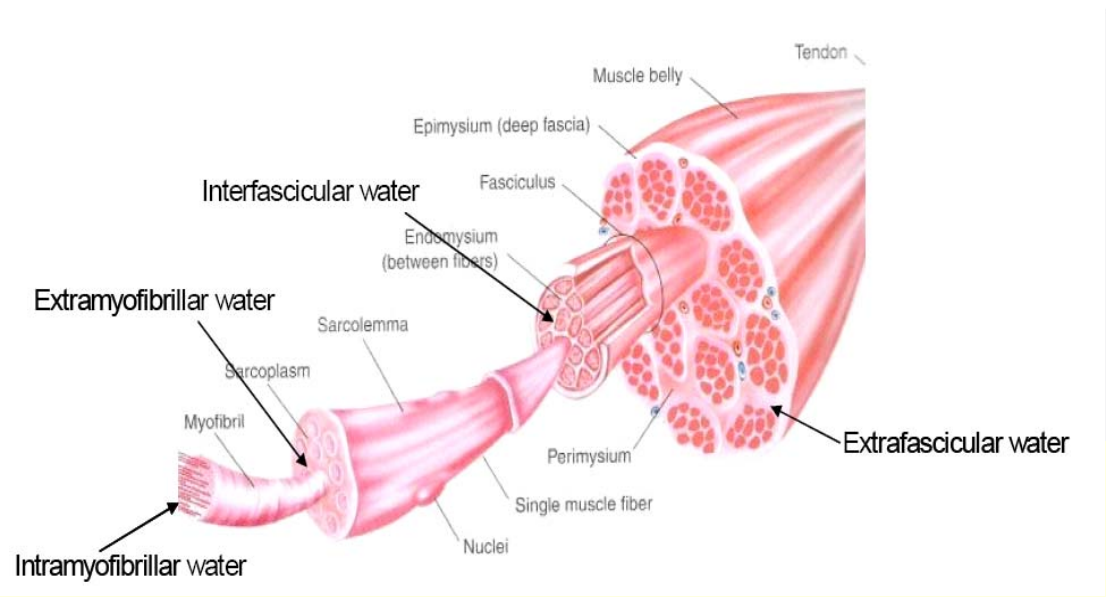
http://www/mirinz.co.nz

How do we measure drip ? You have got to get this right - poor measurement poor results

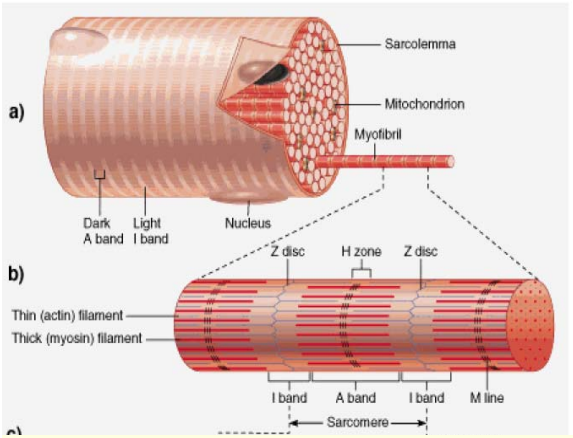
1. Weigh blot and reweigh
2. Hang meat in a bag
3. Measure drip in a tray
4. Squash weighed meat and watch the spread
5. Centrifuge meat and weigh
6. When we do this over time we see how the drip arises and increases
7. Visual estimate of drip are flawed

Water is scattered throughout the muscle in between cells and various spaces – but it just doesn't leak out

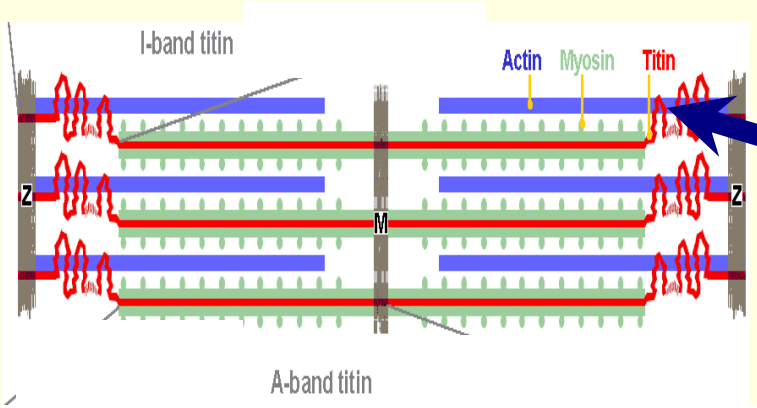
In muscles



In muscle fibres



In muscle proteins



Note: It is titin breakdown that is important for drip release as meat tenderises
More later

Live muscle to meat

- Live muscle does not drip - at *rigor mortis* energy runs out and water “equilibrates”. Higher pH muscles have less drip.
- **At *rigor mortis*, there is no major drip unless protein denatures.**
  - **Classically this is PSE pork - high pre *rigor* temperatures, low pH denatures myosin (Modern pork without the halothane gene and good processing has this under control)**
- **The PSE condition does not happen in beef and lamb and venison under usual processing conditions, so forget it!**
  - Meat science text books, refer extensively to pork - we need to update with new knowledge
- ***Rigor mortis* protects muscle from further changes**
- Water holding capacity (WHC) is the amount of added water.
- By the way, according to Honikel, there is no relationship between WHC and juiciness - surprising

New Information – drip and tenderisation

- There is very little drip at *rigor mortis* in sheep cattle and venison (unlike pork) - drip arises when the meat tenderises
- If there is a lot of drip in a few hours after slaughter, it means **the meat has tenderised fast -** electrical stimulation, because it ensures early tenderisation, shows early drip
- After *rigor mortis* muscle is protected from any temperature/pH effects. This is not generally recognized
- **Electrical stimulation does not and in fact cannot cause extra drip in sheep and cattle**
- Unfortunately you cannot have tender meat and no drip
- In the market place 6 weeks away the drip will reach the same levels for the same tenderness

Electrical stimulation and drip

No stimulation - not good

- High *rigor mortis* temperatures reduce tenderness
  - This is because the enzymes that tenderise meat are **inhibited** at high *rigor* temperatures and this **limits** tenderisation and **limits** drip
- **Stimulation - good**
- Causes rapid *rigor mortis* – **this is good, not bad as some think**
  - *Rigor* protects meat from any pH/temperature effects, therefore protects tenderising enzymes, enhances tenderisation **- has no effect on total drip**
  - Warm meat tenderises fast, drip increases initially and meat reaches a higher degree of tenderness than for non stimulated meat

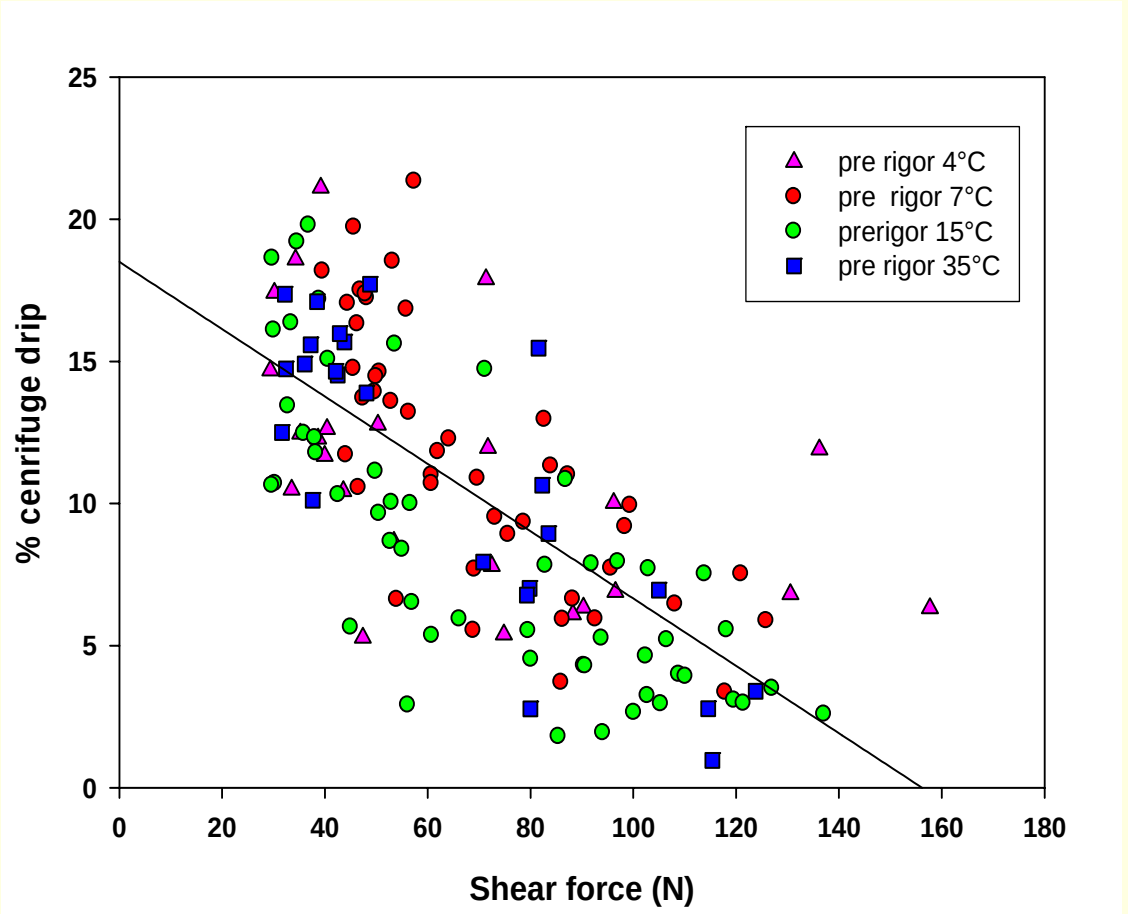
- **“Stimulation” is not an add-on to “no stimulation” – it really is a completely different process**
- **Thus stimulation ensures early *rigor*, protects the enzymes that tenderise meat and does not affect total drip.**

What is the background to these statements?

- Several studies since 2001 for beef and lamb were involved, some as part of the NIR project
- We followed meat as it tenderised
  - With and without electrical stimulation
  - With wrapping (behaves like meat on a carcass) and without wrapping
  - We controlled temperature and shortening - high (35°C) and low (15°C, 7°C, 4°C)
  - We aged at a constant temperature
- **As the meat tenderised there was an increase in drip over time** - unrelated to temperature
- This was initially surprising considering many earlier reports (just incomplete)
- We have published this for beef and lamb

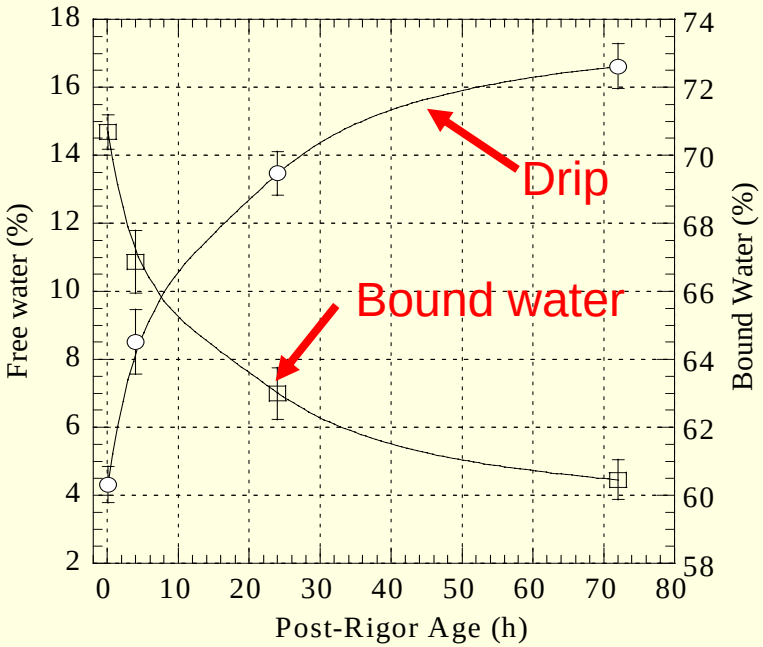
Relationship between drip, shear and *rigor* temperature in lamb while ageing

- There is no drip increase at high *rigor* temperatures

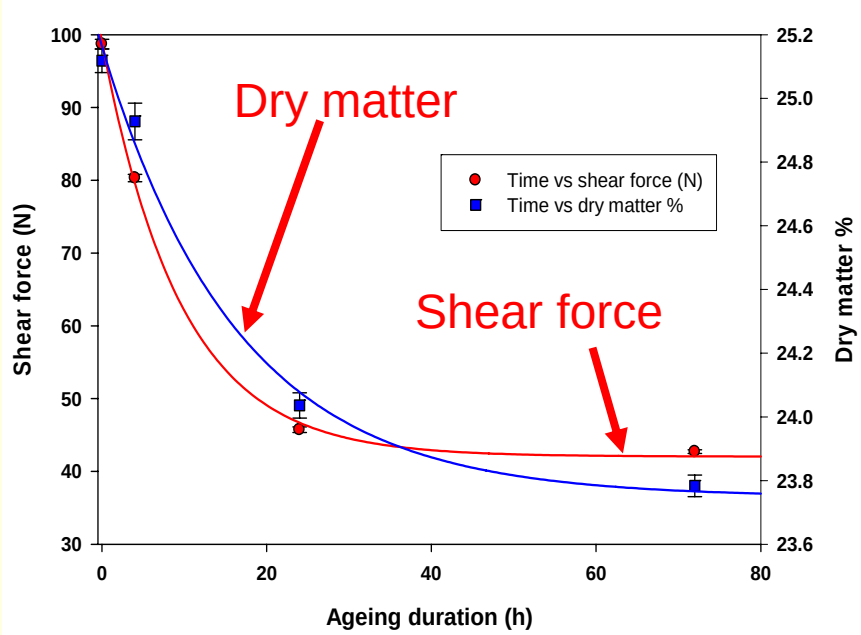


Changes in drip (free water), bound water, dry matter and tenderisation in lamb

All from same muscles

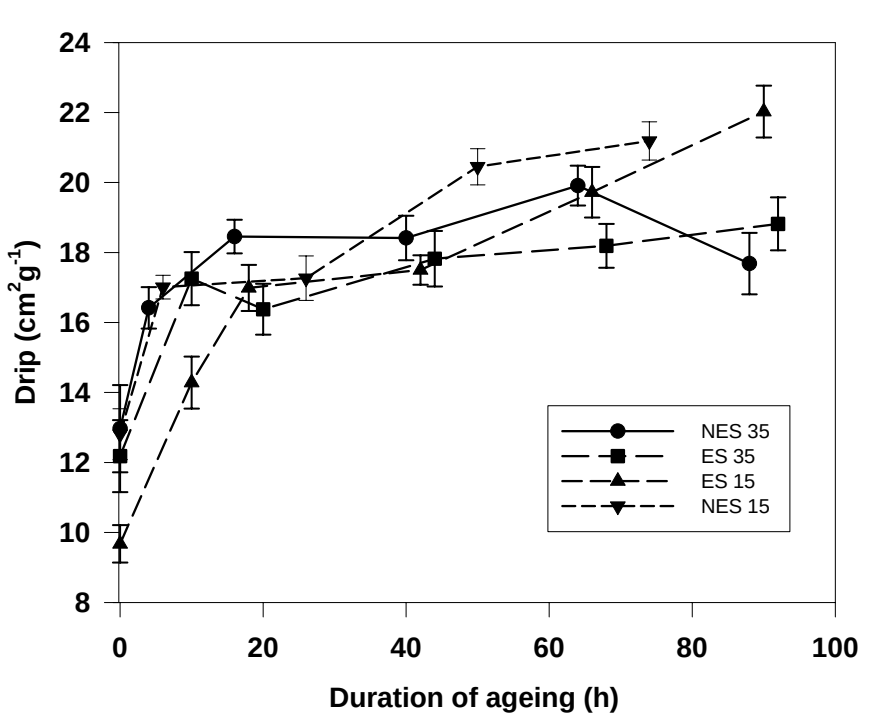


Drip and bound water
McGlone et al 2005

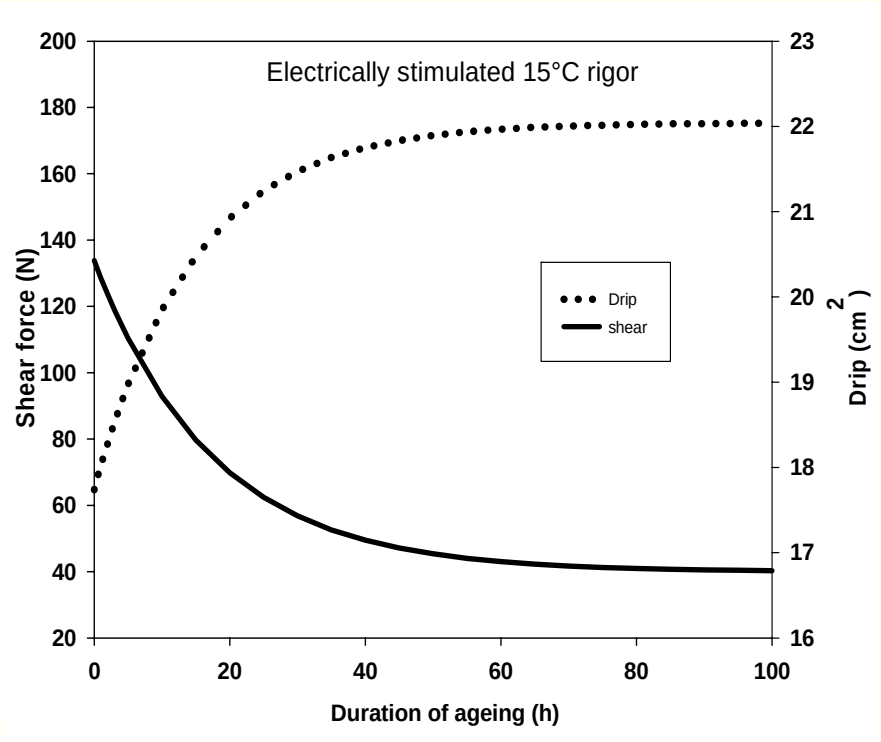


Dry matter and shear

Drip and tenderisation in beef



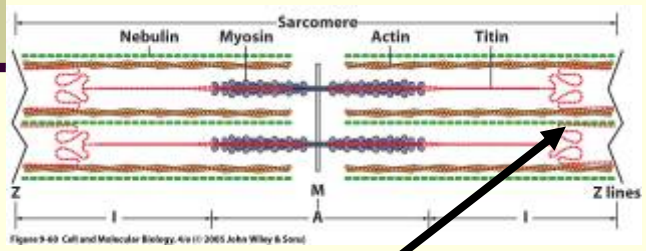
Drip with various pre *rigor* treatments
Sarcomere length may influence drip and not important here



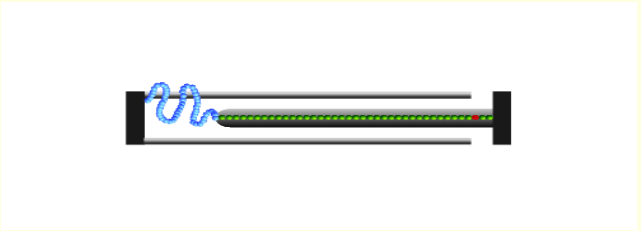
This is an electrical stimulation treatment with a fitted curve and including shear force

Where does the drip come from?

- **Drip is formed over time as the meat tenderises**
- It comes from a generally unrecognized protein called “titin” that is up to 10% in muscle
  - Titin is the largest protein in animal kingdom
  - **Breaks down as meat tenderises.**
  - **When proteins degrade they release water.**
- **Drip is inevitable if the meat tenderises - Pity.**

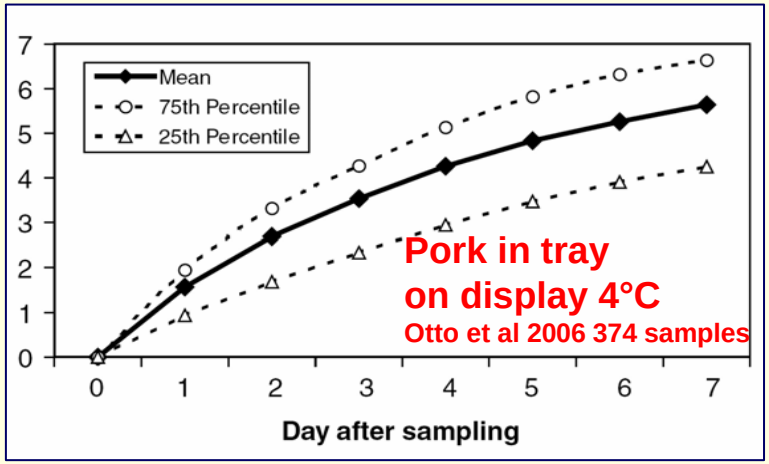


Titin

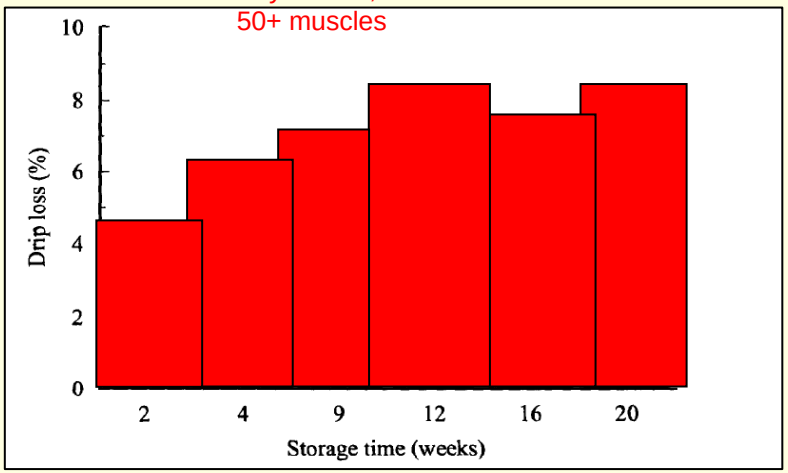


Titin in living muscle has a role of energy recovery – it isn’t just there to make meat tough

Other examples in the literature



Chilled beef -1.5°C
Payne et al, 1998
50+ muscles



What is the take home message?

- Drip arises as meat tenderises. **No tenderisation - no drip**
- Final drip will be the same for the same tenderness
- High *rigor* temperatures in beef lamb and venison do not increase drip
- Electrical stimulation
  - Does not increase drip - as meat tenderises faster it appears earlier
  - Enhances tenderisation as well as preventing cold shortening
  - We need to have the best stimulation – by the way don't stimulate twice
  - Some quarters suggest reduced stimulation – **Wrong!**
  - Give **full** stimulation not a tickle – you cannot over stimulate as the responses are self limiting (exhaustion is exhaustion).
  - It can be **good** low voltage beef or high voltage lamb.
  - Processing variation explains why drip differs from plant to plant
- **This is serious stuff and needs more research – it will explain some of the variation in meat quality in New Zealand**