











- methane yields: Investigation of the degradation kinetics of structural compounds during anaerobic digestion. *Bioresour Technol* 179: 299–305. <https://doi.org/10.1016/j.biortech.2014.12.008>
- [16] Kratky L, Jirout T. (2015). The effect of process parameters during the thermal-expansionary pretreatment of wheat straw on hydrolysate quality and on biogas yield. *Renew Energ.* 77: 250-258. <https://doi.org/10.1016/j.renene.2014.12.026>
- [17] Jackowiak D, Bassard D, Pauss A, Ribeiro T. (2011). Optimisation of a microwave pretreatment of wheat straw for methane production. *Bioresour Technol* 102: 6750-6756. <https://doi.org/10.1016/j.biortech.2011.03.107>
- [18] Peng X, Aragao Börne R, Achu Nges I, Liu J. Impact of bioaugmentation on biochemical methane potential for wheat straw with addition of *Clostridium cellulolyticum*. *Bioresour Technol* 152: 567–571. <https://doi.org/10.1016/j.biortech.2013.11.067>
- [19] Shell DJ, Hardwood C. (1994). Milling of lignocellulosic biomass: Results of pilot-scale testing. *Appl Biochem Biotechnol* 45-46: 1159-1168. <https://doi.org/10.1007/BF02941795>
- [20] Koullas DP, Christakopoulos P, Kekos D, Macris BJ, Koukios EJ. (1992). Correlating the effect of pretreatment on the enzymatic hydrolysis of straw. *Biotechnol Bioeng* 39(1): 113–116. <https://doi.org/10.1002/bit.260390116>
- [21] Kratky L, Jirout T. (2011). Biomass size reduction machines for enhancing biogas production. *Chem Eng. Technol* 34(3): 391-399. <https://doi.org/10.1002/ceat.201000357>
- [22] Sharma SK, Mishra IM, Sharma MP, Saini JS. (1988). Effect of particle size on biogas generation from biomass residues. *Biomass* 17: 251–263. [https://doi.org/10.1016/0144-4565\(88\)90107-2](https://doi.org/10.1016/0144-4565(88)90107-2)
- [23] Dumas C, Ghizzi Damasceno GS, Barakat A, Carrère H, Steyera JP, Rouau X. (2015). Effects of grinding processes on anaerobic digestion of wheat straw. *Industrial Crops and Products* 74: 450–456. <https://doi.org/10.1016/j.indcrop.2015.03.043>
- [24] Menardo S, Airoldi G, Balsari P. (2012). The effect of particle size and thermal pre-treatment on the methane yield of four agricultural by-products. *Bioresour Technol* 104: 708–714. <https://doi.org/10.1016/j.biortech.2011.10.061>
- [25] Adapa P, Tabil L, Schoenau G. (2011). Grinding performance and physical properties of non-treated and steam exploded barley, canola, oat and wheat straw. *Biomass Bioenerg* 35: 549-561. <https://doi.org/10.1016/j.biombioe.2010.10.004>
- [26] Mani S, Tabila LG, Sokhansanj S. (2004). Grinding performance and physical properties of wheat and barley straws, corn stover and switchgrass. *Biomass Bioenerg* 27: 339–352. <https://doi.org/10.1016/j.biombioe.2004.03.007>
- [27] Bitra VSP, Womac AR, Chevanan N, Miu PI, Igathinathane C, Sokhansanj S, Smith DR. (2009). Direct mechanical energy measures of hammer mill comminution of switchgrass, wheat straw, and corn stover and analysis of their particle size distributions. *Powder Technol* 193: 32–45. <https://doi.org/10.1016/j.powtec.2009.02.010>
- [28] Manola U. (2016). Biomass crushing and separating device. U.S. Patent 9,266,113, Feb. 23, 2016.
- [29] (1998). Standard methods for the examination of water and wastewater. 20th ed., APHA (American Public Health Association), Washington, DC.
- [30] Van Soest PJ, Robertson JB, Lewis BA. (1991). Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. *J Dairy Sci* 74: 3583–3597. [https://doi.org/10.3168/jds.S0022-0302\(91\)78551-2](https://doi.org/10.3168/jds.S0022-0302(91)78551-2)
- [31] (2006). Official methods of analysis, 18th ed., AOAC (Association of Official Analytical Chemists), Gaithersburg, MD.
- [32] St. Joseph. (2006). ANSI/ASABE S319.3: Method of determining and expressing fineness of feed materials by sieving. ASABE (American Society of Agricultural and Biological Engineers). In: ASABE Standards 602.
- [33] (2014). Piano d’Azione Italiano per l’Efficienza Energetica, ENEA (Agenzia nazionale per le nuove tecnologie, l’energia e lo sviluppo economico sostenibile), Rome, IT. Available: [https://ec.europa.eu/energy/sites/ener/files/documents/2014\\_neeap\\_it\\_italy.pdf](https://ec.europa.eu/energy/sites/ener/files/documents/2014_neeap_it_italy.pdf); 2014.
- [34] Kratky L, Jirout T. (2013). The effect of mechanical disintegration on the biodegradability of wheat straw. *Inż Ap Chem* 52(3): 202-203.
- [35] Menardo S, Cacciatore V, Balsari P. (2015). Batch and continuous biogas production arising from feed varying in rice straw volumes following pre-treatment with extrusion. *Bioresour Technol* 180: 154-161. <https://doi.org/10.1016/j.biortech.2014.12.104>

## NOMENCLATURE

ADF	Acid detergent fiber
ADL	acid detergent lignin
CH <sub>4</sub>	methane
CP	crude protein
CHP	combined heat and power
d <sub>50</sub>	median particle size, μm
EE	ether extract
kWh	kilowatt hour
NDF	neutral detergent fiber
Nm <sup>3</sup>	cubic meters at normal conditions
TS	total solids
VS	volatile solids