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SEIT 1737



FuLaWi
Fodder from agroforestry



Feed Quality and Conservation of Foliage from Agroforestry through Ensiling

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**20. International Silage Conference
Gainesville**

July 21 – 24, 2025

Agroforestry ~ A system full of promise



Biodiversity



Agricultural
resilience



Sustainability



<https://static.vecteezy.com/goat-eating-a-leaf-given-by-a-man-photo.JPG>

https://www.eesi.org/images/content/Ag_Series_1uv_Agroforestry.png

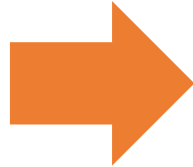
Deciduous trees ~ A seasonal resource



<https://www.shutterstock.com/image-photo/deciduous-trees-isolated-600nw-2470689789.jpg>



Focus of our Research



Evaluate **silage quality** and **nutritional profiles** of willow and poplar foliage through a controlled laboratory-scale silo experiment

Materials and Methods

Harvesting Date

September 6th, 2023



Black poplar
(*P. deltoides*
x *P. nigra*)



Balsam poplar
(*P. maximowiczii*
x *P. nigra*)



Willow
(*S. viminalis*
x *S. schwerinii*)

Source



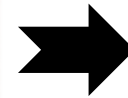
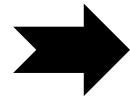
LIGNOVIS

Großschirma, Saxony
Germany

(Short rotation coppice
plantation - unfertilized)



Sample Preparation



Ensiling Treatments

1. Control



no additive

3. Molasses



30 g sugar beet molasses/kg FM

2. Chemical additive



4 ml/kg FM
sodium benzoate &
sodium propionate (3:1)

4. Molasses + LAB



30 g sugar beet
molasses/kg FM

3×10^8 CFU
homofermentative
LAB/kg FM



Silage Preparation

Leaves were ensiled in vacuum-sealed PVC bags
→ Rostock model silages (ROMOS)

~500 g FM/mini silo



48 mini silos
(3 species × 4 treatments × 4 reps)



Storage for 91d
(at $15.8 \pm 2.3^{\circ}\text{C}$)



Analytical Parameters

Crude nutrient composition and
fiber fractions (NDF, ADF, ADL)

NH₃-N, true protein

Total phenols, total
tannins, condensed
tannins, total flavonoids

Silage pH,
fermentation acids
and alcohols

Water-soluble
carbohydrates (WSC)

Buffering capacity



Analytical Parameters

Crude nutrient and fiber
fractions (NDF, ADF, ADL)

Protein fractionation

Total phenols, Total

**Data were analyzed using a 3 × 4 factorial design in SAS
(v9.4 MIXED procedure)**

Fermentation acids,
alcohols and pH

Water-soluble
carbohydrates (WSC)

Buffering capacity



Results ~ Composition fresh foliage

Item	Black poplar	Balsam poplar	Willow
Dry matter, g/kg	249	284	308
Organic matter, g/kg DM	869	901	916
Crude protein, g/kg DM	174	136	199
NDFom, g/kg DM	397	374	441
ADFom, g/kg DM	301	292	333
ADL, g/kg DM	118	105	178
Energy content*, MJ ME/kg DM	10.2	10.3	9.7

*Estimated according to Menke and Steingass (1988)

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Results ~ Composition fresh foliage

Item	Black poplar	Balsam poplar	Willow
Water-soluble carbohydrates, g/kg DM	84	89	62
Sugar*, g/kg DM	58	76	50
Buffering capacity [§] , g lactic acid/kg DM	45	38	33
Sugar : buffering capacity ratio	1.3	2.0	1.5

*Includes glucose, fructose, sucrose

§Amount of lactic acid required to adjust pH to 4.0

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Results ~ Composition of Silages

Item	Black poplar ensiled	Balsam poplar ensiled	Willow ensiled
Dry matter, g/kg	257	286	320
Organic matter, g/kg DM	857	892	912
Crude protein, g/kg DM	183	148	206
True protein, % CP	69	74	87
NDFom, g/kg DM	385	355	495
ADFom, g/kg DM	329	327	370
Energy content*, MJ ME/kg DM	9.8	9.8	9.2

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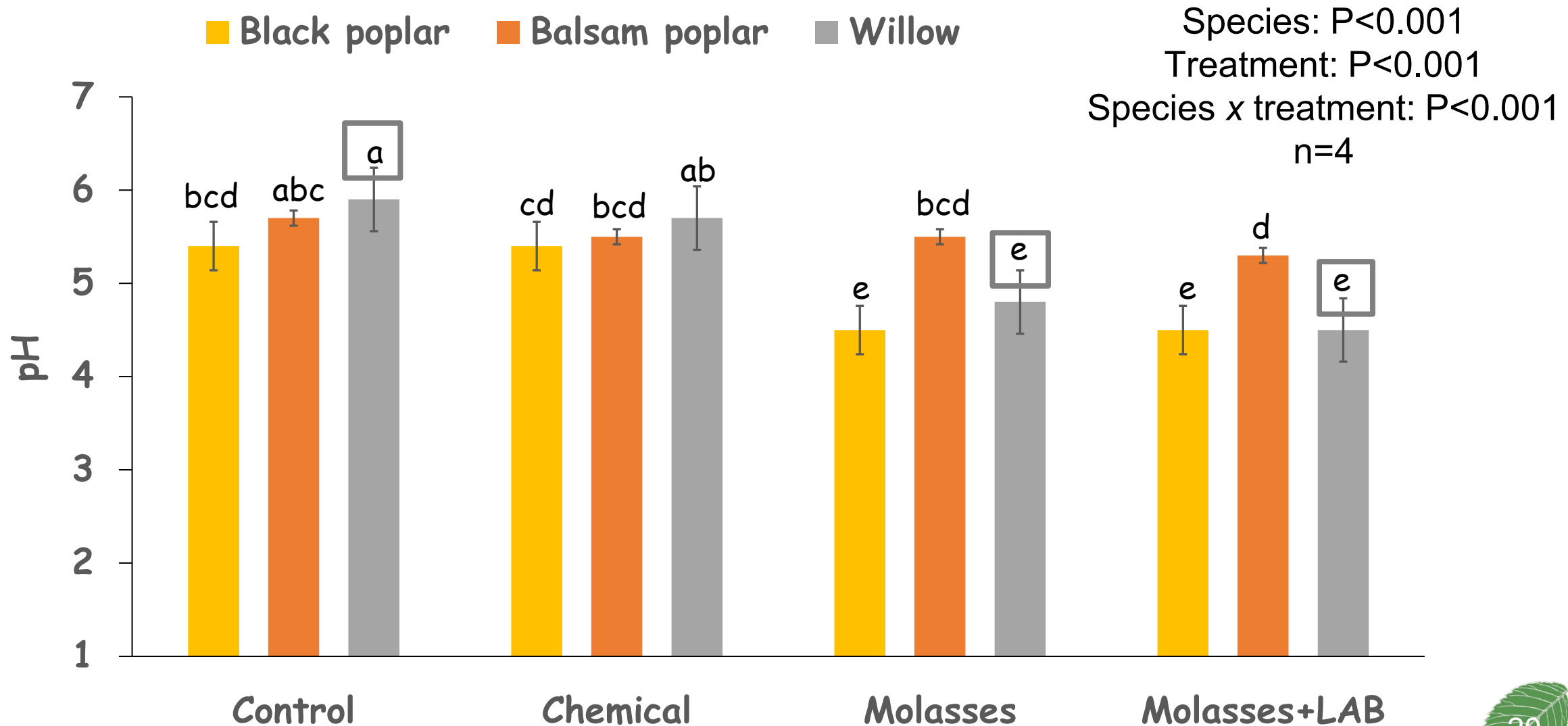
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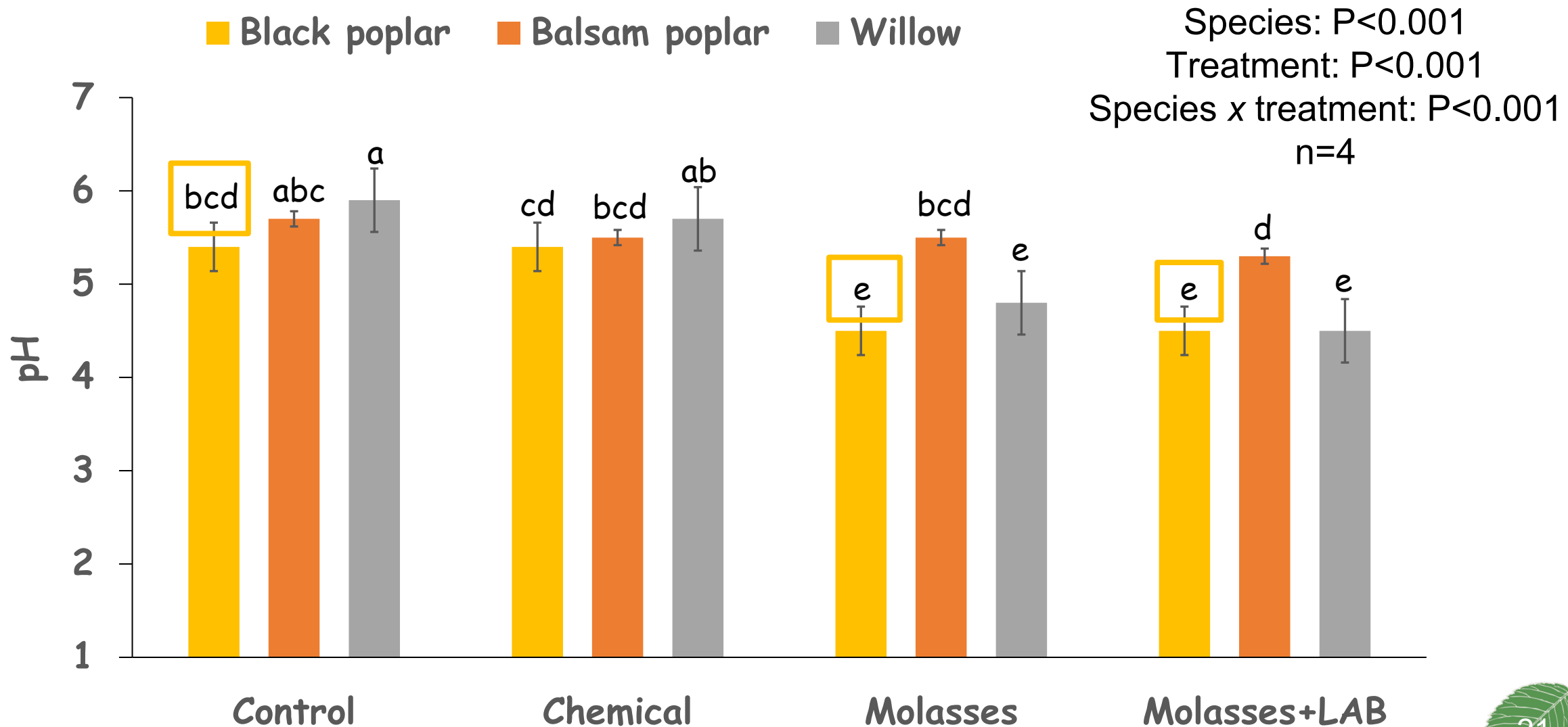
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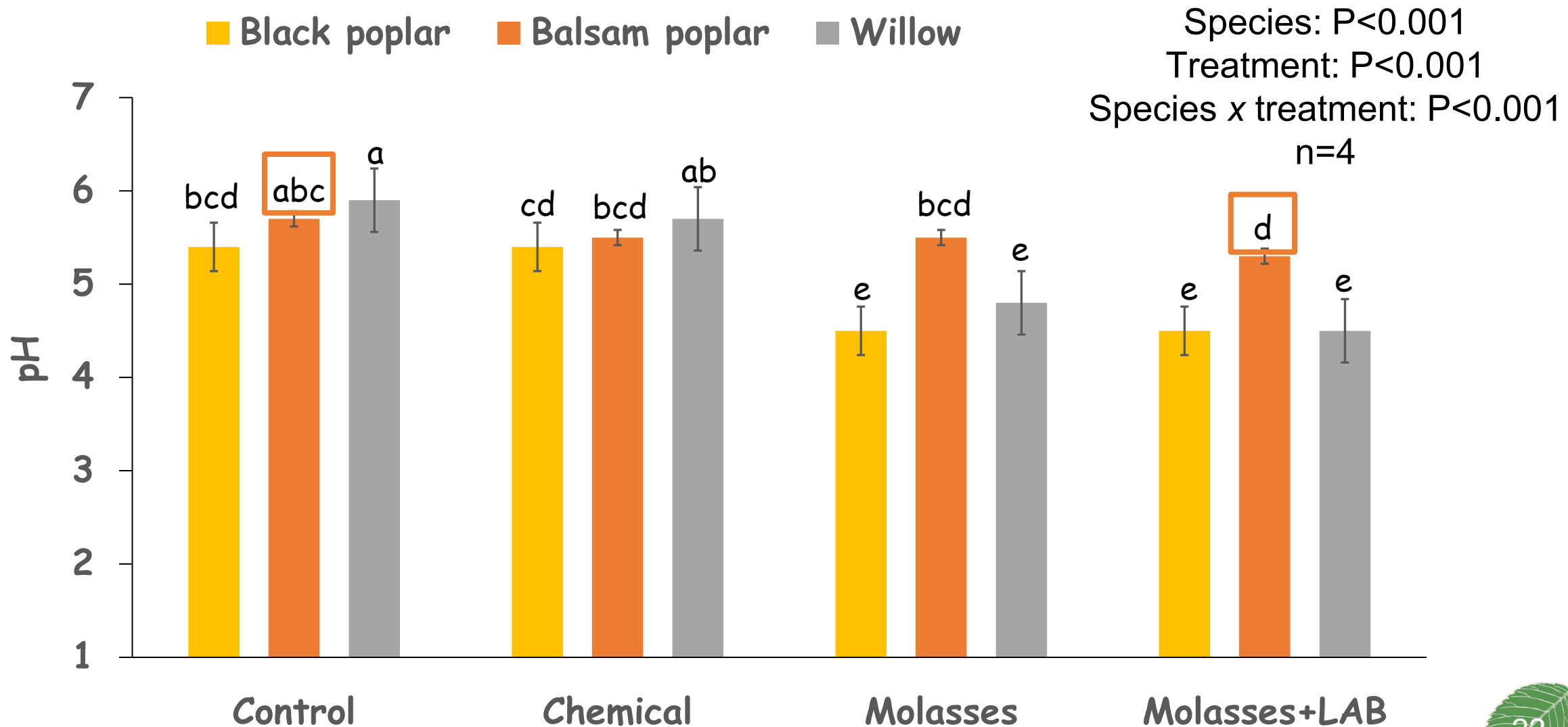
Results ~ Silage pH



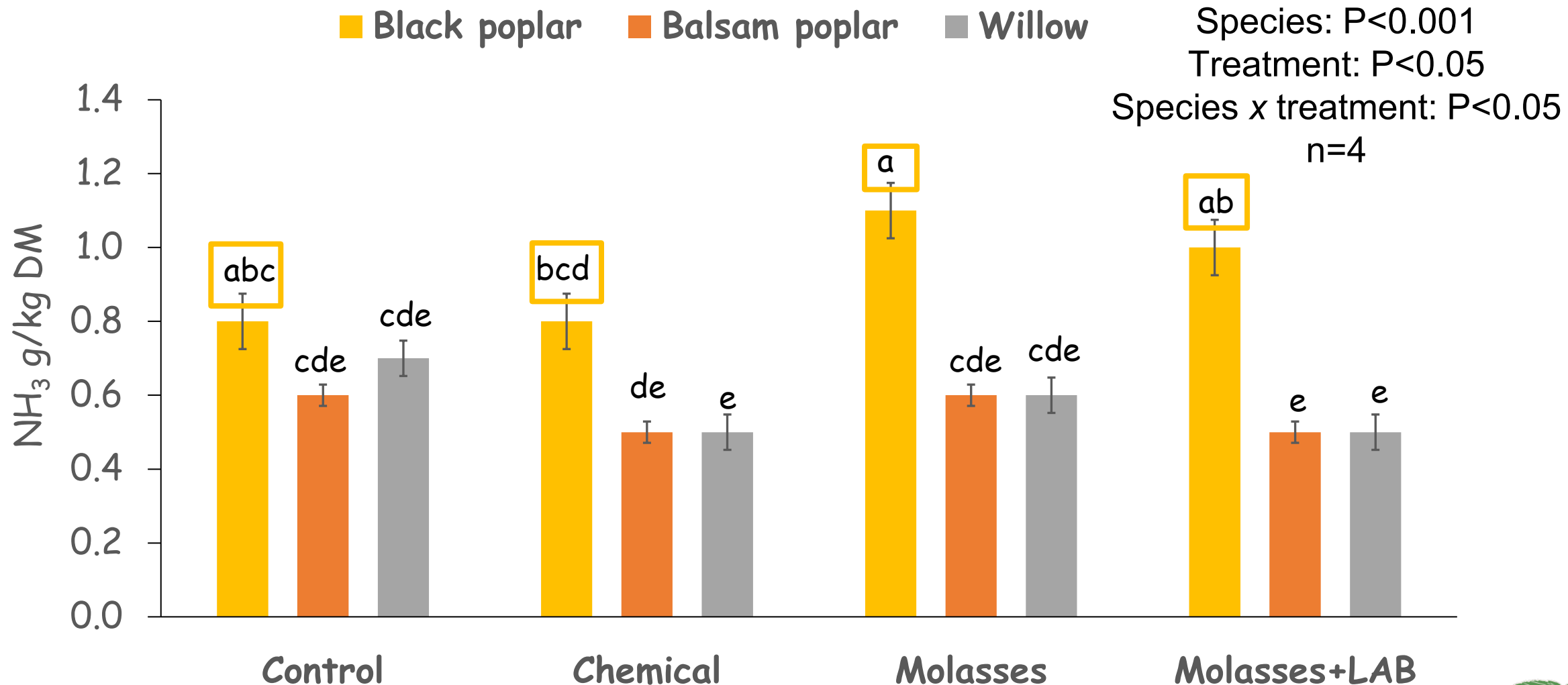
Results ~ Silage pH



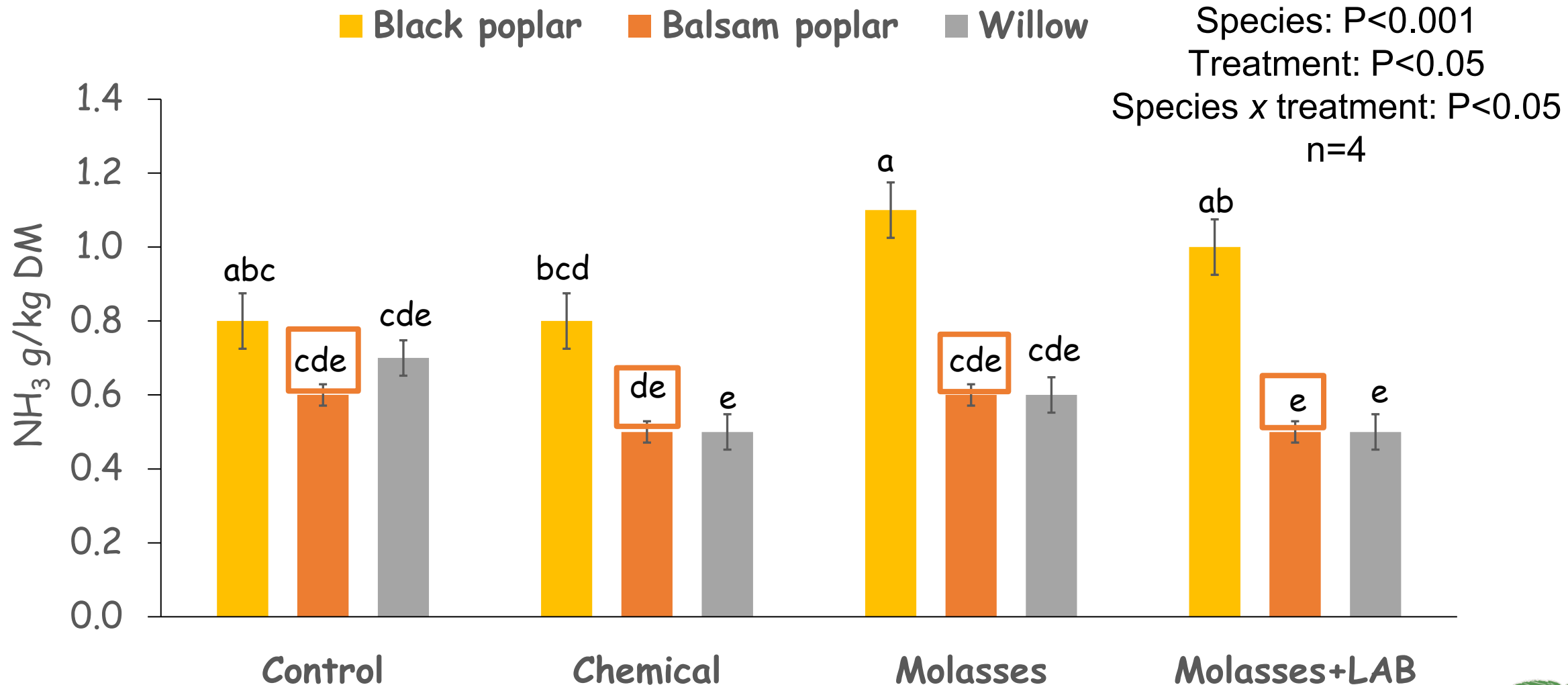
Results ~ Silage pH



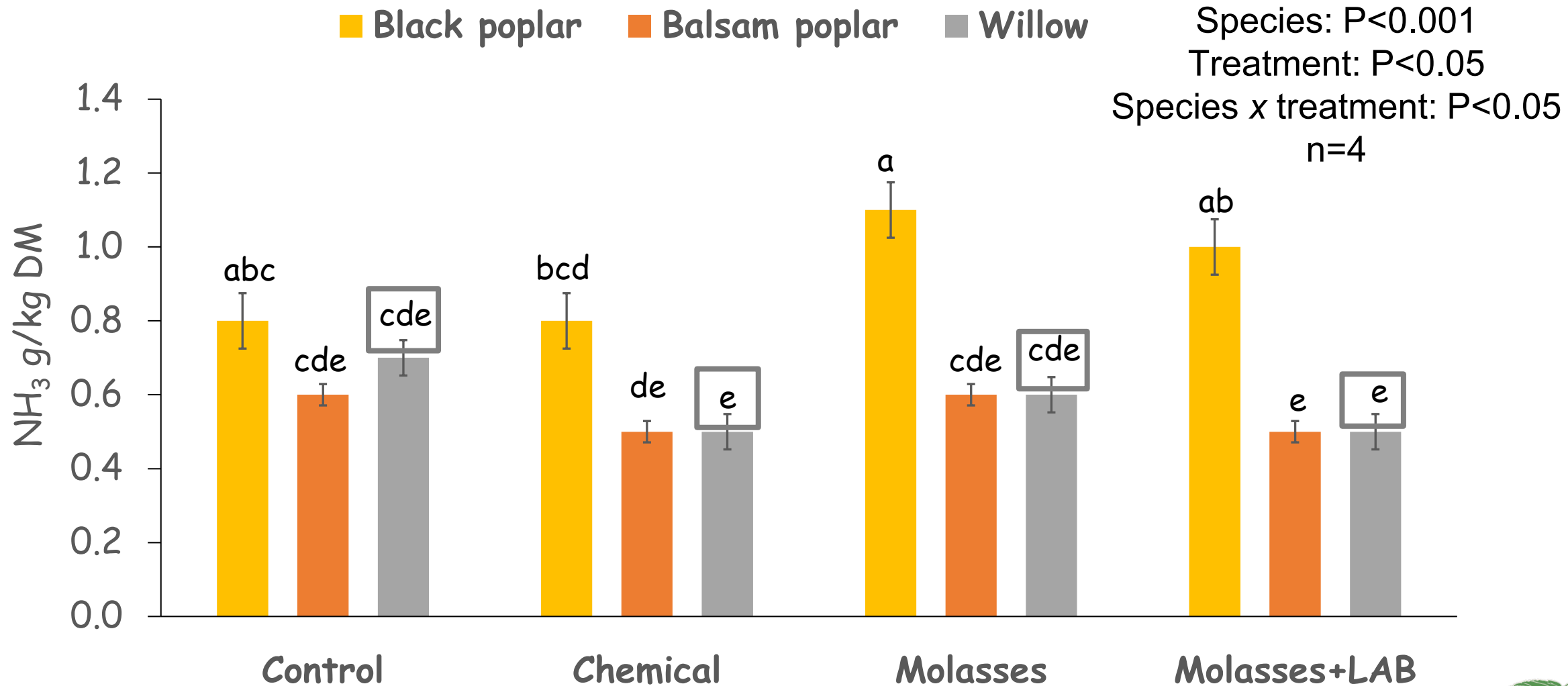
Results ~ NH₃ content silages



Results ~ NH₃ content silages



Results ~ NH₃ content silages



Closing Summary



Willow

- High crude and true protein content
- Greatest drop in pH



Balsam poplar

- Highest sugar-to-buffering ratio
- Lowest fiber content
- Harder to acidify



Black poplar

- Lower pH when molasses is added

Future steps

1

Ensiling of willow and poplar biomass at three time points (spring, summer, fall)

2

In vivo feeding experiment with goats (dried and ensiled willow and poplar leaves and twigs)



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FuLaWi
Fodder from agroforestry

**“Nature offers the feed.
Science helps us to
preserve it”**

With support from



Federal Ministry
of Agriculture, Food
and Regional Identity

Project manager



Federal Office
for Agriculture and Food



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by decision of the
German Bundestag