

# Effects of processing

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# Effects of processing

## Beneficial effects

- Preservation
- Degradation of antinutritional components, e.g. thiaminase or trypsin inhibitors
- Improvement in starch digestibility
- Increasing of palatability

## Undesirable effects

- Reduction of biological availability of amino acids (e.g. due to Maillard reaction)
- Loss of heatlabile vitamins
- Reduction of enzyme activity, probiotics
- Decrease in palatability

# Processing

- Dry food

- Extrusion
- Baking
- Pelletising



- Moist food

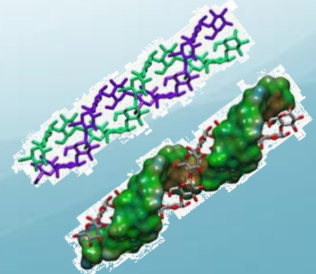
- Cans
- Pouches



	Extrusion	Baking	Pelletising	Canning
Temperature [°C]	110-160	175-230	60-80	100-121
Pressure [bar]	200	-	-	1-1,5
Retention time [min]	~2	20	~4	depending on size (min 20)

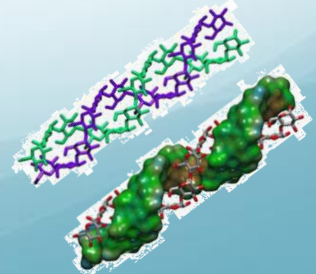
# Starch gelatinisation (SG)

- In presence of water and/or heat
- Breaking down intermolecular bonds
  - Granule swelling
  - Crystal or double helical melting
  - Amylose leaching
- Temperature dependent: 55-87°C



# Starch gelatinisation

- Gelatinisation grade correlates positive with temperature and pressure  
→the higher the grade, the more energy is needed
- Resistant starch ↓
  - Useful for a healthy digestion
  - Useful in different types of diets



# Effect of processing on SG

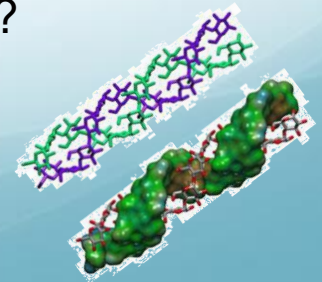
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extrusion vs. baking: higher pressure,  
lower temperature, shorter processing time



less destructive for resistant starch

Heat and pressure only at the  
border areas of the kibble  
→ adequate starch gelatinisation?  
→ sufficient digestibility?



# Proteins

Heat above 42°C leads to denaturation

→ breaking of hydrogenic bonds + building of new bonds

→ changes in secondary and tertiary structure



Denaturation happens in any processing



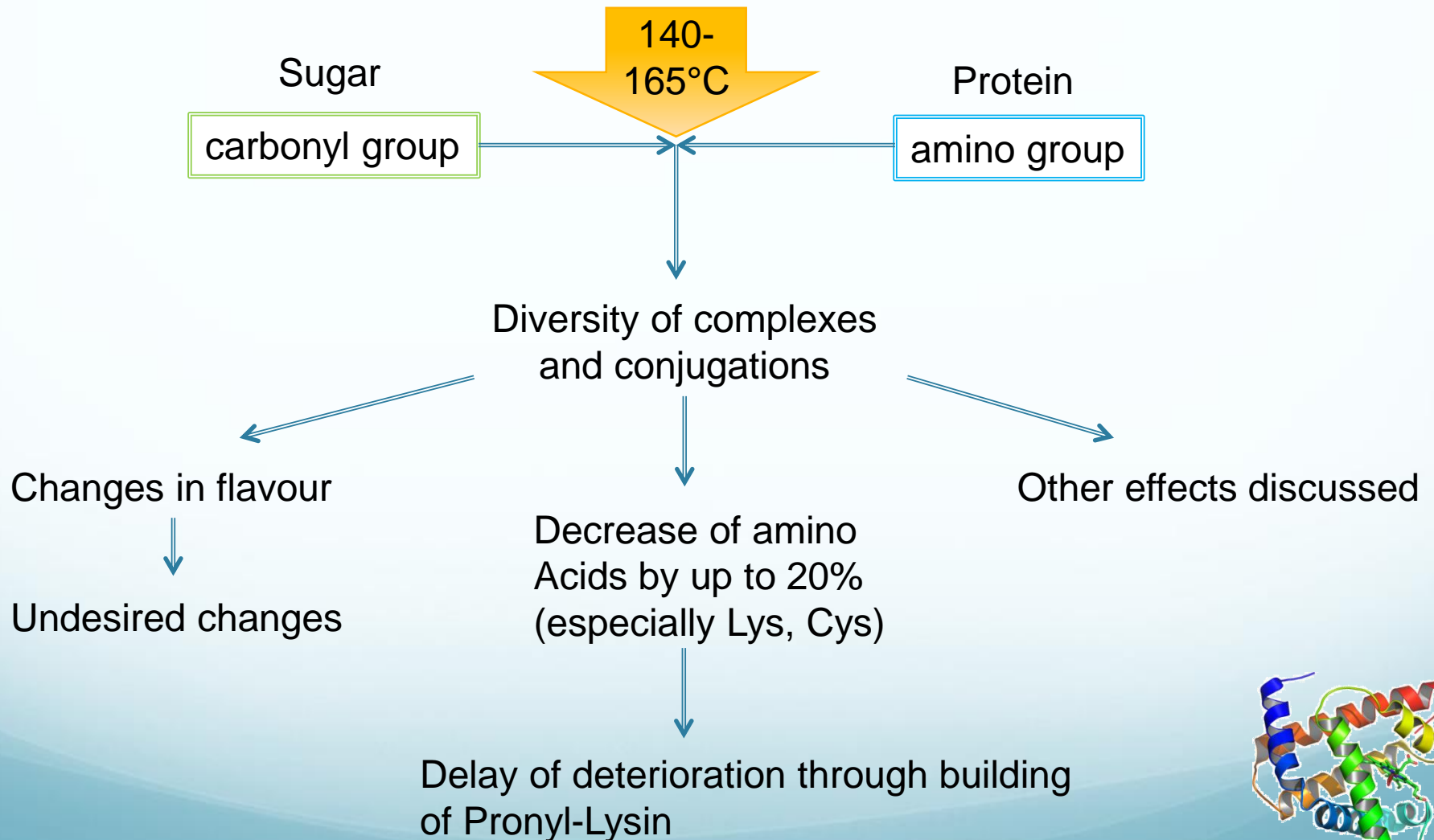
# Proteins – amino acids

- Changes in racemisation or formation
  - impairs protein nutritional quality
  - especially in plant proteins: bioavailability of lysine could be too low
- Reaction of proteins with carbohydrates





# Proteins – maillard reaction



# Effect of processing on proteins (maillard reaction)

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Depending on ingredients,  
e.g. reducing sugars + high  
protein

Temperature too  
high, caramelising  
more typical

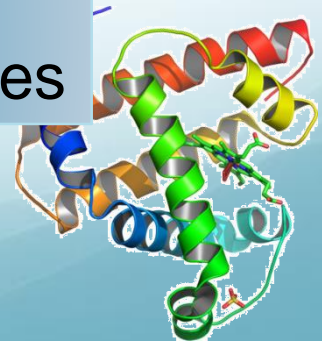
Temperature too low  
+ moisture in canned food  
→ maillard reaction not to  
be expected



# Creatine

- **Humans:** oral supplementation increases muscle concentration of creatinine with low resting muscle concentrations of creatine
- **Dogs:** increase of muscle mass and creatine concentration in the muscle in untrained dogs after oral supplementation
- Not declared as essential

Keep in mind:  
creatine is high in the natural diet of carnivores



# Creatine

- Instable in watery solutions → pH dependent
- The lower the pH + the higher the temperature, the faster the disaggregation to creatinine



Lower creatine levels after processing



# Taurine

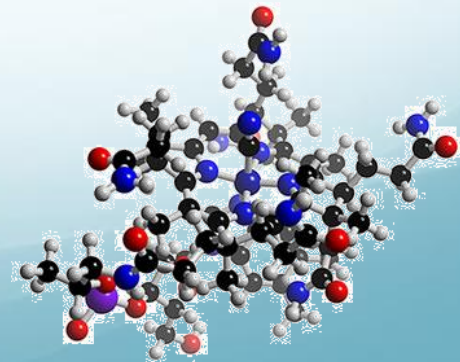
- Essential in cats
- Positive in some kind of diets
- The longer the processing time, the lower the taurine bioavailability

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Bioavailability in extruded diets > canned diets

# Vitamins

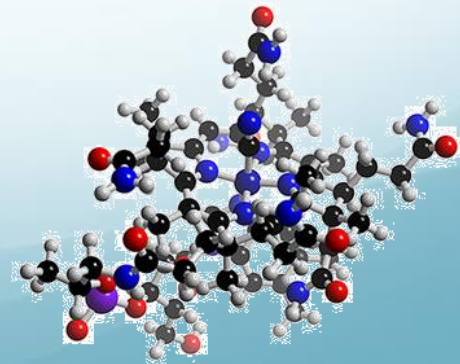
- High concentrations in different feed components, e.g. vitamin A in liver
- Different sources have different sensitivities during processing
- More or less sensitive for temperature, pressure, retention time, pH, UV-light
  - Any processing lowers the content of vitamins in the product
  - Additional losses during storage



# Effects of processing on vitamins

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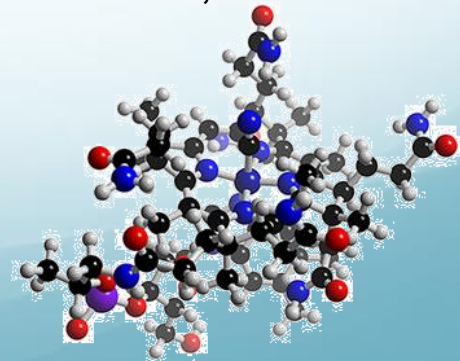
Destruction of vitamins  
30-80% losses



# Effects of processing on vitamins

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Less destruction of vitamins,  
but still losses



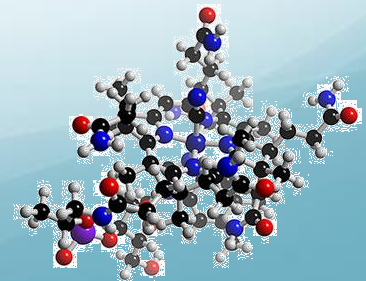


# Effects of processing on vitamins

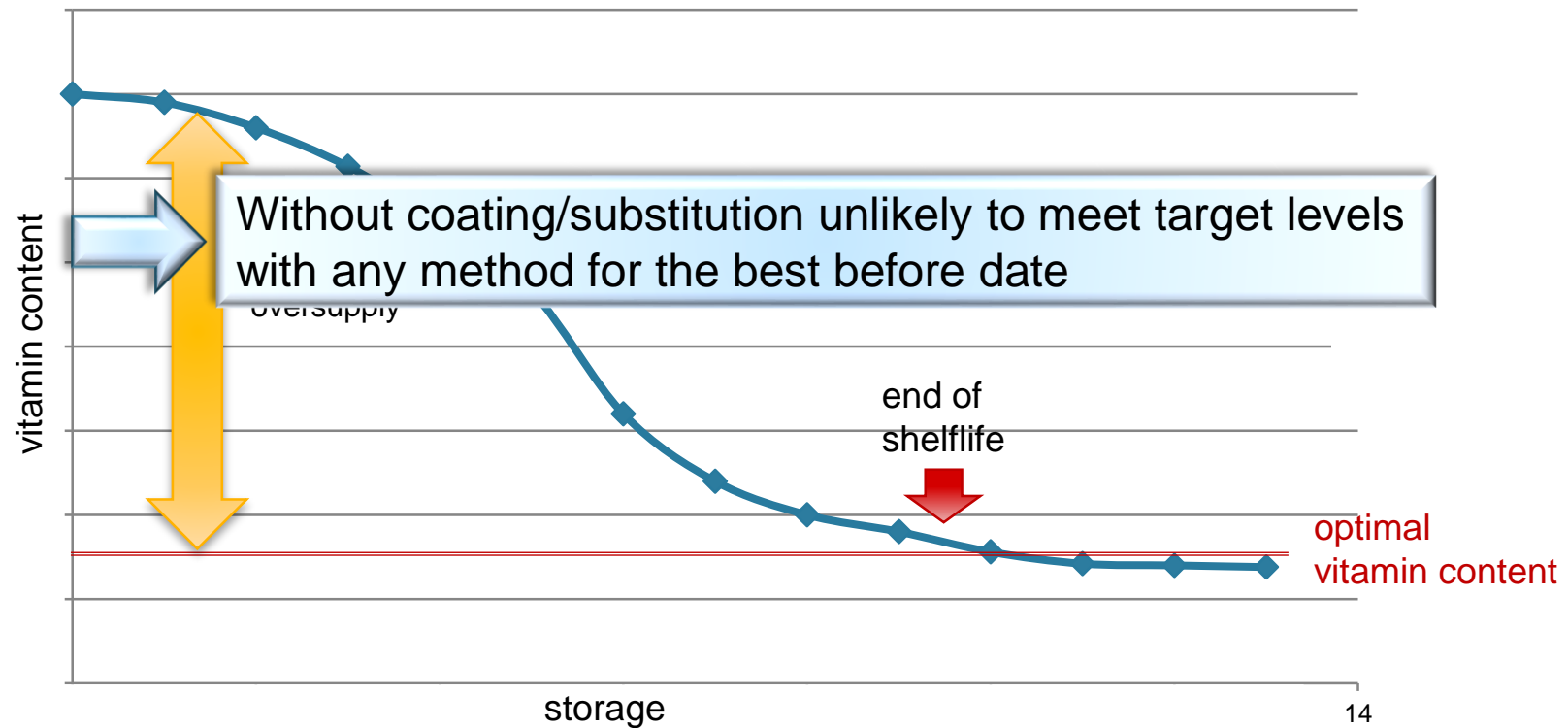
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→ Destruction of vitamins  
30-80% losses

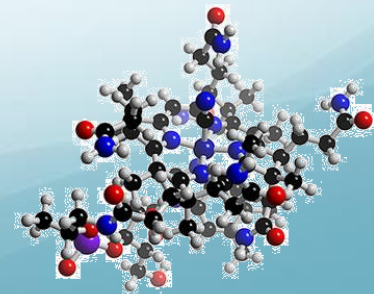
→ the bigger the can the longer the time  
→ calculated target level may be wrong



# Vitamins



Enough vitamins at the end of shelflife lead to oversupply right after production



# Pre processing

- **Dry diets**
  - Meat and animal derivatives already processed
  - Grains and other carbohydrates sometimes already processed
  - Vegetables and derivatives of vegetable origin sometimes already processed
- **Moist diets:** all ingredients could be processed before, but don't have to be

# Take home messages

1. Processing changes a lot!
2. Processing doesn't equal processing!
3. Size of the package matters!
4. Take a look on the ingredients and their effects on each other!
5. Calculate, process, analyse!
6. Gold standard for optimal assessment: testing of digestibility in vitro or even in vivo!

# literature

1. Bauer B.A., Knorr D. (2005): The impact of pressure, temperature and treatment time on starches: pressure- induced starch gelatinisation as pressure time temperature indicator for high hydrostatic pressure processing. *Journal of food engineering*, 68 (3), p.329-334
2. Muhr A.H., Blanshard J.M.V. (1982): Effect of hydrostatic pressure on starch gelatinisation. *Carbohydrate Polymers*, 2 (1), p.61-74
3. Bazolli R.S., Vasconcellos R.S., De-Oliveira L.D. , Sa F.C., Pereira G.T., Carciofi C. (2015): Effect of the particle size of maize, rice, and sorghum in extruded diets for dogs on starch gelatinization, digestibility, and the fecal concentration of fermentation products. *Journal of Animal Science*, 93 (6), p. 2956-2966.
4. Mooney A. (2010): Stability of essential nutrients in pet food manufacturing and storage. Master Thesis, Department of Grain Science and Industry College of Agriculture, Kansas State University
5. Tribble S.D. (2012): The effects of canning on B-vitamin retention in a model cat diet with an emphasis on thiamine. Master Thesis, Department of Grain Science and Industry College of Agriculture, Kansas State University
6. Dobenecker B., Braun U. (2015): Creatine and creatinine contents in different diets types for dogs – effects of source and processing. *Journal of Animal Physiology and Animal Nutrition*, 99 (6), p. 1017-1024
7. Tran Q.D., Hendriks W.H., Van der Poel A.F.B. (2008): Effects of extrusion processing on nutrients in dry pet foods. *Journal of science of food and agriculture*, 88, p.1487-1493
8. Hickman M.A., Rogers Q.R., Morris J.G. (1990): Effect of processing on fate of dietary [<sup>14</sup>C]taurine in cats. *Journal of Nutrition*, 120, p.995-1000
9. Hickman M.A., Rogers Q.R., Morris J.G. (1992): Taurine balance is different in cats fed purified and commercial diets. *Journal of Nutrition*, 122, P.553-559
10. Hiramoto, S., Itoh, K., Shizuuchi, S., Kawachi, Y., Morishita, Y., Nagase, M., ... & Kagaya, I. (2004). Melanoidin, a Food Protein-Derived Advanced Maillard Reaction Product, Suppresses *Helicobacter pylori* in vitro and in vivo. *Helicobacter*, 9(5), 429-435.
11. Dobenecker B., Braun U. (2011): Effects of guanidinoacetic acid supplementation in dogs. *Proceedings of the ESVCN, Zaragoza*, p.75