Pressurized hot water extraction of silage

Protein from Grass

Final seminar 12.03.2014

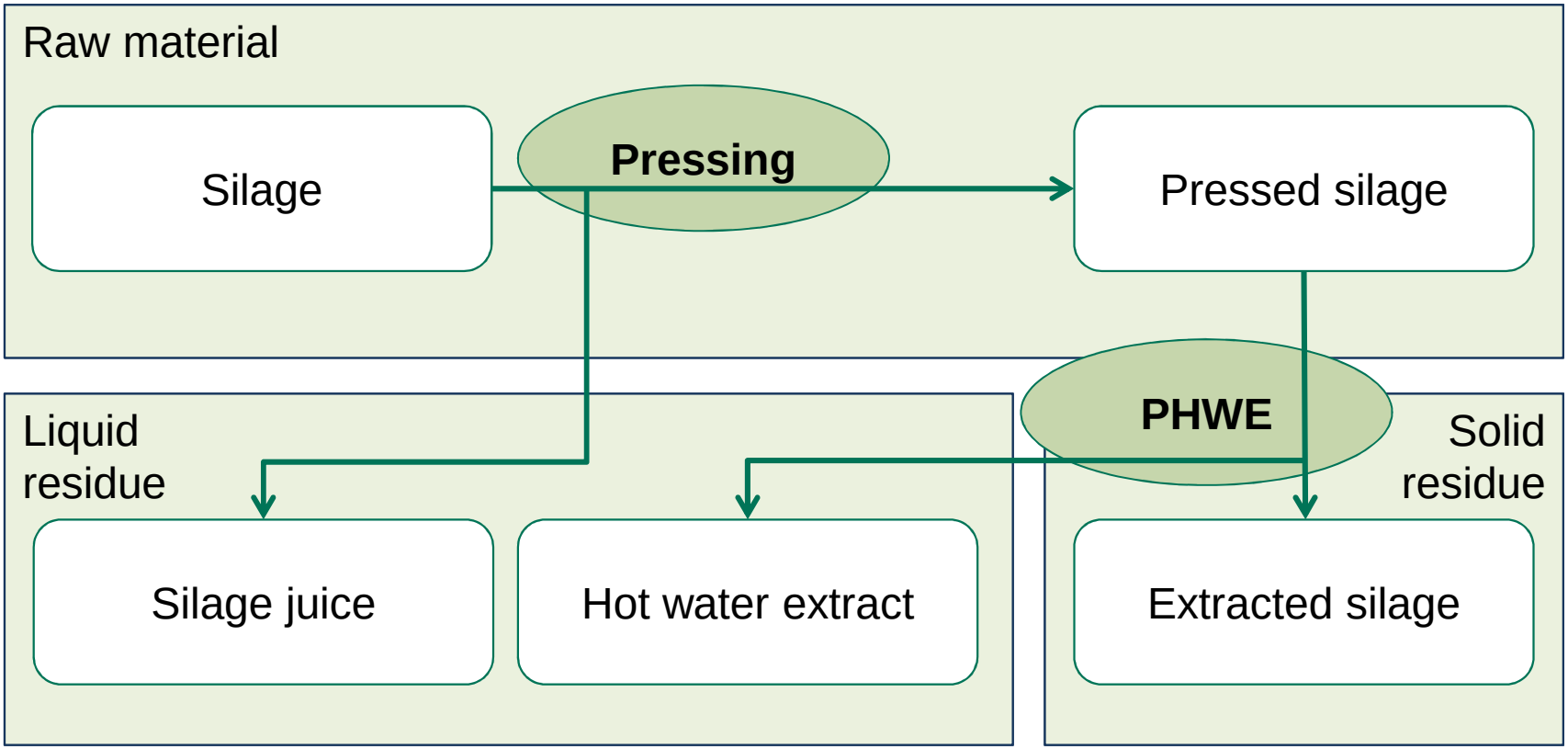
Work group:

- *Researcher, Sanna Hautala*
- *Laboratory engineer, Olli Byman*
- *Laboratory engineer, Matias Häyrynen*
- *Professor, Hannu Ilvesniemi*

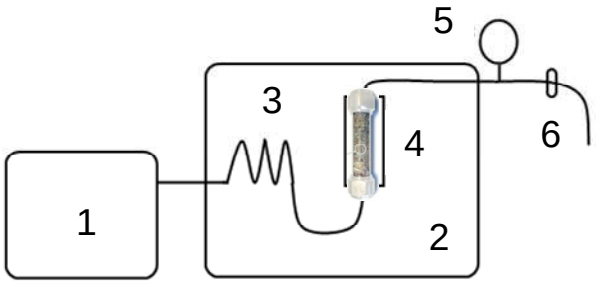
Aim

- Wash the silage from inhibiting substances
- Laboratory scale
  - Test different extraction parameters
  - Test the suitability of the silage for the pilot scale extractor
- Pilot scale
  - Extract large amount of silage with chosen parameters for further experiments

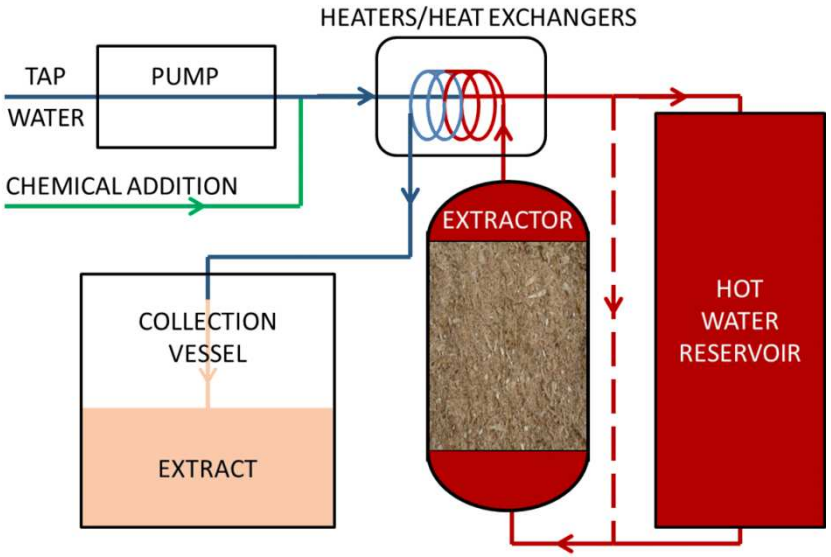
Aim

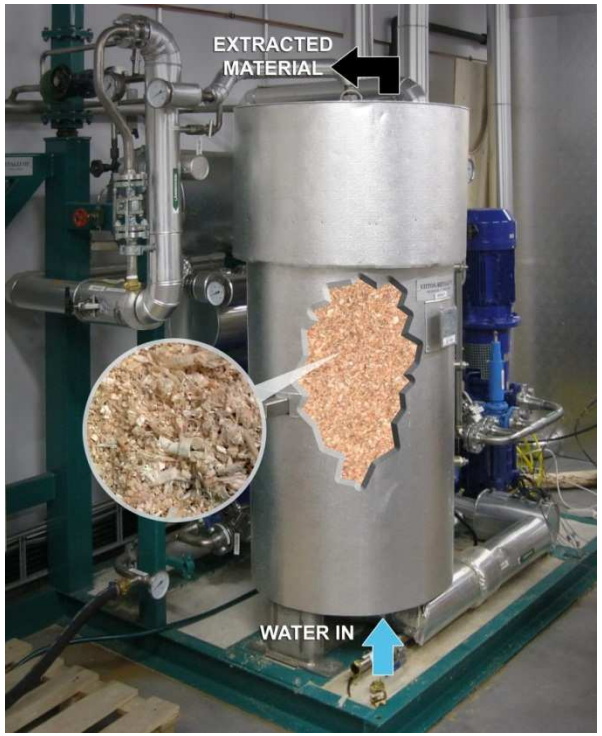

Raw material
Silage
Pressing
Pressed silage
PHWE
Liquid residue
Solid residue
Silage juice
Hot water extract
Extracted silage

Equipment



1. HPLC pump 2. GC-oven 3. Preheating capillary
4. Extraction vessel 5. Manometer 6. Valve





Laboratory scale extractions

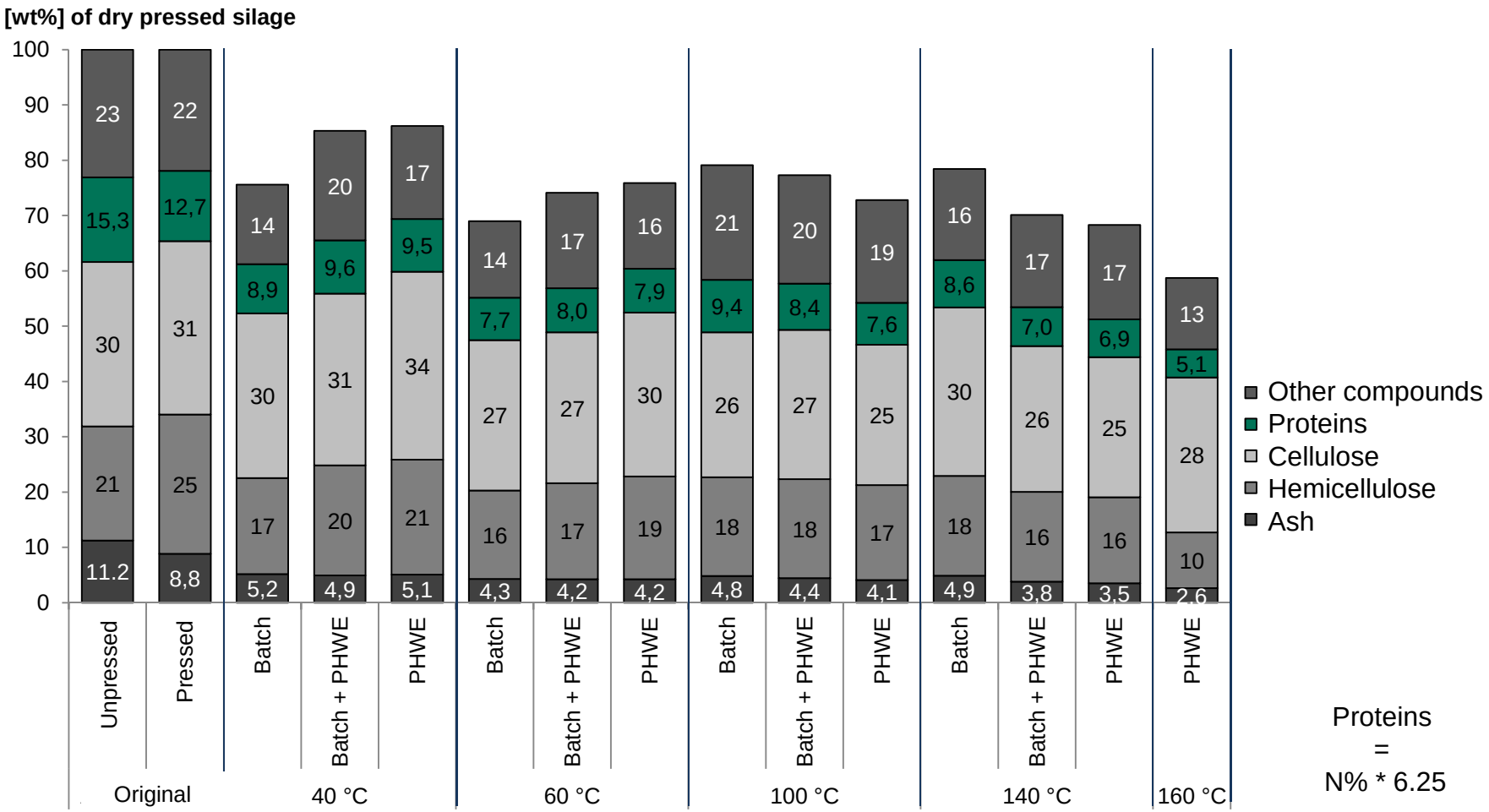
- Three different extraction methods was tested for pressed silage
  - Batch 30 min
  - Batch + PHWE 15 + 15 min
  - PHWE 30 min

Batch = No water flow through the extraction vessel

PHWE = Water is flowing through the extraction vessel continuously

T [°C]	m_{silage} wet/dry [g]	Pressing	Water flow rate [ml/min]	Extraction time [min]
40 °C	48/12 g	Yes	2 ml/min	30 min
60 °C	48/12 g	Yes	2 ml/min	30 min
100 °C	48/12 g	Yes	2 ml/min	30 min
140 °C	48/12 g	Yes	2 ml/min	30 min
160 °C	48/12 g	No	4 ml/min	60 min

Consistency of the extracted silage

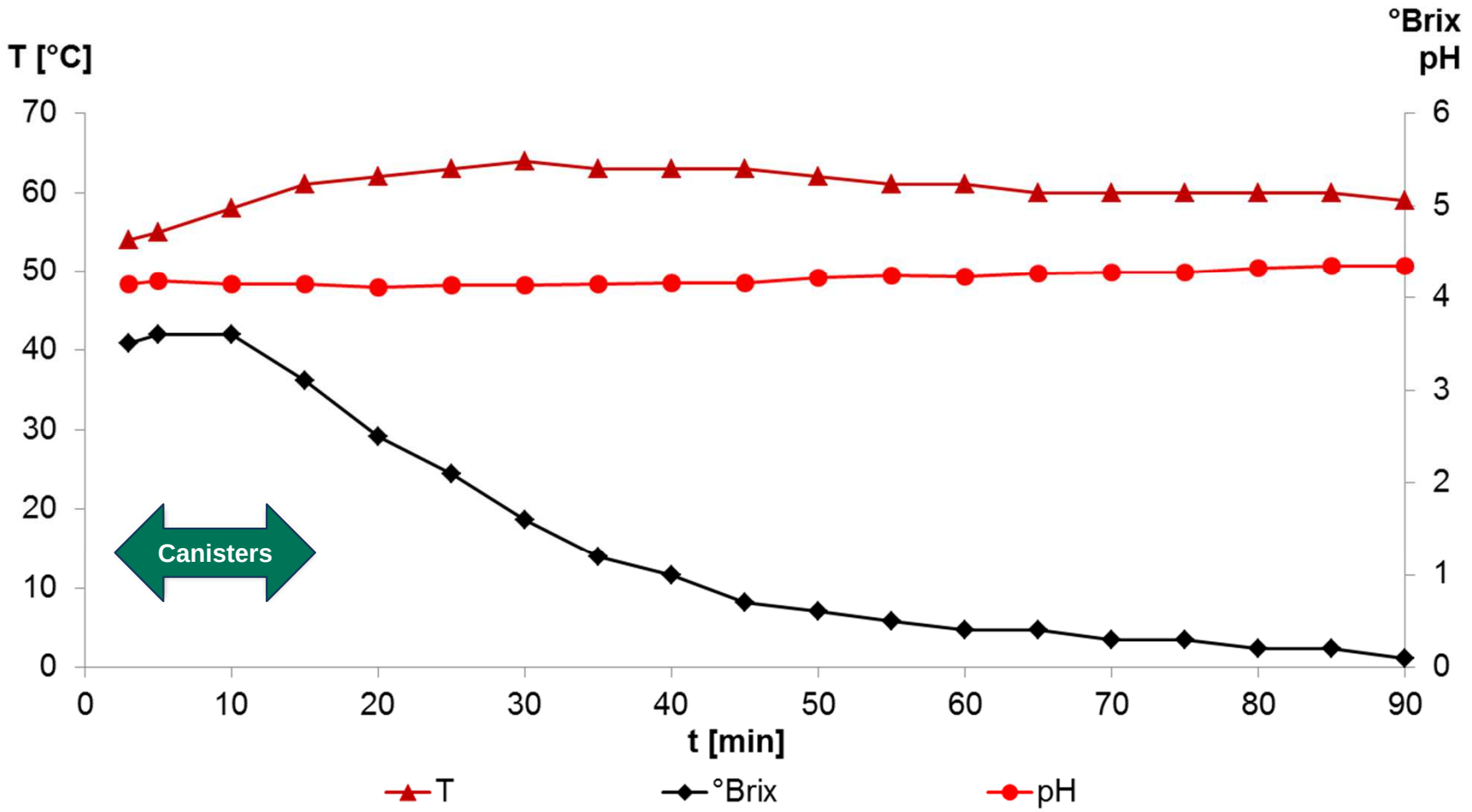


Pilot scale extraction

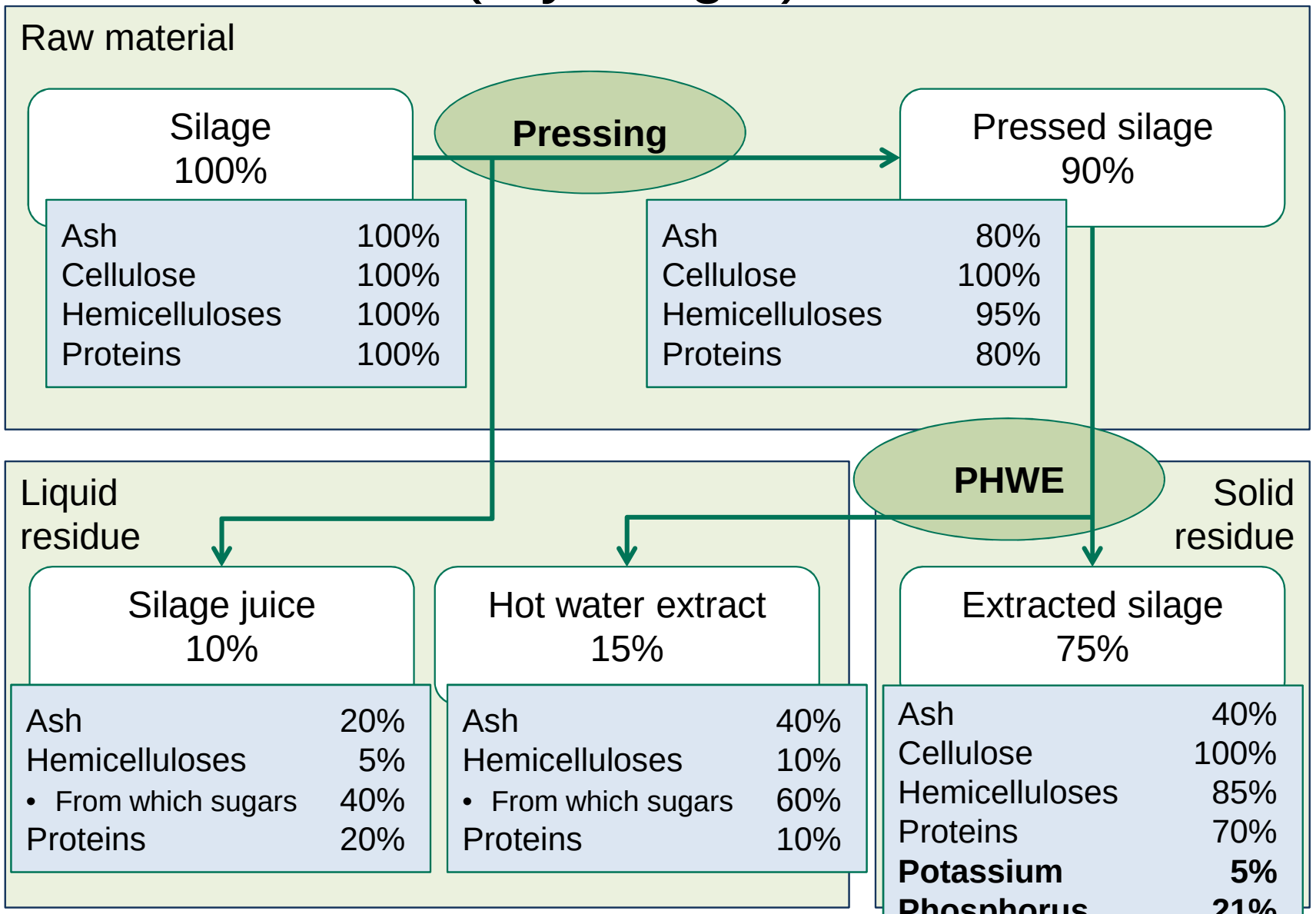
- Flow-through PHWE method for pressed silage
- Extraction time longer, until the °Brix was 0
  - °Brix is based on refractive index, used to measure e.g. sugars
- First 100 liters was collected into canisters

T [°C]	m_{silage} wet/dry	Pressing	Water flow rate [ml/min]	Extraction time [min]
40 °C	48/12 g	Yes	2 ml/min	30 min
60 °C	48/12 g	Yes	2 ml/min	30 min
100 °C	48/12 g	Yes	2 ml/min	30 min
140 °C	48/12 g	Yes	2 ml/min	30 min
160 °C	48/12 g	No	4 ml/min	60 min
60 °C	**144/43 kg**	**No**	**10 kg/min**	**90 min**

Pilot scale extraction



Mass balances (dry weight)



Conclusions

- It is possible to extract/wash silage with a pilot scale flow-through PHWE system
- Extraction at 60 °C
  - Removed 60% of ash, 95% of potassium, and 80% of phosphorus
  - Removed only 30% of nitrogen and 15% of hemicelluloses
  - Did not remove cellulose
- Increasing the extraction temperature over 160 °C
  - Extraction of hemicelluloses and nitrogen really begun
  - At 160 °C, 70% of nitrogen and 50% of hemicelluloses was removed