

Influence of the development stage of the plant biomass for protein yield in a green biorefinery

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PURPOSE OF THE STUDY

- ▶ Assess the effect of the **PLANT BIOMASS** type and **DEVELOPMENTAL STAGE** of the plant biomass at harvesting on the **PROTEIN CONCENTRATE YIELD** and **RECOVERY OF PROTEINS** from the biomass into the protein concentrate.

THREE DIFFERENT PLANT BIOMASSES

CHICORY



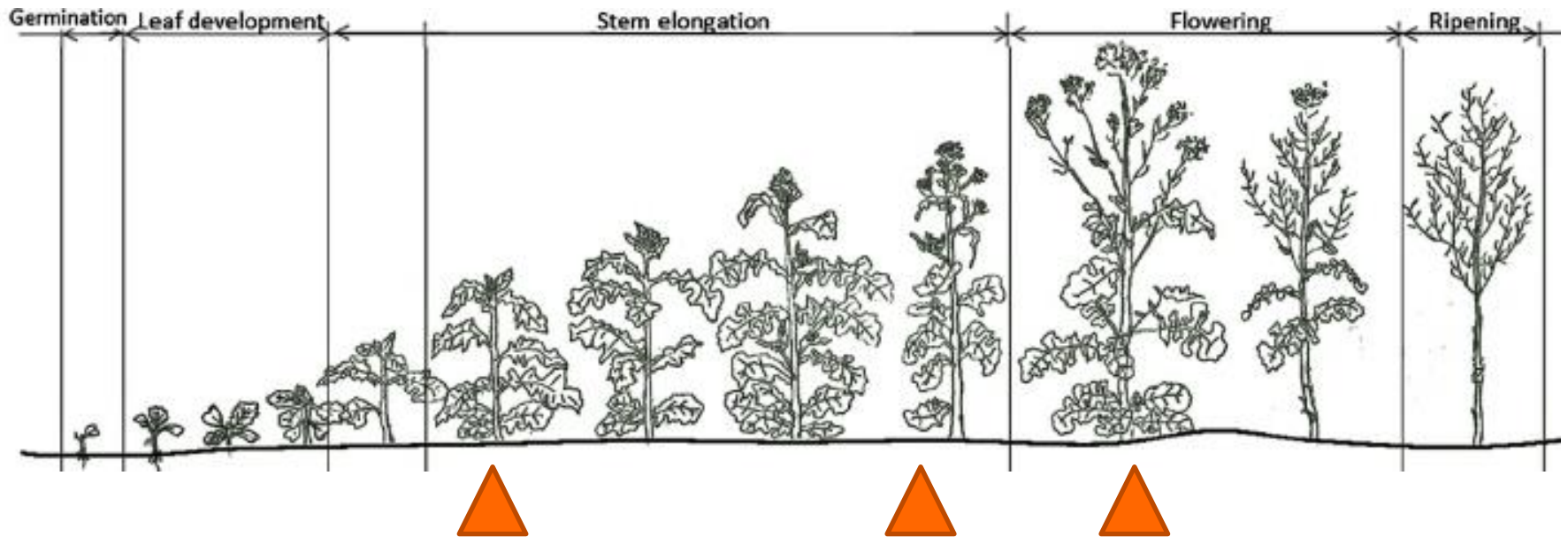
RED CLOVER



TIMOTHY



DIFFERENT DEVELOPMENTAL STAGES



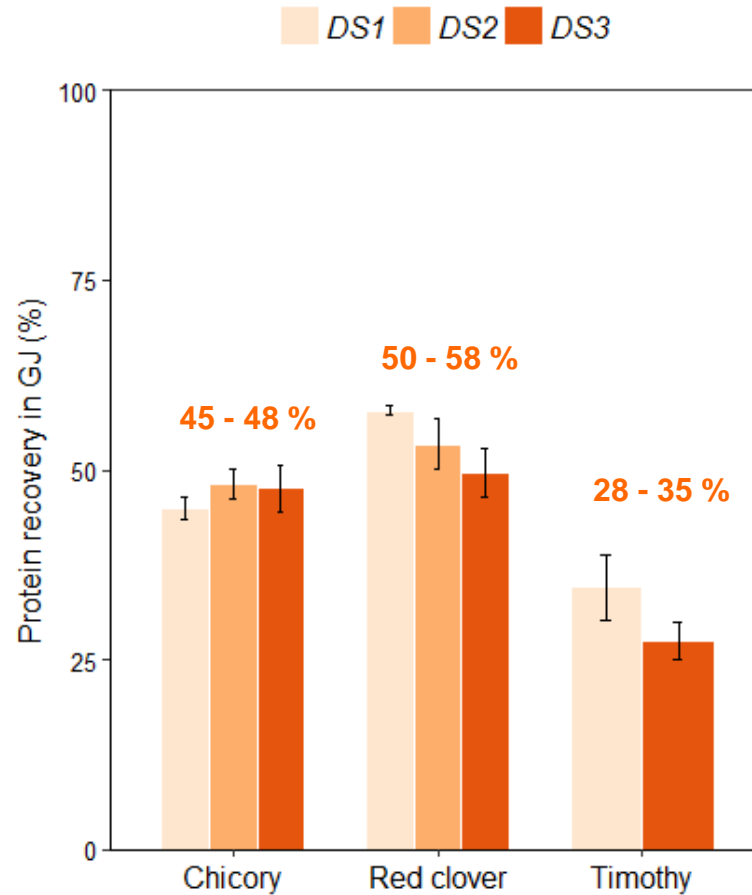
DIFFERENT DEVELOPMENTAL STAGES

Plant	Development stage	DM (%)	CP (%DM)	
Chicory	DS1	Elongation – Main shoot begins to elongate	11.5	14.5
	DS2	Elongation – 5 to 9 internodes elongated	11.1	11.8
	DS3	Inflorescence emergence – 1 st individual flowers of secondary inflorescence visible (still closed)	14.2	9.6
Red clover	DS1	Elongation – 40 % of full height	16.4	21.7
	DS2	Inflorescence emergence – Full length, buds visible in some plants	19.6	17.4
	DS3	Flowering – halfway to full flowering	26.5	16.4
Timothy	DS1	Elongation – 2 nd internode detectable	25.9	10.0
	DS3	Earing – Ear 70 % passed	31.0	8.1

SCREW PRESSING OF FRESLY HARVESTED BIOMASS



EFFICIENCY OF SCREW PRESSING



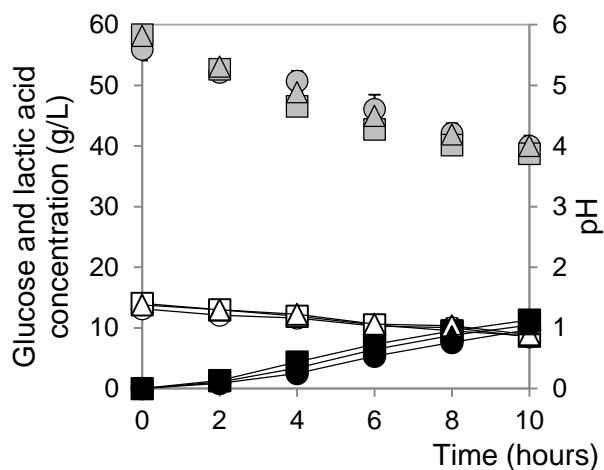
GREEN JUICES – PROTEIN SOURCES AND FERMENTATION SUBSTRATES

Plant biomass		DM (%)	Proteins (g/L)	Glucose (g/L)	Sugars* (g/L)
Chicory	DS1	6.9	11.2	13.1	28.4
	DS2	6.5	10.5	14.1	31.2
	DS3	7.0	9.2	13.8	30.7
Red clover	DS1	10.4	31.1	28.1	45.9
	DS2	12.4	34.7	32.7	53.2
	DS3	14.1	36.8	38.4	63.1
Timothy	DS1	14.9	21.2	21.5	59.7
	DS2	13.6	16.3	30.5	59.0

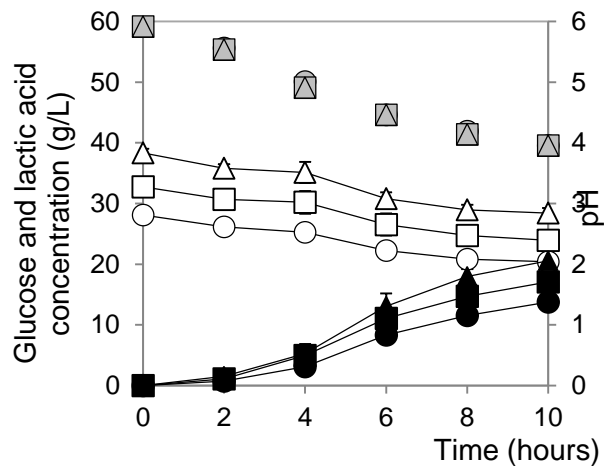
*Sum of glucose, xylose-fructose, arabinose and cellobiose.

LACTIC ACID FERMENTATION IN GREEN JUICES

A. CHICORY



B. RED CLOVER



C. TIMOTHY

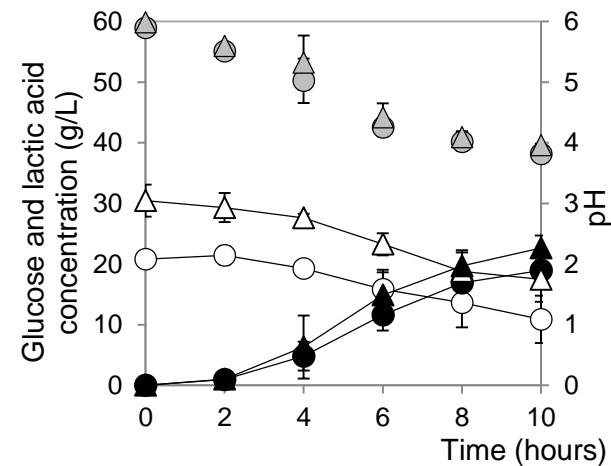
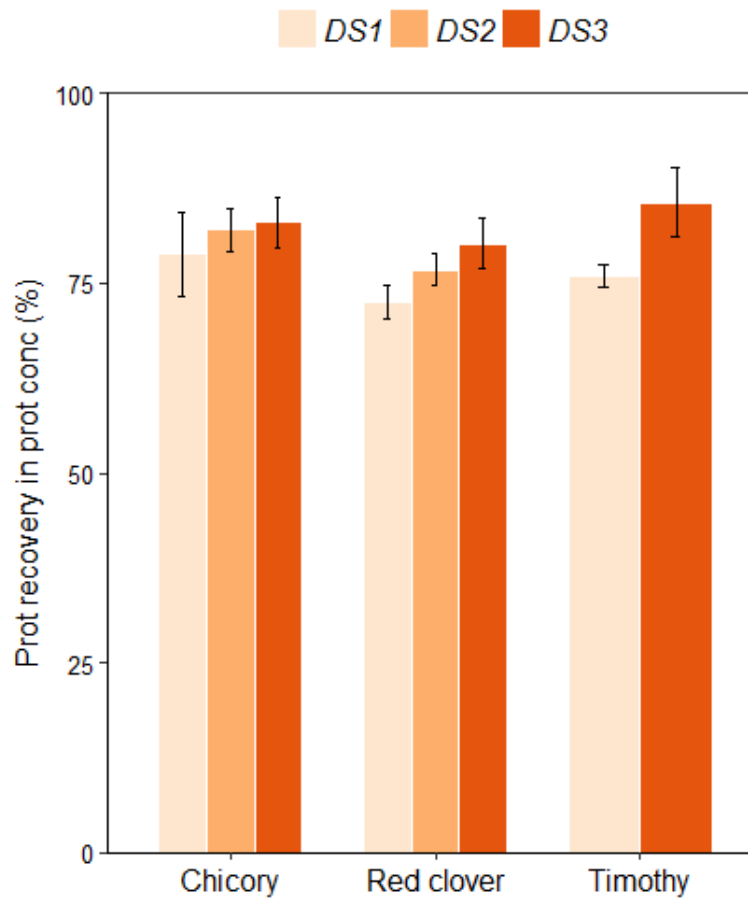


Figure 1. Evolution of pH (grey), glucose (black) and lactic acid (white) during fermentation of green juices from chicory (A), red clover (B) and timothy (C) at *DS1* (circle), *DS2* (square) and *DS3* (triangle). Bars show standard deviation for all results.

FERMENTATION - CENTRIFUGATION

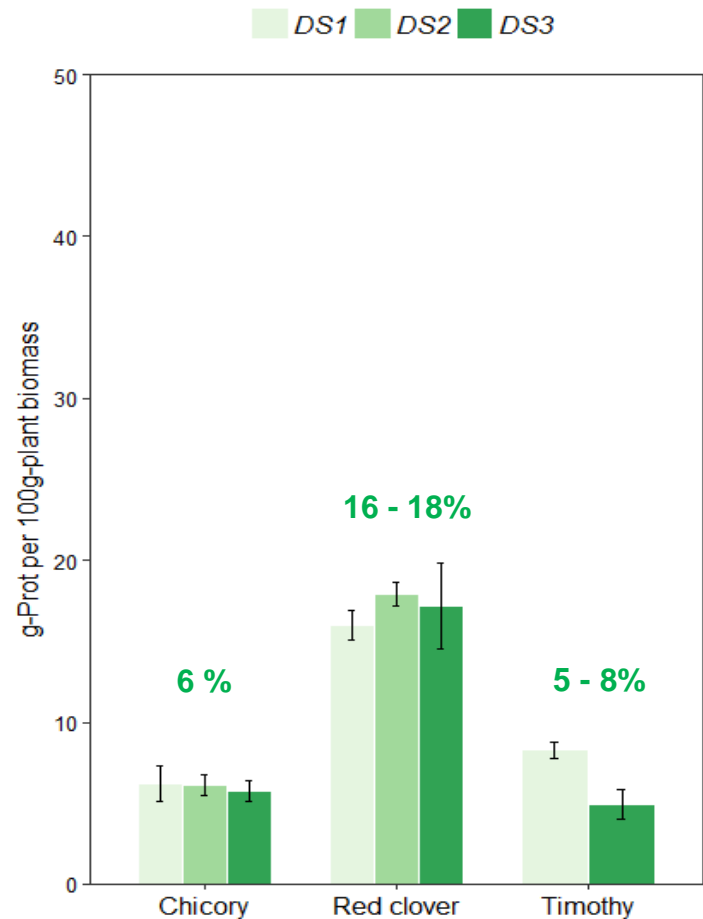
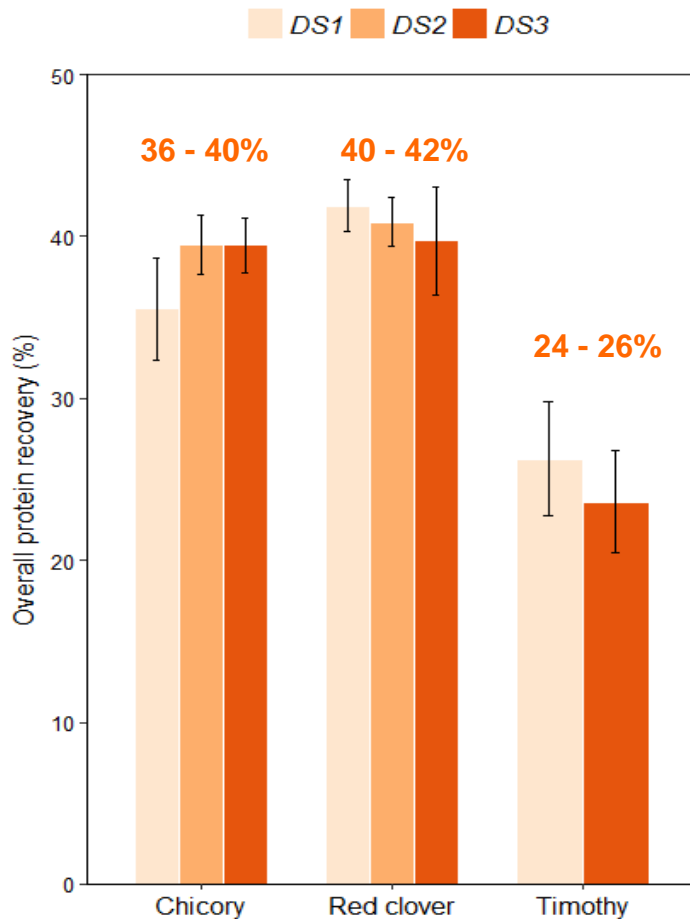


EFFICIENCY OF THE FERMENTATION - CENTRIFUGATION



- ▶ Protein recovery in the protein concentrates after the fermentation - centrifugation was **72-83%**

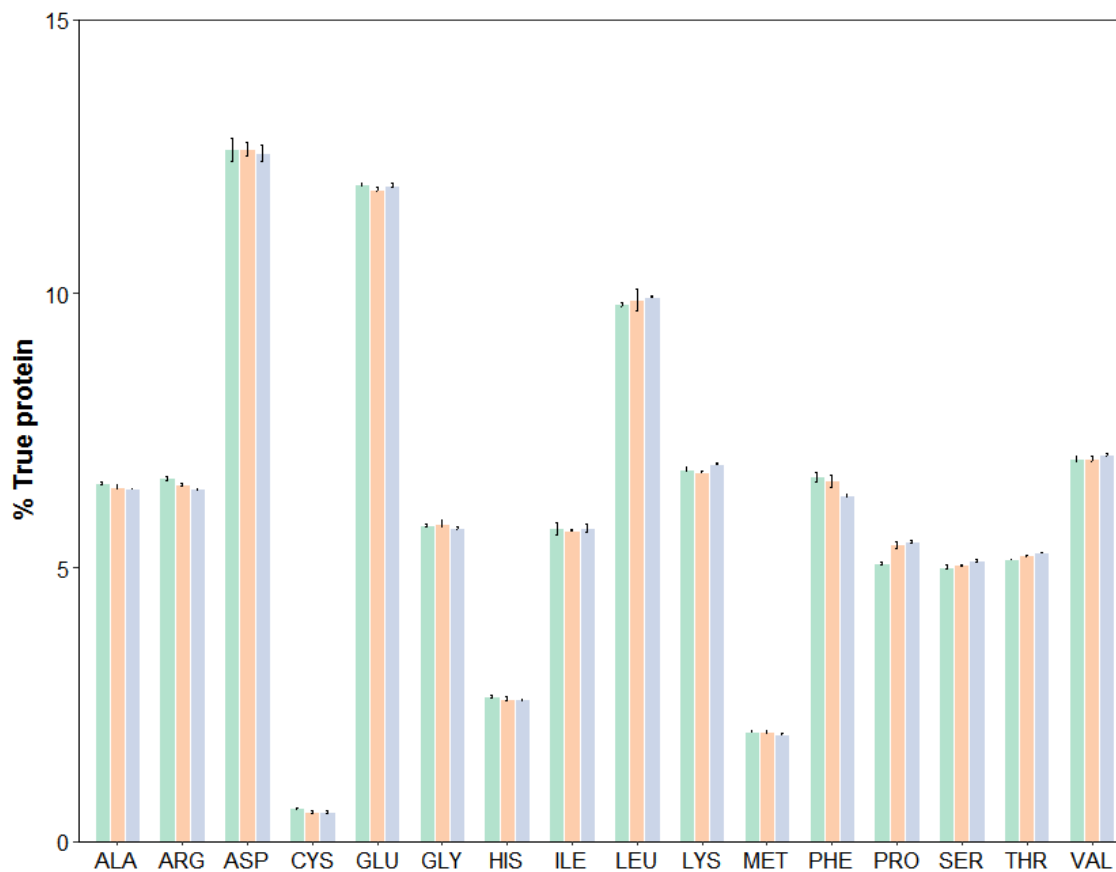
OVERALL PROCESS RECOVERIES



FEEDING QUALITY IN DRY PROTEIN PRODUCT

		Essential aminoacids for poultry									
g/kg DM		Arg	Cys	His	Ile	Leu	Lys	Met	Phe	Thr	Val
Soybeans		31.4	5.8	10.1	18.5	29.3	26.2	5.2	19.7	15.6	18
Red clover	<i>DS1</i>	23.0	2.1	9.2	19.9	34.0	23.6	7.0	23.1	17.9	24.2
	<i>DS2</i>	21.3	1.7	8.5	18.5	32.3	22.0	6.5	21.5	17.0	22.8
	<i>DS3</i>	18.1	1.5	7.3	16.1	28.0	19.4	5.5	17.8	14.9	19.9

FEEDING QUALITY IN DRY PROTEIN PRODUCT



CONCLUSIONS

- Robustness of the fermentation-centrifugation method – **recovery of proteins between 72-86%**
- Up to **42% of proteins** in the fresh biomass were recovered in the protein concentrate – very similar recoveries in chicory and red clover.
- **Red clover** most suitable for a green biorefinery:
 - Highest protein concentrate yields (18-21%)
 - Balanced amino acid composition, comparable with soybeans
 - Dry protein product contained **35-42% of proteins**



