



11<sup>th</sup> International Conference on  
Sustainable Solid Waste Management

# Neural Network-Enhanced Hydrolysis Process for Valorizing Spent Coffee Grounds

H.M. Fogarin; M.C.M. Santos; J.P. Souza; E.R.  
Filletti; K.J. Dussán

Department of Engineering, Physics and Mathematics, São Paulo State University  
(UNESP), Institute of Chemistry, Araraquara, Av. Prof. Francisco Degni, 55 – Jardim  
Quitandinha, 14800-900, Brazil.

Institute for Research in Bioenergy (IPBEN), São Paulo State University (UNESP), Av.  
Prof. Francisco Degni, 55 Jardim Quintandinha, Araraquara 14800-900, Brazil.



# Introduction



Valorization of agricultural waste



Spent Coffee Grounds

## Composition % w/w

Hemicellulose - 30-40 %

Lignin - 25-33 %

Lipids - 10-20%

Cellulose - 8.6-13.3 %

Proteins - 6.7 - 13.6 %

Polyphenols - 2.5%

Minerals - traces



Cosmetics



Pharmaceutical



Bioethanol

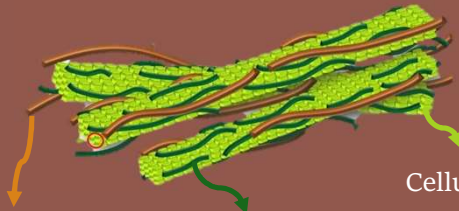
Fertilizer



## Bottleneck



Lignin



Hemicellulose

Cellulose



## Objective

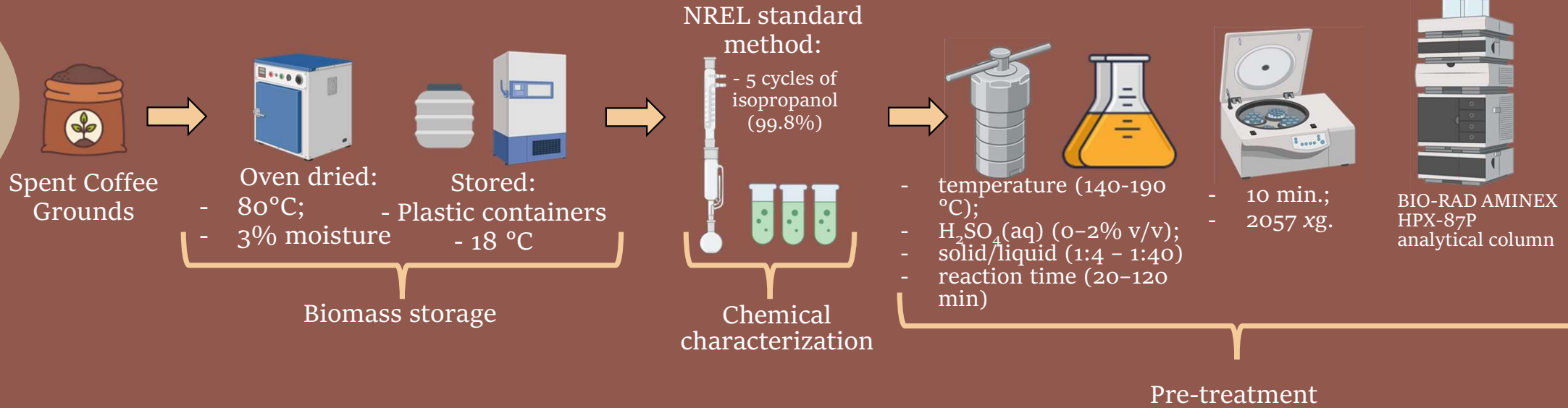
Enhance the efficiency of hemicellulose extraction (mannose and galactose) through the application of artificial neural networks (ANN).

Bhaturiwala RA, Modi HA. Extraction of oligosaccharides and phenolic compounds by roasting pretreatment and enzymatic hydrolysis from spent coffee ground. J Appl Biol Biotech 2020; 8(04):75-81.

DOI: <https://dx.doi.org/10.7324/JABB.2020.80412>

Jensen, C.U., Rodriguez Guerrero, J.K., Karatzos, S. et al. Fundamentals of Hydrofaction™: Renewable crude oil from woody biomass. Biomass Conv. Bioref. 7, 495-509 (2017). <https://doi.org/10.1007/s13399-017-0248-8>

# Materials and Methods



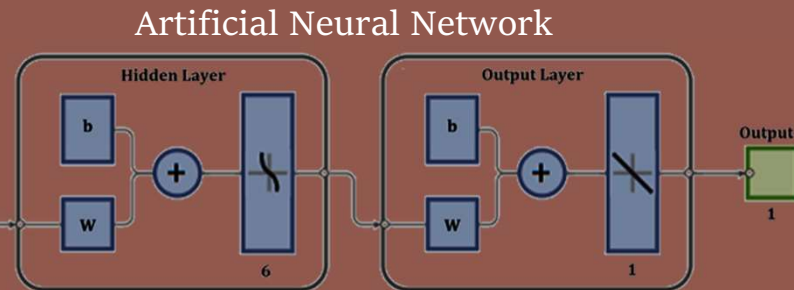
HPLC data

Extraction efficiency

$$EF(\%) = \frac{((0.9 \times H) + (0.88 \times P)) \times V_s}{W \times \%HE_i} \times 100$$

- H and P = the concentrations of hexoses and pentoses present in the hydrolysate
- V<sub>s</sub> = the working volume (liters).
- W is the initial weight of the SCG
- HE(%) = % of the hemicellulose present in the SCG free from extractives.

KDO input



- Resilient Backpropagation (RProp);
- Training (70%), validation (15%), and testing (15%) sets of the total data

### Slide 3

---

#### KDO

Aqui tem que definir cada item que tem na equação, assim não esquece na hora da apresentação.

Kelly Dussán Medina; 2024-05-10T18:10:45.688

# Results and Discussion

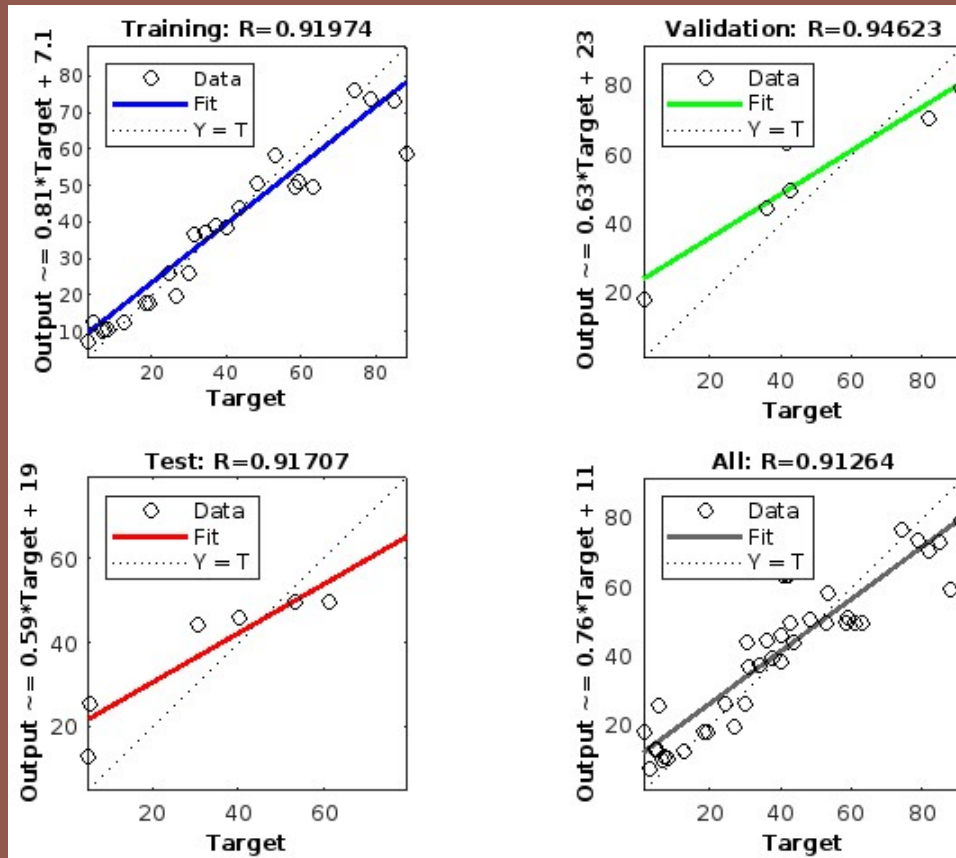
Components	Composition % (w/w)
Hemicellulose	37.10 ± 1.63
Total Lignin	24.31 ± 3.39
Cellulose	11.19 ± 0.37
Acetil groups	Not Detected
Cinzas	1.43 ± 0.01
Extractives	25.96 ± 1.66

Hemicellulose is the most abundant fraction in the spent coffee grounds

Dilute acid less than 2.0 % enhanced the hemicellulose extraction.

Assay	Temperature (°C)	Solid/liquid ratio (g/mL)	Reaction Time (min)	H <sub>2</sub> SO <sub>4</sub> (% v/v)	Hemicellulose Extraction Efficiency (% w/w)
8	140	1/22.0	70	0.0	1.23
12	165	1/40.0	20	1.0	91.44
21	165	1/40.0	70	2.0	84.86
38	155	1/11.0	80	1.0	88.30

# Results and Discussion



- $R^2$  values for training, validation, testing, and total data sets were 0.92, 0.95, 0.92, and 0.91, respectively.
- The best performance was achieved in epoch 40 of 46 times.
- $R^2$  values between training and validation sets are close together, this suggests that the developed model is reliable and able to predict the extraction efficiency satisfactorily.



## Conclusion

- High regression values indicate the adequacy of the ANN model developed to predict the Hemicellulose Extraction Efficiency;
- Dilute acid at 1 % (v/v) enhanced the extraction of the hemicellulose portion, however concentrations above that cause the degradation of the sugars into undesired compounds.

## Acknowledgements

This work was supported by São Paulo Research Foundation-FAPESP, grants n° 2022/03000-0, n° 2023/01752-8 and n° 2022/11905-3 and by Coordination of Superior Level Staff Improvement-CAPES.



Thank you

unesp 

IPBEN   
Instituto de Pesquisa  
em Bioenergia

