

# Agro-energy feedstock: Miscanthus

- ⌘ Miscanthus x giganteus
- ⌘ Sterile hybrid propagated through rhizomes
- ⌘ Bulk sample harvested in Germany Air dried and stored in freezer
- ⌘ Composite sample being used for all analyses



# Agro-energy feedstock: Miscanthus

- ⌘ Perennial crop
  - ✧ Grows to 11-14 ft in height/year
- ⌘ High biomass yields
  - ✧ C4 grass with high rate of carbon fixation
  - ✧ 14 – 17 tons/acre (up to 27 tons/acre in trials)
  - ✧ Crop stands survive 25-30 years without significant loss in biomass yields
- ⌘ Presently used in Europe for power and heat generation



# Moisture and Ash content

⌘ Moisture content of air dried Miscanthus sawdust (6 mm)

✧ 4.6%

⌘ Ash content

✧ Measured by ramped heating to 525 ° C in a muffle furnace

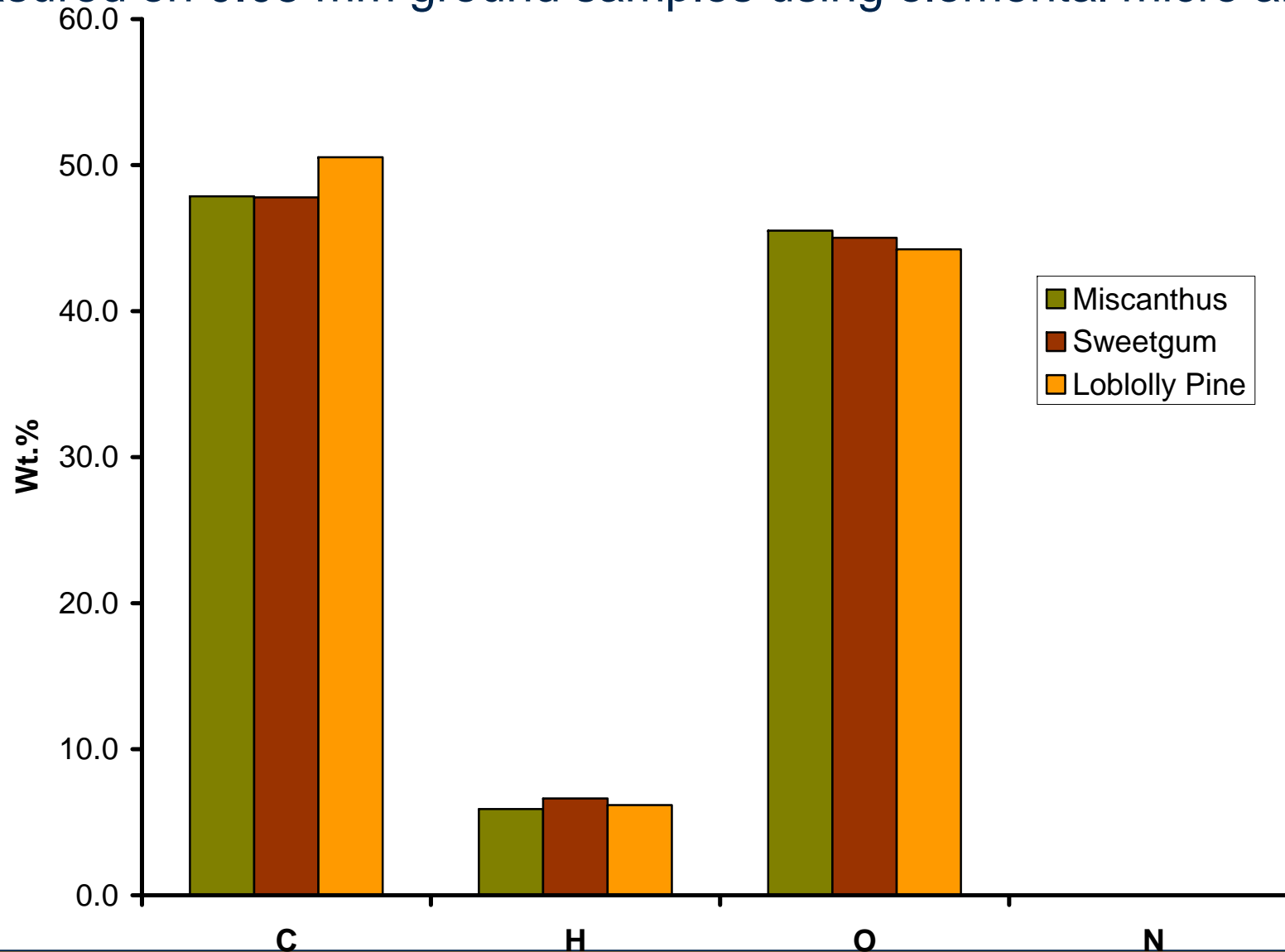
✧ 2.2%

✧ Higher than Loblolly pine (0.2 %) & sweetgum (0.8 %)



# Elemental analysis

Measured on 0.05 mm ground samples using elemental micro analyzer

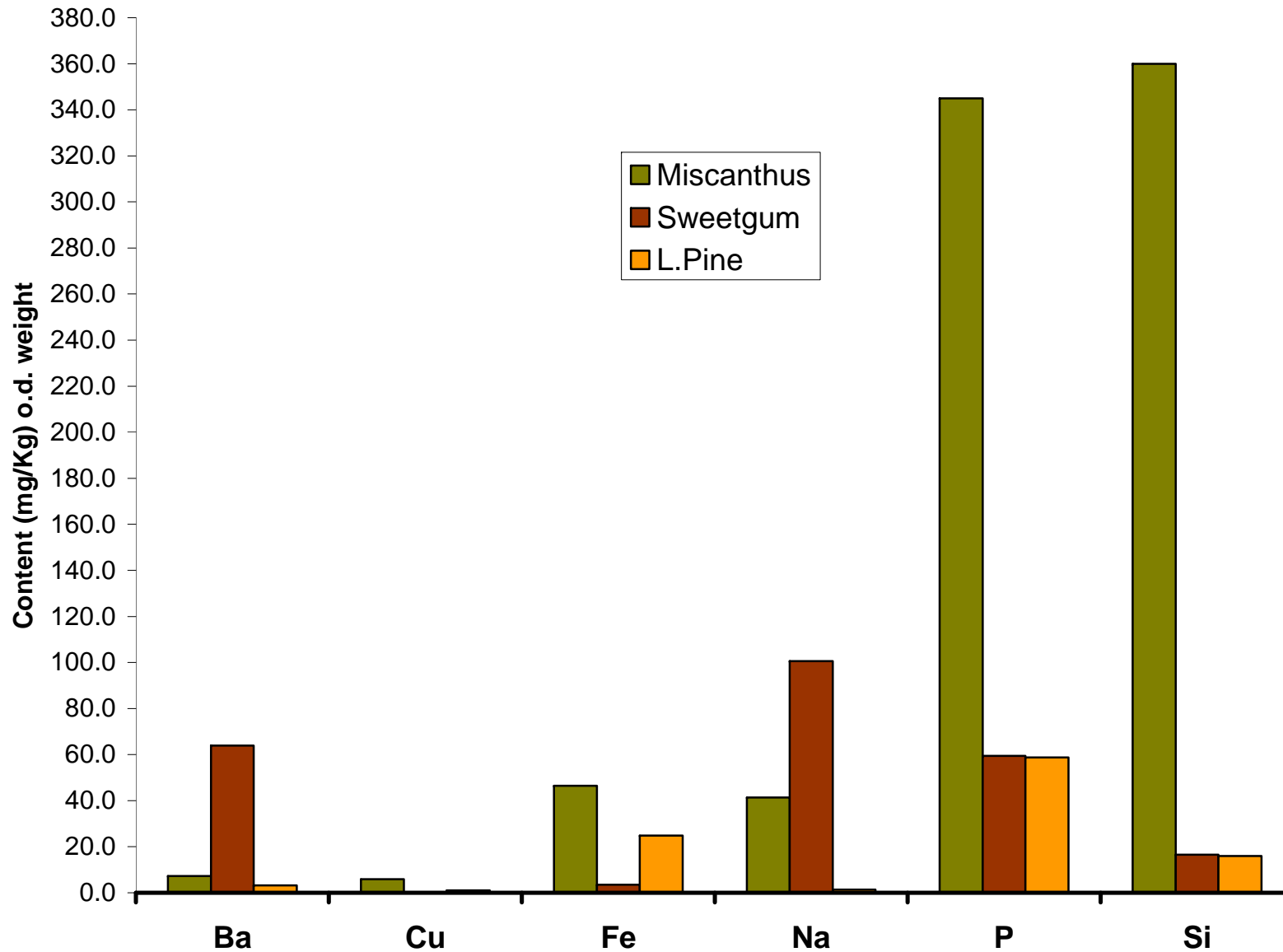


# Inorganic elements

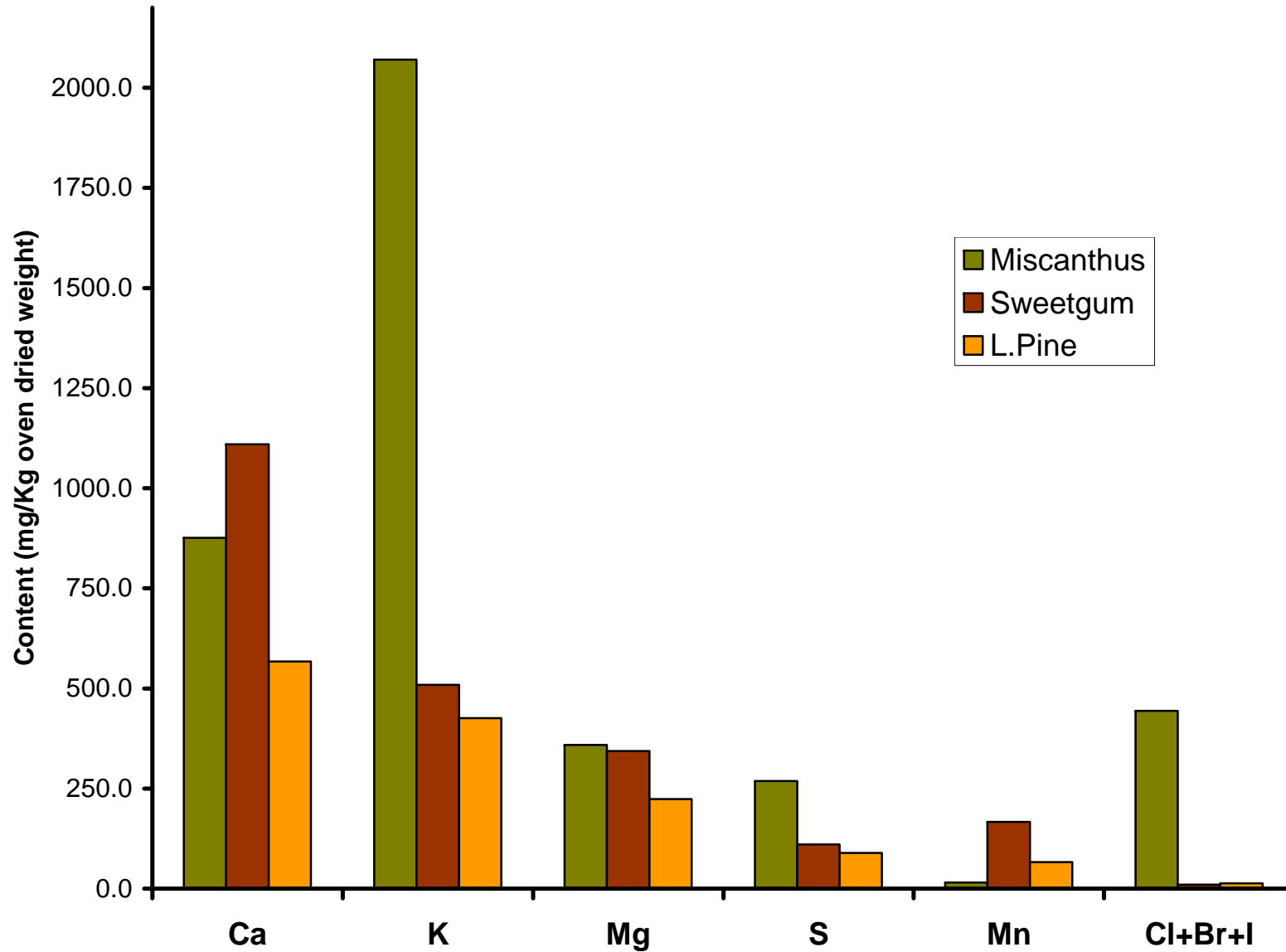
- ⌘ Analyzed in 6 mm ground samples
- ⌘ Acid digestion followed by ICP-emission spectroscopy
- ⌘ Coulometric method for total halogen (Cl+Br+I)



# Inorganic elements

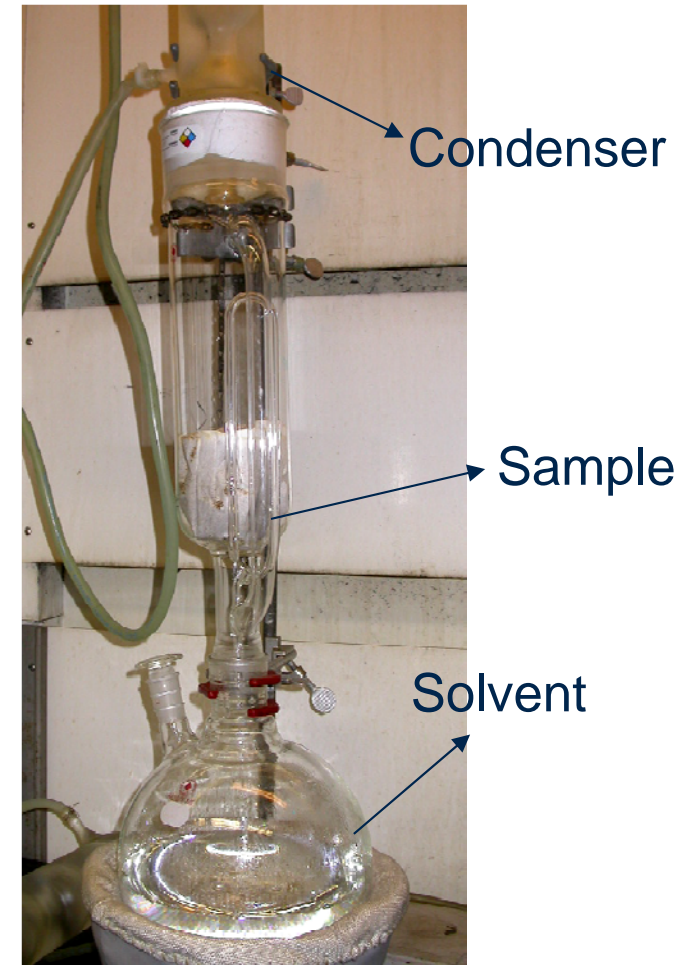


# Inorganic elements



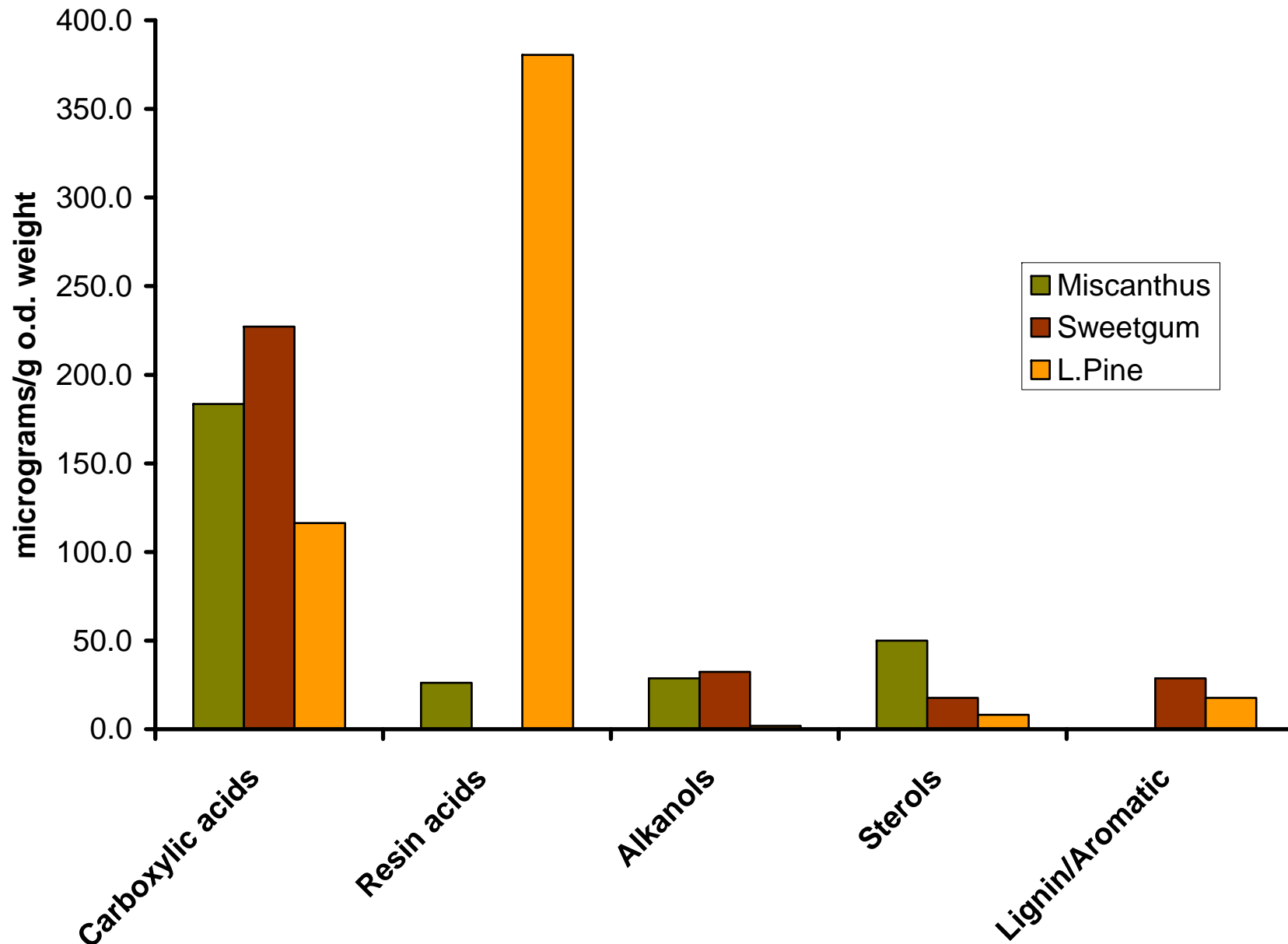
# Extractives

- ⌘ Solvent-soluble, non-volatile material
- ⌘ Extracted with dichloromethane
- ⌘ Characterized using GC-MS
- ⌘ Extractives content:
  - \* 1.0 %
    - 2.9 % for Loblolly pine
    - 0.4 % for Sweetgum
  - \* Water soluble extractives (important for grassy biomass)
    - 3.6 %

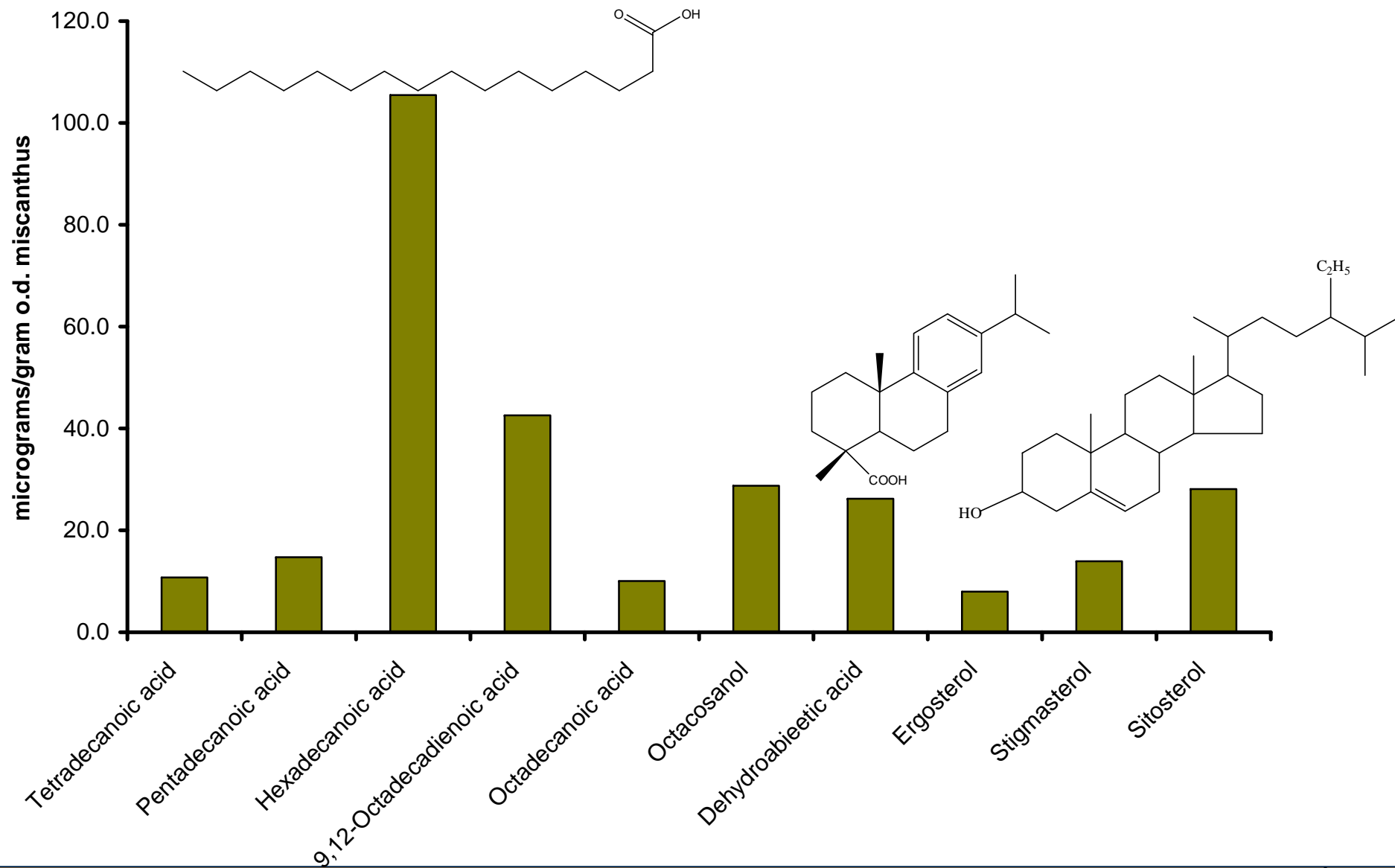




# Dichloromethane extractives composition

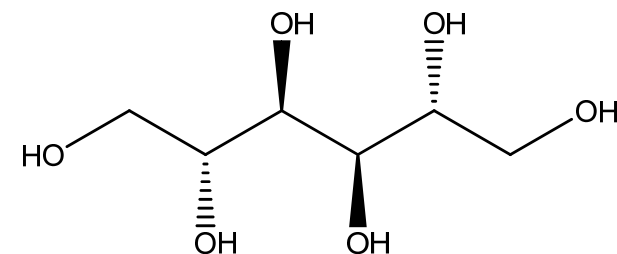


# Dichloromethane Extractives : Miscanthus

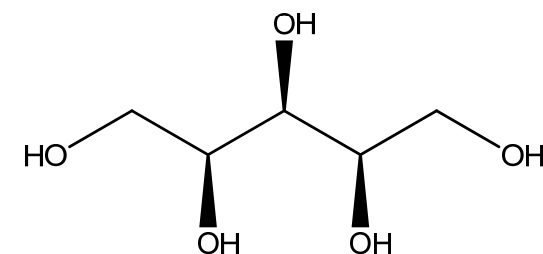


# Water soluble extractives: Miscanthus

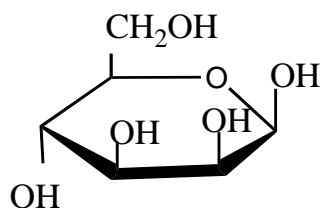
Compound	Amount ( $\mu\text{g/g}$ Miscanthus)
Alpha-L-Galactopyranose	40.24
Alpha-D-Arabinopyranose	52.81
Xylitol	512.22
D-Glucose	30.12
p-hydroxyl cinnamic acid	1145.21
D-Mannitol	1358.42
Mannose	105.84



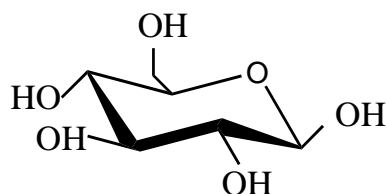
**Mannitol**



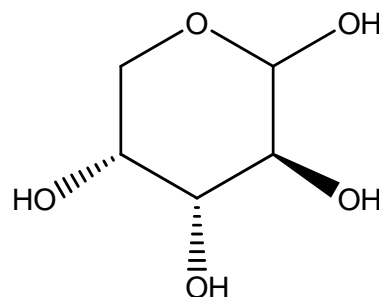
**Xylitol**



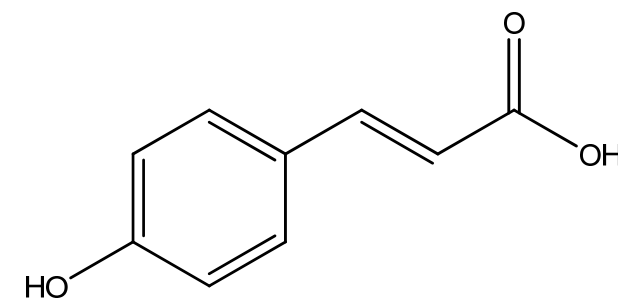
**Mannose**



**Glucose**



**Arabinopyranose**



**P-hydroxyl cinnamic acid**



# Acid soluble and insoluble lignin

## ⌘ Klason lignin

- ✦ Acid insoluble lignin isolated using NREL methods
- ✦ Extractive free (40 mesh) sample hydrolyzed using 72 %  $\text{H}_2\text{SO}_4$

## ⌘ Acid soluble lignin

- ✦ Measured using UV-vis spectrophotometer
- ✦ Calculated from absorption at 205 nm

## ⌘ Pretreatment effluents

- ✦ pH adjusted by the addition of 72 %  $\text{H}_2\text{SO}_4$  and autoclaved at 121 ° C for 1 hour
- ✦ Solution filtered and lignin content measured as the sum of solid residue (Klason lignin) and soluble lignin measured with UV.



# Lignin content and composition

## Klason lignin

Miscanthus: 25 %

Loblolly pine: 29 %

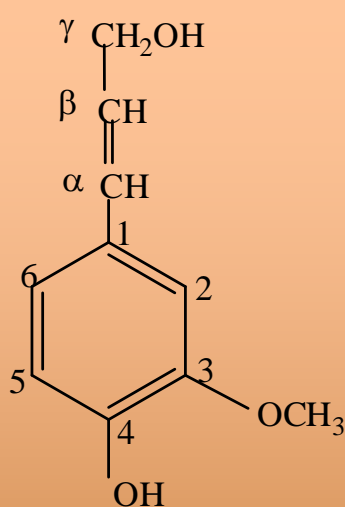
Sweetgum: 26 %

## Acid soluble lignin

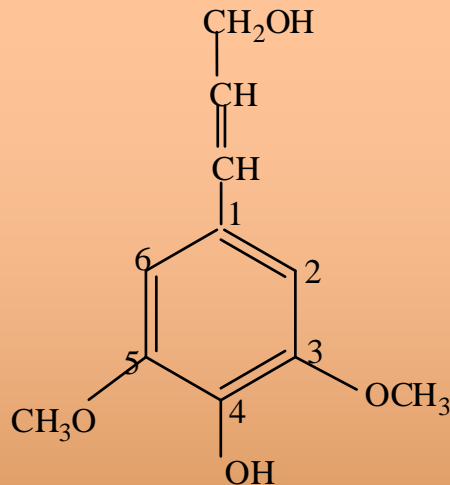
Miscanthus: 1.1 %

Loblolly pine: 0.5 %

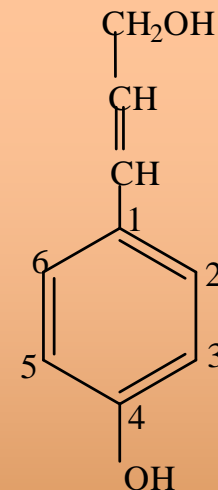
Sweetgum: 2.6 %



**Guaiacyl**



**Syringyl**



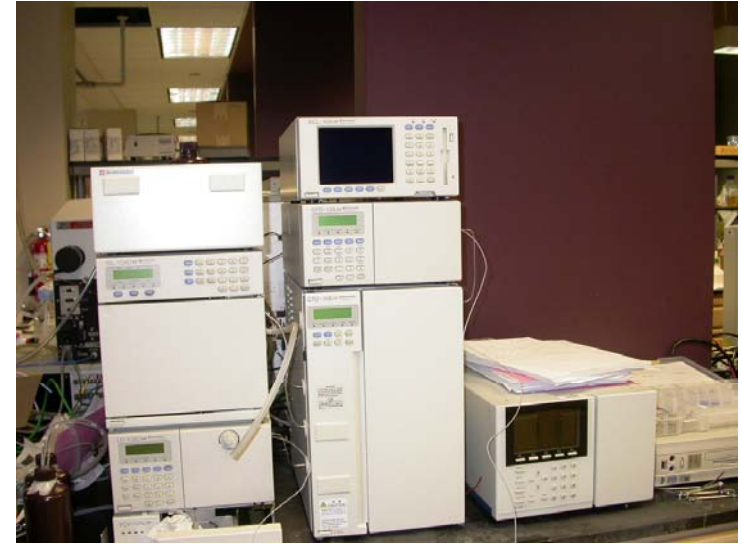
**p-Coumaryl**

SW	x		x
HW	x	x	x
Grass	x	x	x

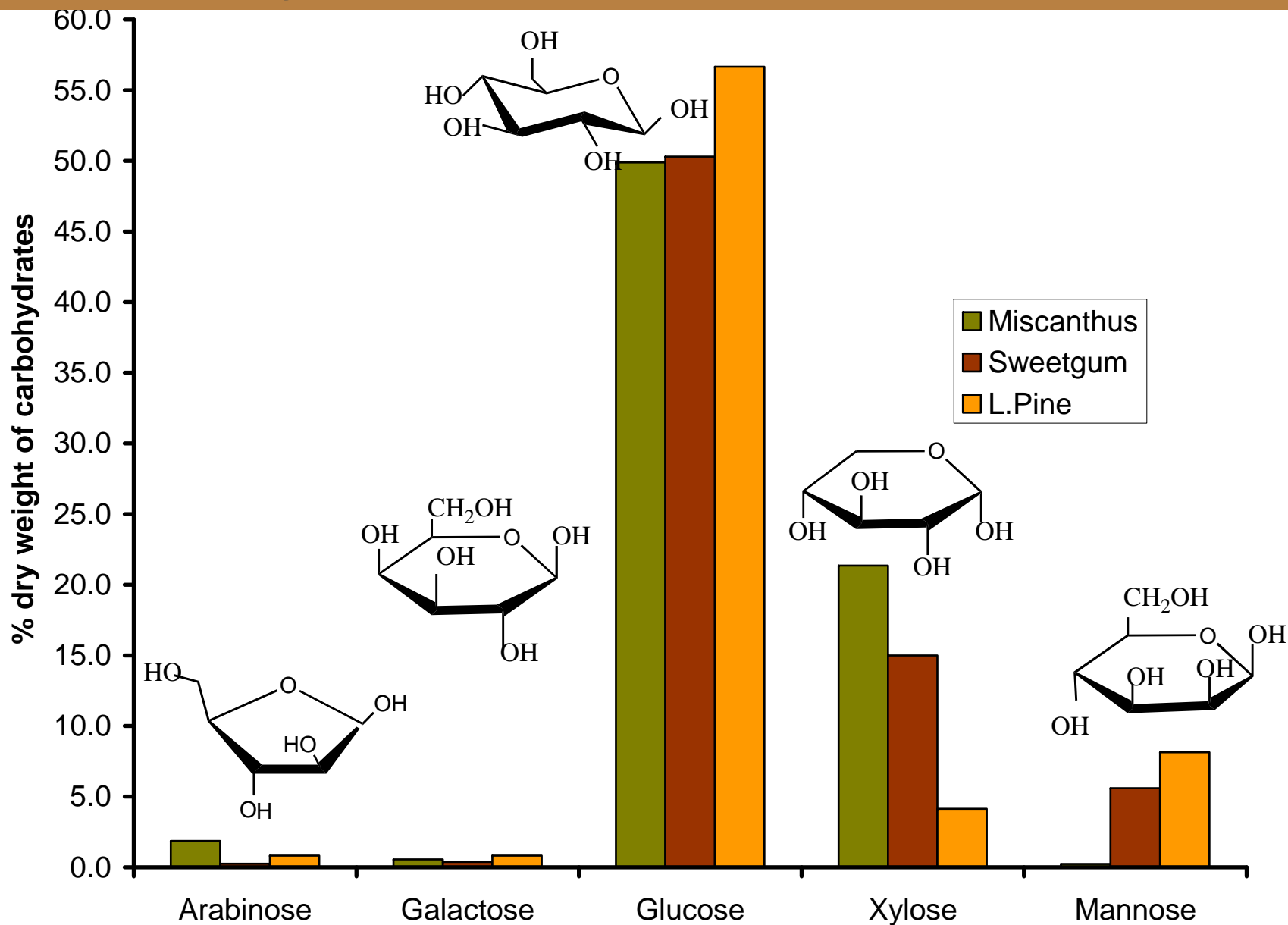


# Carbohydrate analysis

- ⌘ 40 mesh extractive free wood
- ⌘ Hydrolyzed with 72 %  $H_2SO_4$
- ⌘ Diluted to 3%  $H_2SO_4$  and autoclaved at 121° C for 1 hour
- ⌘ For pretreatment effluents
  - pH adjusted by the addition of 72 %  $H_2SO_4$
  - Autoclaved at 121 ° C for 1 hour
  - Filtered and filtrate used for sugar analysis
- ⌘ Sugars measured using HPLC with pulsed amperometric detector



# Carbohydrate profile



# Summary: Miscanthus composition

- ⌘ Higher ash content than sweetgum or pine
  - ✧ Higher contents of P, K, Si and halides
- ⌘ Dichloromethane extractives mostly carboxylic acids, alkanols and sterols
- ⌘ Water extractives mostly derived from carbohydrates
- ⌘ 26 % total lignin content
  - ✧ Lower than woody biomass feedstocks
- ⌘ Carbohydrates are mostly glucose and xylose
  - ✧ Xylose content highest among the three feedstocks

