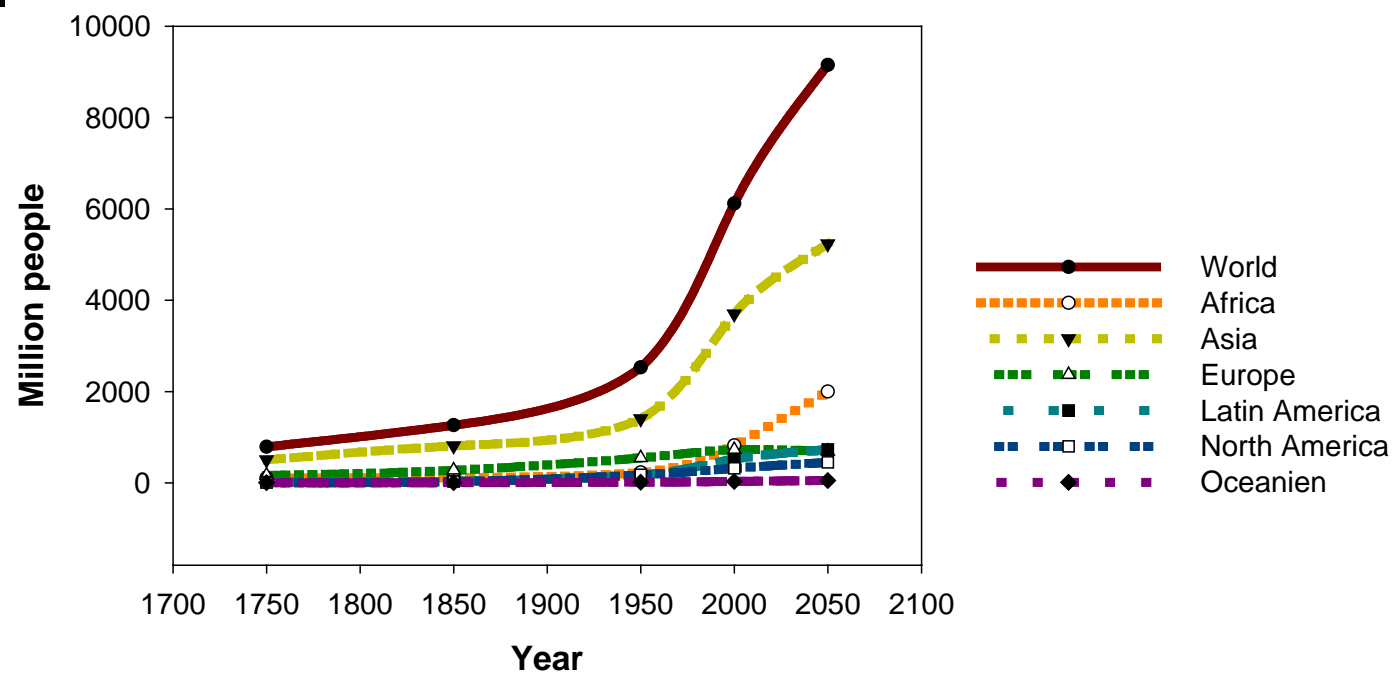
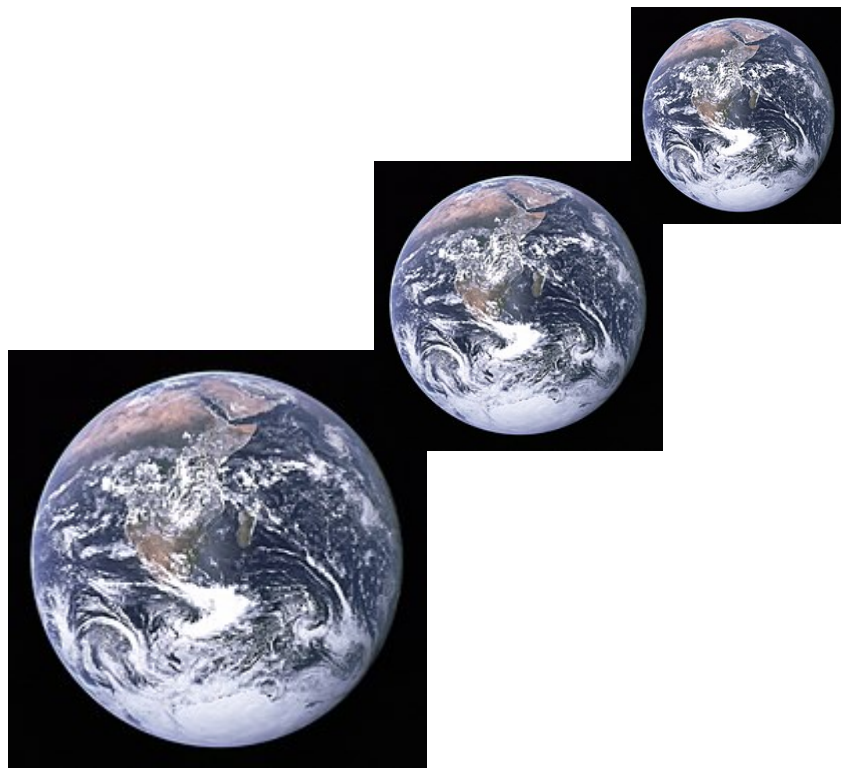


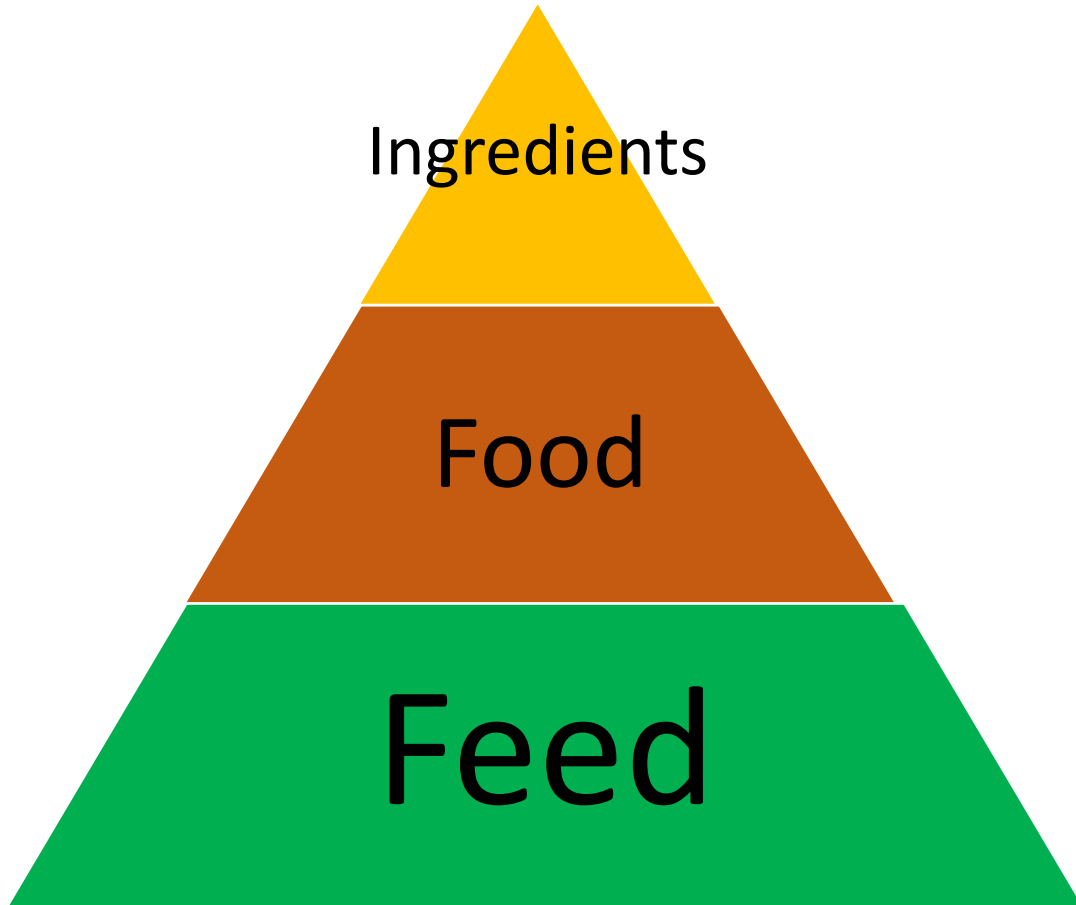
Improved quality of soluble protein from green biomass

Trine K. Dalsgaard,
Department of Food Science, Aarhus University

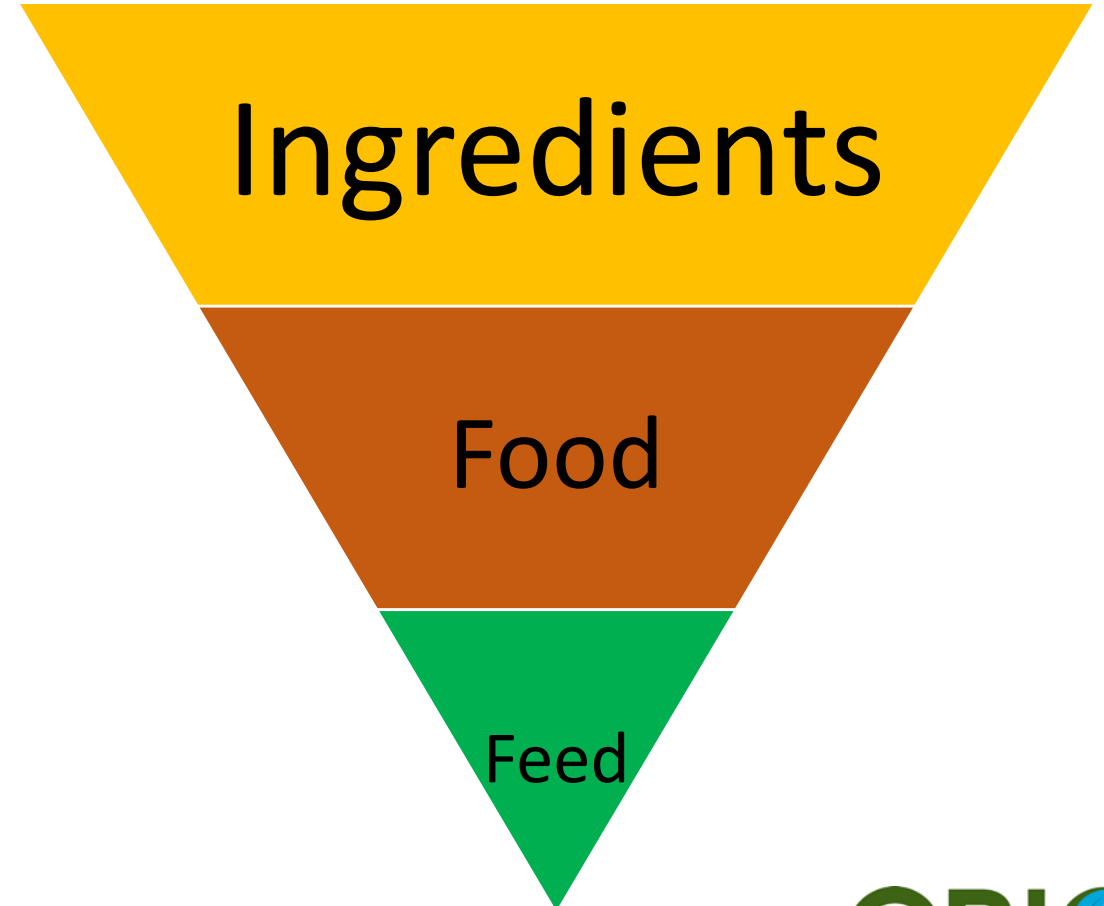
How to feed the world in the future?



Yield



Value



Protein and amino acid yield of various crops under Danish growing conditions

	Yield, DM ton/ha	Protein %	Protein kg/ha	Lysine kg/ha	Methionine kg/ha
Soy	2	35	700	43	9
Rapeseed	5	20	1000	60	20
Wheat	9	11	1000	30	16
Faba bean	6	25	1500	92	11
Pea	6	22	1300	92	13
Clover grass	13	20	2600	200	90
Red clover	12	21	2600	200	90
Extensive grass	3	12	350	25	12

DCA-report

Crops

- Red clover
- White clover
- Rye grass
- Lucerne (alfalfa)
- Spinach



Amino acid composition in protein concentrates (g/100 g protein)

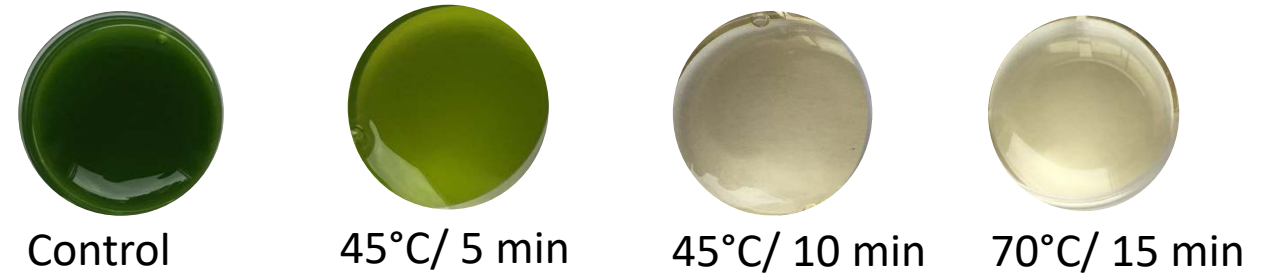
	Soy	White clover	Red clover	Lucerne	Ryegrass
Lysine	6.1	6.1	6.1	6.4	5.9
Methionine + Cysteine	2.7	2.6	2.6	2.8	3.0
Threonine	3.8	5.2	5.0	4.9	5.2
Tryptophan	1.5	2.1	2.8	2.7	2.0

Jensen, 2014



Issues to deal with concerning yield and quality of protein

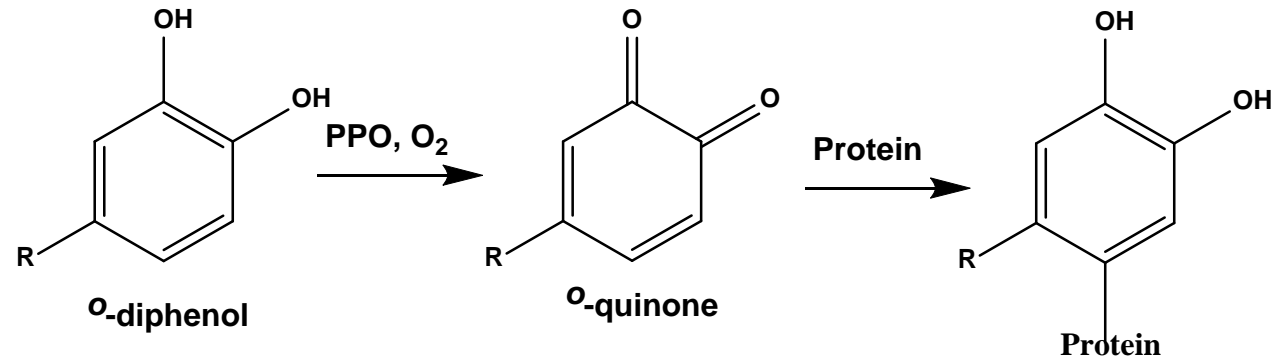
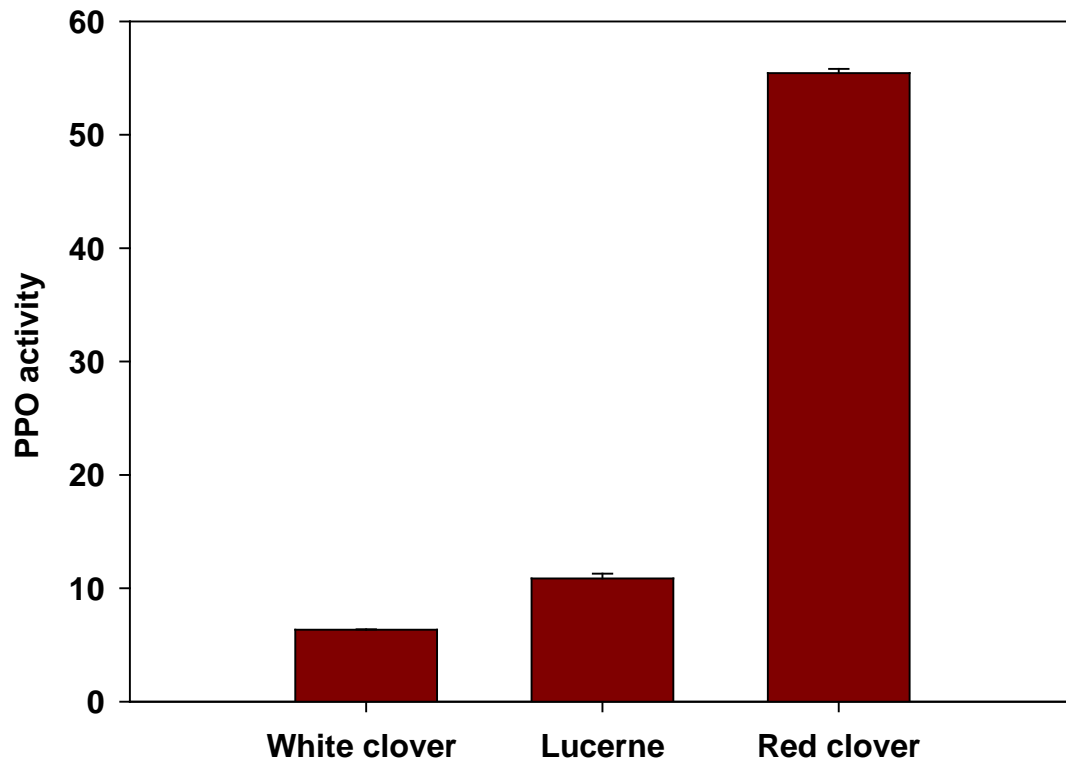
- Color
 - Chlorophyll level
 - Enzymatic browning reaction



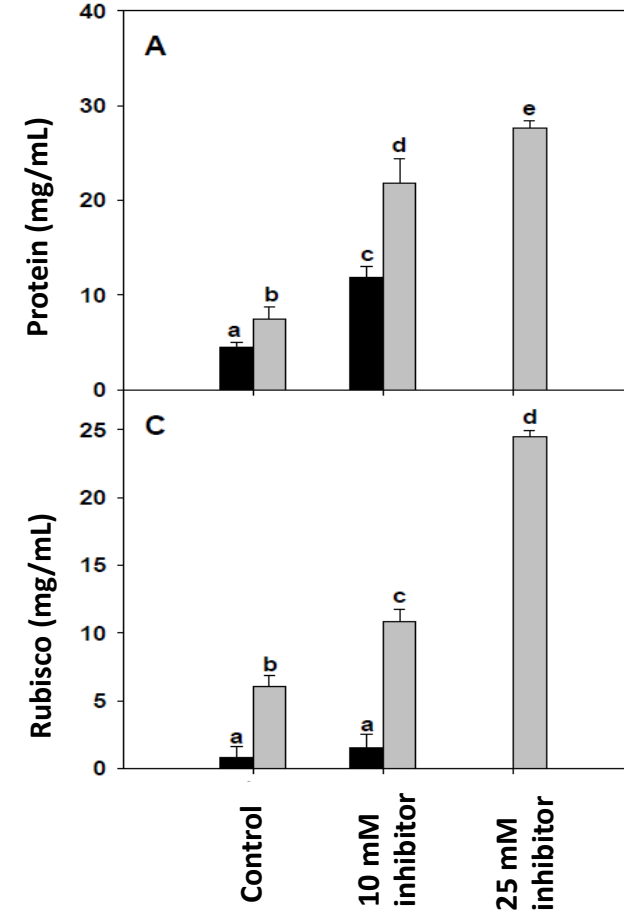
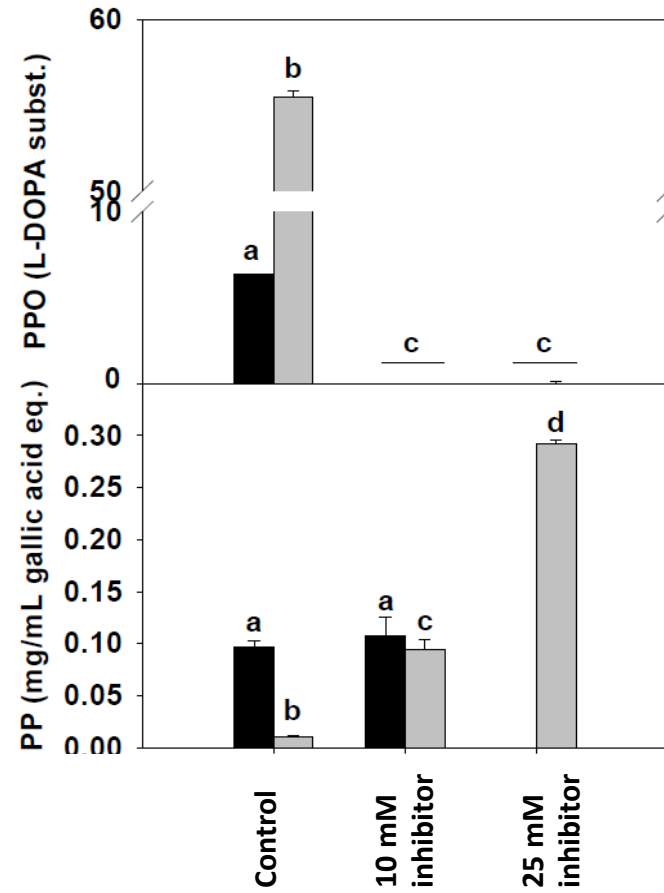
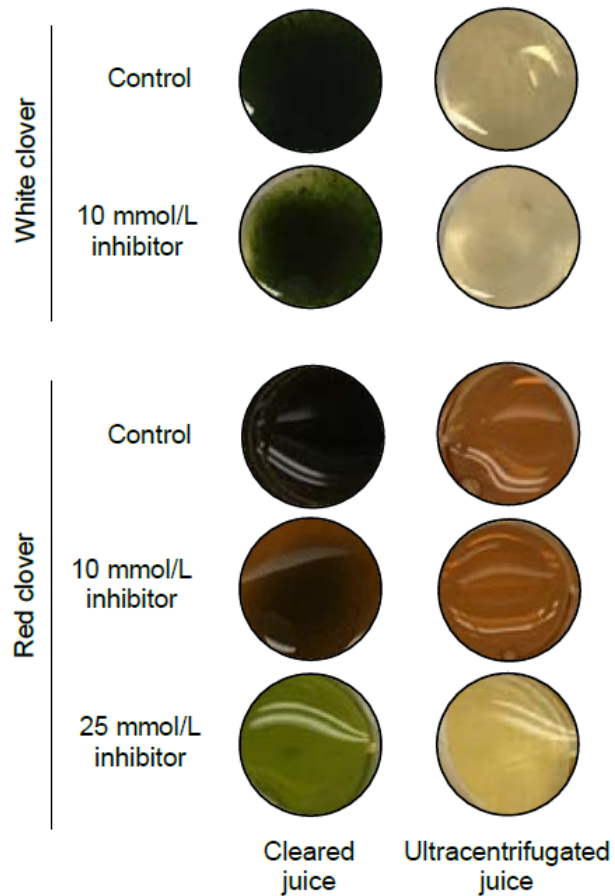
- Chemical changes and shelf-life
 - Enzymatic browning reaction
 - Chlorophyll level



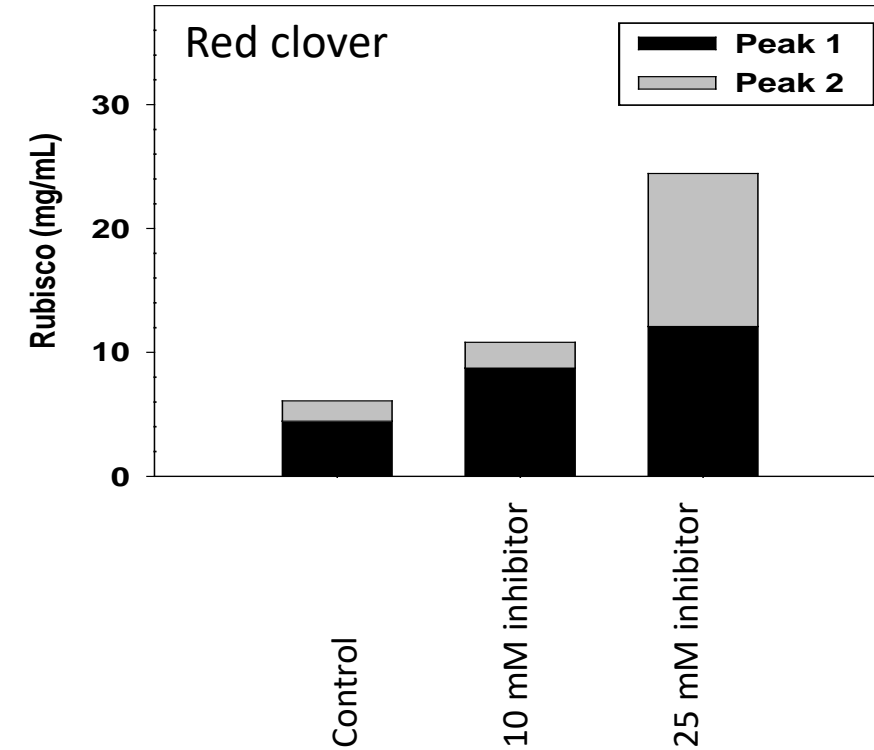
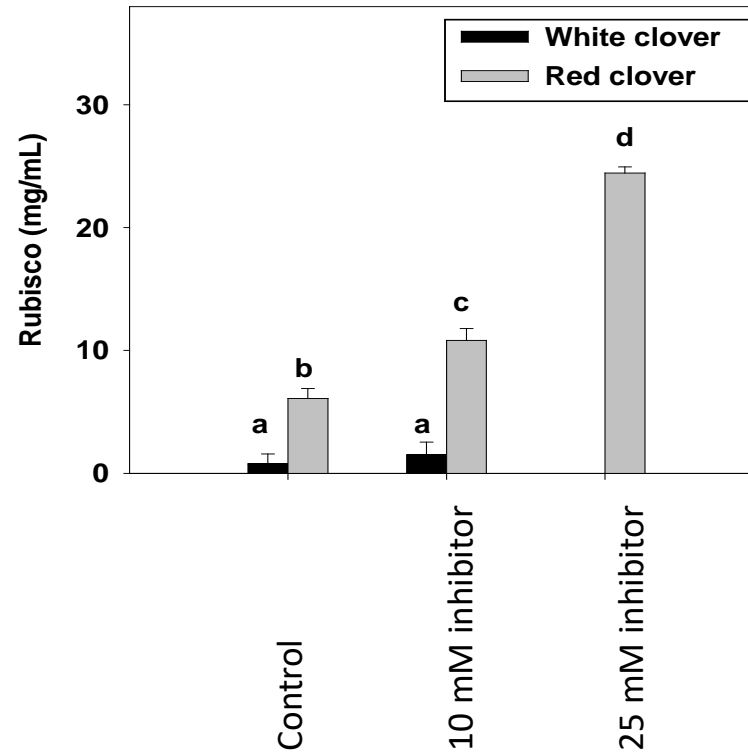
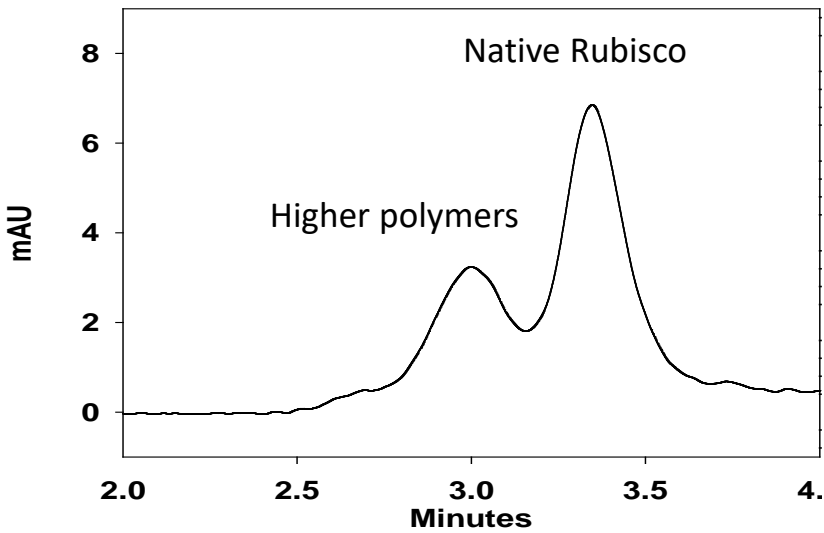
Enzymatic browning is a major obstacle – Redox enzyme/polyphenol oxidase activity



Enzymatic browning – Effect on soluble proteins in the juice

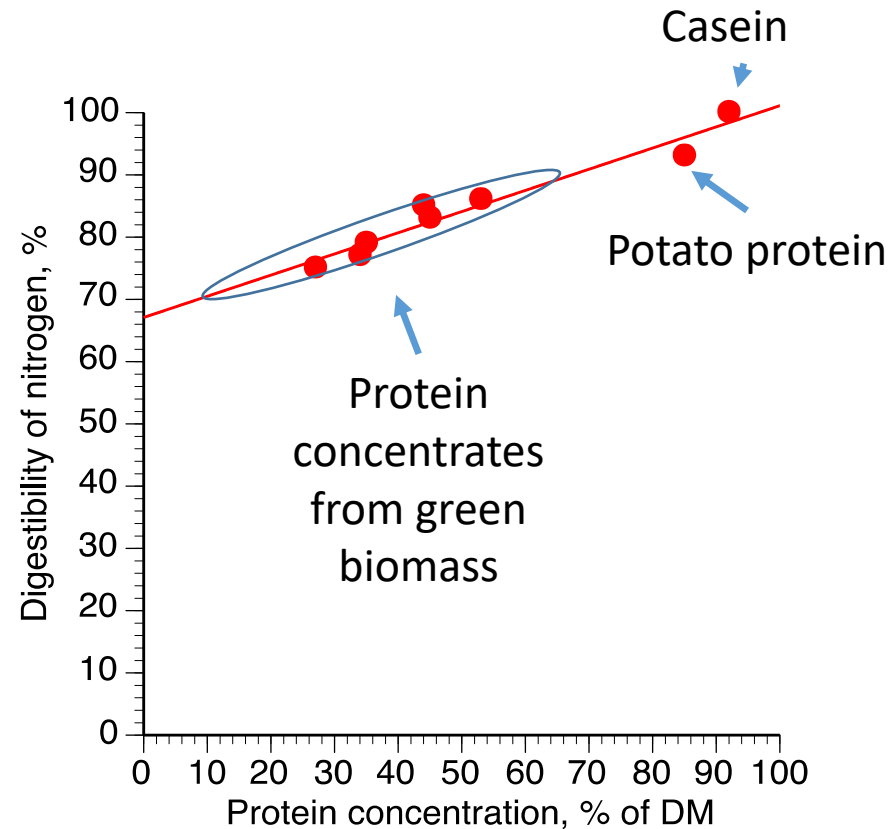


Effect of antioxidant on solubility



- The recovery of native Rubisco is high in juice with high level of inhibitor
- The quality of the protein is expected to improve

What about digestibility? – Correlates with protein % in DM

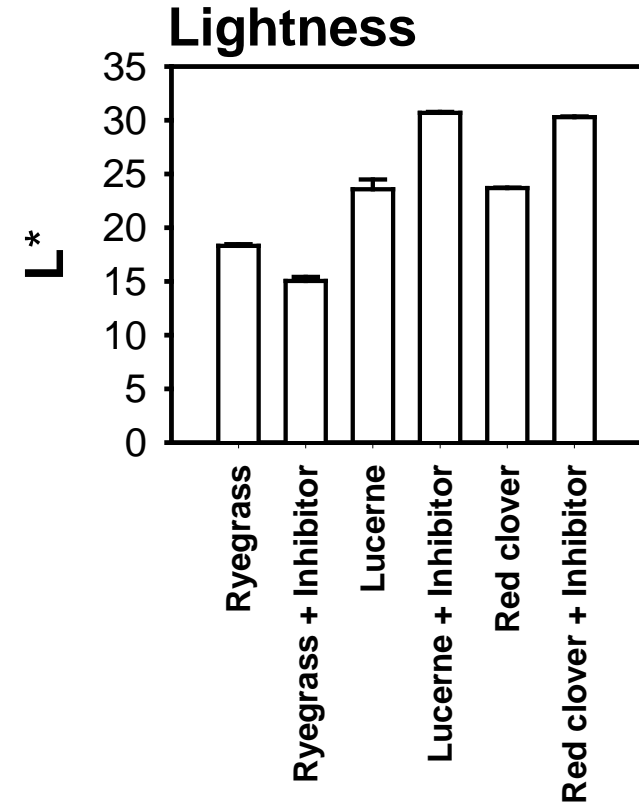
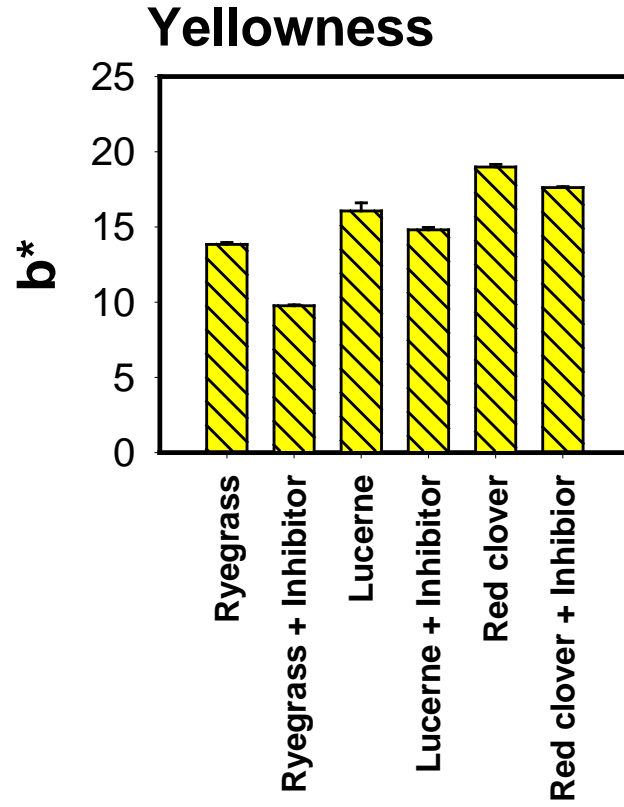
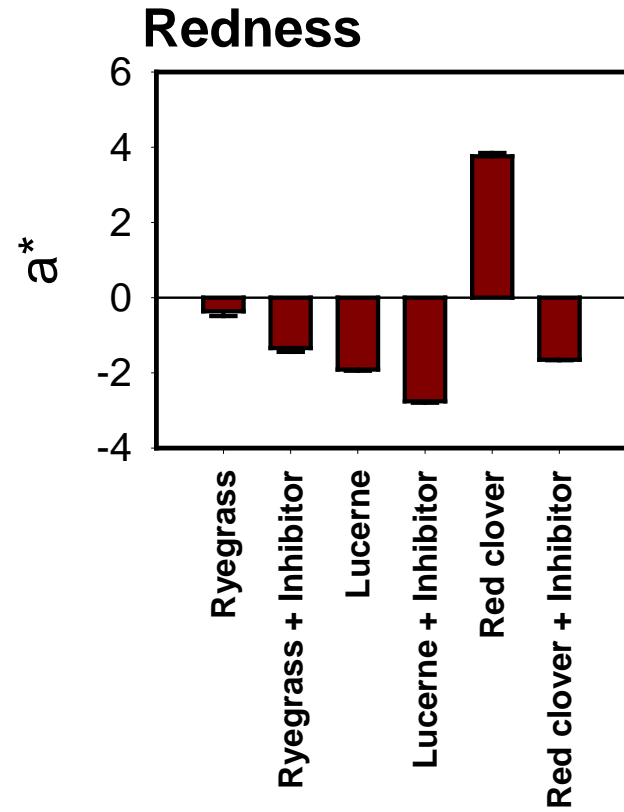


Experimental set up for biological evaluation

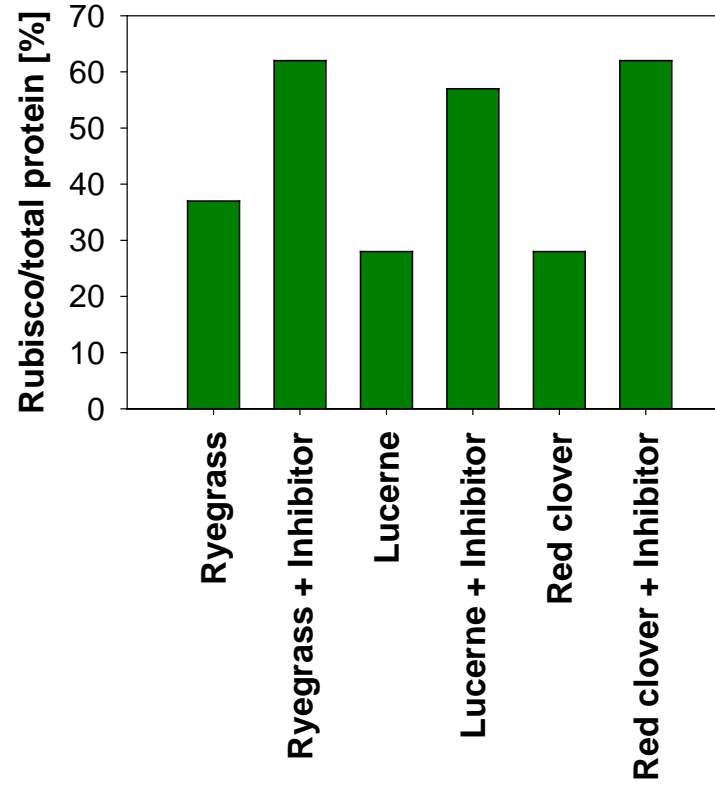
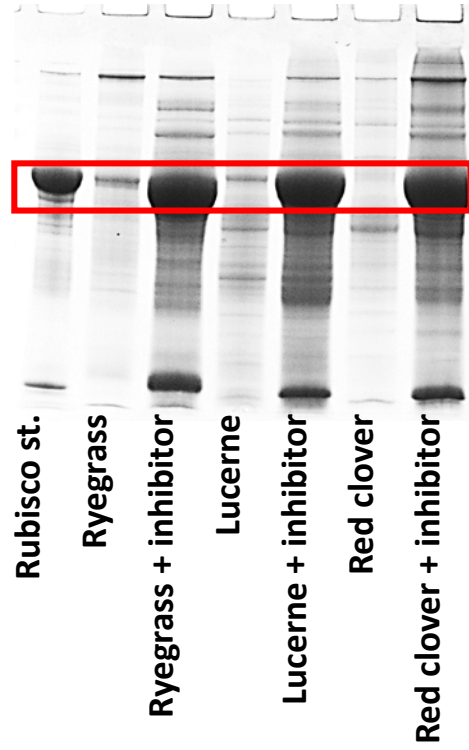
	Rye grass	Rye grass	Lucerne	Lucerne	Red clover	Red clover
Inhibitor	-	+	-	+	-	+



Color of the juice



Soluble proteins in different juices



Comparison of amino acid composition

Amino acid	FAO/WHO	Whole egg	Casein	Soybean	RuBisCo
Lysine	5.5	6.4	8.0	6.9	6.5
Tryptophan	1.0	1.2	1.3	1.3	2.7
Threonine	4.0	5.0	4.3	4.3	5.3
½ Cystine and Methionine	3.5	5.5	3.5	2.4	3.4
Valine	5.0	7.4	7.4	5.4	6.7
Isoleucine	4.0	6.6	6.6	5.1	4.9
Leucine	7.0	8.8	10.0	7.7	9.4
Tyrosine and Phenylalanine	6.0	10.1	11.2	8.9	12.8

Data taken from *Barbeau and Kinsella (1988)*.

Chemical composition of extracted protein concentrate

	DM	Nitrogen	Protein	Ash
Ryegrass	93.77	6.30	39.34	7.42
Ryegrass + inhibitor	93.60	5.88	36.75	10.04
Lucerne	93.17	7.51	46.94	7.79
Lucerne + inhibitor	93.27	7.63	47.69	10.03
Red clover	93.36	6.53	40.78	7.34
Red clover + inhibitor	93.73	6.42	40.13	10.33



Digestibility of dry matter and protein in rats

Unpublished data



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Changing the relationship between protein content and digestibility

Unpublished data



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Which amino acids are affected by the inhibitor

Unpublished data

- The oxidation/chemical changes on amino acid level are different the different species in between
- Modification of a single amino acid cannot explain the impact on digestibility

Conclusion

- Polyphenol oxidase/redox enzyme activity is a main obstacle in the extraction high quality protein from green biomass
 - It can be inhibited by addition of an effective antioxidant
- Inhibition of polyphenol oxidase/redox enzymes
 - Increased the recovery of many amino acids but in particular Cys was impacted by addition of inhibitor during extraction
 - Increased the content of the soluble protein rubisco in the juice, which, however, did not affect the protein content in the extracts after precipitation
 - Increased the digestibility by 5% for lucerne (alfalfa) and ryegrass but not for red clover
- Improved recovery of a single amino acid cannot explain the inhibitors effect on improved digestibility
 - More investigation is needed to understand the complexity between oxidative changes and digestibility

What is lacking

- Color: removal of chlorophyll
- Higher extraction yield
 - protein concentrate: >75 %
 - protein isolate: >95 %



Functional properties, sensory and consumer preception

- Foam (cake)



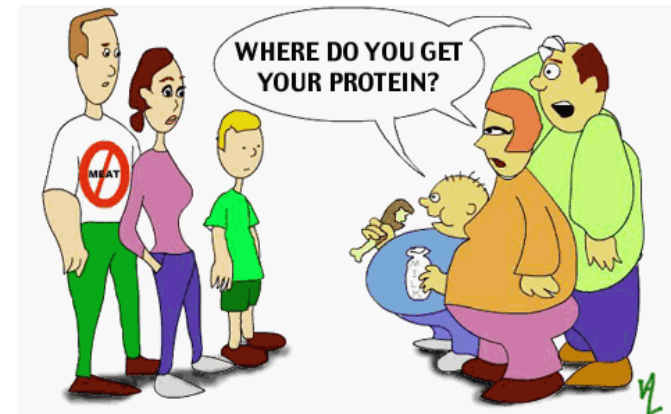
- Emulsifier (mayonnaise)



- Gelling (cold soufflé)



Acknowledgement



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Senior scientist
Søren Krogh Jensen



Technician
Hanne Søndergaard Møller

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