



REFERENCES

- Álvarez, C., González, A., Negro, M.J., Ballesteros, I., Oliva, J.M., and Sáez, F. 2017. Optimized use of hemicellulose within a biorefinery for processing high value-added xylooligosaccharides. *Ind. Crop. Prod.* 99: 41–48.
- Aachary, A.A. and Prapulla, S.G. 2008. Corncob-induced endo-1,4- β -D-xylanase of *Aspergillus oryzae* MTCC 5154: production and characterization of xylobiose from glucuronoxylan. *J. Agric. Food. Chem.* 56 (11): 3981–3988.
- Aachary, A.A. and Prapulla, S.G. 2009. Value addition to corncob: production and characterization of xylooligosaccharides from alkali pretreated lignin-saccharide complex using *Aspergillus oryzae* MTCC 5154. *Biores. Technol.* 100 (2): 991–995.
- Aachary, A.A. and Prapulla, S.G. 2011. Xylooligosaccharides (XOS) as an emerging prebiotics: microbial synthesis, utilization, structural characterization, bioactive properties, and applications: review. *Compr. Rev. Food Sci. Food Safety* 10: 1–15.
- Adhyaru, D.N., Bhatt, N.S., Modi, H.A., and Divecha, J. 2016. Insight on xylanase from *Aspergillus tubingensis* FDHN1: Production, high yielding recovery optimization through statistical approach and application. *Biocatal. Agri. Biotechnol.* 6: 51–57.
- Abdel-Sater, M.A. and El-Said, A.H.M. 2001. Xylan-decomposing fungi and xylanolytic activity in agricultural and industrial wastes. *Int. Biodeterior. Biodegradation* 47: 15–21.
- Ai, Z., Jiang, Z., Li, L., Deng, W., Kusakabe, I., and Li, H. 2005. Immobilization of *Streptomyces olivaceoviridis* E-86 xylanase on Eudragit S-100 for xylooligosaccharide production. *Proc. Biochem.* 40: 2707–2714.
- Ajjolakewu, K.A., Leh, C.P., Abdullah, W.N.W., and Lee, C.K. 2016. Assessment of the effect of easily-metabolised carbon supplements on xylanase production by newly isolated *Trichoderma asperellum* USM SD4 cultivated on oil palm empty fruit bunches. *BioResour.* 11 (4): 9611–9627.
- Akpınar, O., Erdogan, K., and Bostancı, S. 2009. Enzymatic production of xylooligosaccharide from selected agricultural wastes. *Food Bioprod. Process.* 87: 145–151.



- Akpinar, O., Erdogan, K., Bakir, U., and Yilmaz, L. 2010. Comparison of acid and enzymatic hydrolysis of tobacco stalk xylan for preparation of xylooligosaccharides. *LWT Food Sci. Technol.* 43: 119–125
- Alconada, T.M. and Martinez, M.J. 1994. Purification and characterization of an extracellular endo-1,4-beta-xylanase from *Fusarium oxysporum* f. sp. *melonis*. *FEMS Microbiol Lett.* 118 (3): 305–310.
- Alexandratos, S.D. 2009. Ion-exchange resins: a retrospective from industrial and engineering chemistry search. *Ind. Eng. Chem. Res.* 48: 388–398.
- Alvira, P., Tomas-Pejo, E., Ballesteros, M., and Negro, M.J. 2010. Pretreatment technologies for an efficient bioethanol production process based on enzymatic hydrolysis: a review. *Bioresour. Technol.* 101: 4851–4861.
- Anonim. 2018. Produksi Jagung Menurut Provinsi, 2014-2018*) (internet), <https://www.pertanian.go.id/> (accessed 8 April 2019).
- Antoine, A.A., Jacqueline, D., and Thonart, P. 2010. Xylanase production by *Penicillium canescens* on soya oil cake in solid-state fermentation. *Appl Biochem. Biotechnol.* 160: 50–62.
- Aziz, R., Suswati, and Indrawati, A. 2015. Briket limbah jagung sebagai sumber energi alternatif ramah lingkungan di Desa Simolap Kecamatan Tigabinaga Kabupaten Tanah Karo. *ABDIMAS* 19 (2): 109-114.
- Bailey, M.J. and Poutanen, K. 1989. Production of xylanolytic enzymes by strains *Aspergillus*. *Appl. Microbiol. Biotechnol.* 30: 5–10.
- Bakri, Y., Jawhar, M., and Arabi, M.I.E. 2008. Improvement of xylanase production by *Cochliobolus sativus* in solid state fermentation. *Braz. J. Microbiol.* 39: 602–604.
- Bao, Z., Duan, S., Zhang, Z., Xing, H., Su, B., Yang, Q., Yang, Y., and Ren, Q. 2016. Adsorption separation of raffinose from sucrose by activated carbon: Equilibrium, kinetics and dynamic breakthrough. *Separation Sci. Technol.* 51(10): 1636-1644.
- Barbat, A., Gloaguen, V., Moine, C., Sainte-Catherine, O., Kraemer, M., Rogniaux, H., Ropartz, D., and Krausz, P. 2008. Structural characterization and cytotoxic properties of a 4-O-methylglucuronoxylan from *Castanea sativa*. 2. Evidence of a structure – activity relationship. *J. Nat. Prod.* 71: 1404–1409.



- Beg, Q.K., Kapoor, M., Mahajan, L., and Hoondal, G.S. 2001. Microbial xylanases and their industrial applications: a review. *Appl. Microbiol. Biotechnol.* 56: 326–338.
- Benoliel, B., Torres, F.A.G., and de Moraes, L.M.P. 2013. A novel promising *Trichoderma harzianum* strain for the production of a cellulolytic complex using sugarcane bagasse in natura. *Springerplus* 2: 656.
- Bhargav, S., Panda, B.P., Ali, M., and Javed, S. 2008. Solid-state fermentation: an overview. *Chem. Biochem. Eng. Q.* 22 (1): 49–70.
- Biely, P. 1985. Microbial xylanolytic systems. *Trends in Biotechnol.* 3: 286–290.
- Biely, P., Vršanská, M., Tenkanen, M., and Kluepfel, D. 1997. Endo- β -1,4-xylanase families: differences in catalytic proprieties. *J. Biotechnol.* 57: 151–166.
- Bilgrami, K.S. and Pandey, A.K. 1992. In: Jain, E.S.K (Ed.), Industry and fermentation in introduction to biotechnology. pp. 149-165.
- Boonchuay, P., Techapun, C., Seesuriyachan, P., and Chaiyaso, T. 2014. Production of xylooligosaccharides from corncob using a crude thermostable endo-xylanase from *Streptomyces thermovulgaris* TISTR1948 and prebiotic properties. *Food Sci. Biotechnol.* 23(5): 1515-1523
- Bornet, F.R.J., Brouns, F., Tashiro, Y., and Ouvillier, V. 2002. Nutritional aspects of short chain fructooligosaccharides: Natural occurrence, chemistry, physiology and health implications. *Dig. Liver Dis.* 34 (Suppl.2): S111–S120.
- Bradford, M.M. 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein dye-binding. *Anal. Biochem.* 72: 248-254.
- Bruschke H. 1995, Industrial application of membrane separation processes. *Pure Appl. Chem.* 67: 993-1002.
- Brethauer, S. and Wyman, C.E. 2010. Review: continuous hydrolysis and fermentation for cellulosic ethanol production. *Bioresour. Technol.* 101: 4862–4874.
- Capek, K. and Stanek, J., Jr. 1975. Carbohydrates. In: Deyl, Z., Macek, K., Janak, J., (eds). *Liquid Column Chromatography*. pp. 465–522.
- Carvalho, A.F.A., Neto, P.O., Silva, D.F., and Pastore, G.M. 2013. Xylooligosaccharides from lignocellulosic materials: chemical structure,



- health benefits and production by chemical and enzymatic hydrolysis. *Food Res. Int.* 51: 75–85.
- Chapla, D., Divecha, J., Madamwar, D., and Shah, A. 2010. Utilization of agro-industrial waste for xylanase production by *Aspergillus foetidus* MTCC 4898 under solid state fermentation and its application in saccharification. *Biochem. Engineer. J.* 49: 361–369.
- Chapla, D., Pandit, P., and Shah, A. 2012. Production of xylooligosaccharides from corncob xylan by fungal xylanase and their utilization by probiotics. *Bioresour. Technol.* 115: 215–221.
- Chinn, D. and King, C.J. 1999 Adsorption of glycols, sugars, and related multiple-OH compounds onto activated carbons. 2. Solvent regeneration. *Ind. Eng. Chem. Res.* 38: 3746–3753.
- Chithra, M. and Gudipati, M. 2010. Bioactive xylo-oligosaccharides from wheat bran soluble polysaccharides. *Food Sci. Technol.* 43: 421–430.
- Christakopoulos, P., Nerinckx, W., Kekos, D., Macris, B., and Claeysens, M. 1996. Purification and characterization of two low molecular mass alkaline xylanases from *Fusarium oxysporum* F3. *J. Biotechnol.* 51(2):181–189.
- Christakopoulos, P., Nerinckx, W., Kekos, D., Macris, B., and Claeysens, M. 1997. The alkaline xylanase III from *Fusarium oxysporum* F3 belongs to family F/10. *Carbohydr. Res.* 302(3–4): 191–195.
- Christopher, L., Bissoon, S. S., Singh, S., Szendefy, J., and Szakacs, G. 2005. Bleach-enhancing abilities of *Thermomyces lanuginosus* xylanases produced by solid state fermentation. *Process Biochem.* 40: 3230–3235.
- Chugh, P., Soni, R., and Soni, S. K. 2016. Deoiled rice bran: A substrate for coproduction of a consortium of hydrolytic enzymes by *Aspergillus niger* P-19. *Waste Biomass Valor.* 7(3): 513–525.
- Cipriani, T.R., Mellinger, C.G., deSouza, L.M., Baggio, C.H., Freitas, C.S., Marquez, M.C.A., Gorin, P.A.J., Sasaki, G.L., and Iacomini, M. 2008. Acidic heteroxylans from medicinal plants and their anti ulcer activity. *Carbohydr. Polym.* 74: 274–278.
- Collins, T., Gerday, C., and Feller, G. 2005. Xylanases, xylanase families and extremophilic xylanases. *FEMS Microbiol. Rev.* 29: 3–23.
- Courtin, C.M., Swennen, K., Verjans, P., and Delcour, J.A. 2009. Heat and pH stability of prebiotic arabinoxylooligosaccharides, xylooligosaccharides and fructooligosaccharides. *Food Chem.* 112: 831–837.



- Das, A. and Ray, L. 2016. Production of crude xylanase using an isolated fungal strain *Aspergillus* sp. S6 by solid state fermentation. *Proceedings: International Conference on Advances in Bioprocess Engineering and Technology 2016 (ICABET 2016)* 3 (10): 3343–3360.
- Duan, J. and Gregory, J. 2003 Coagulation by hydrolysing metal salts. *Adv. Colloid Interface Sci.* 100–102: 475–502.
- Dwivedi, P., Vivekanand, V., Ganguly, R., and Singh, R. P. 2009. *Parthenium* sp. as a plant biomass for the production of alkalitolerant xylanase from mutant *Penicillium oxalicum* SAU E -3.510 in submerged fermentation. *Biomass Bioenergy* 33 (4): 581-588.
- Ebringerová, A. and Heinze, T. 2000. Xylan and xylan derivatives-biopolymers with valuable properties, 1. Naturally occurring xylans structures, isolation procedures and properties. *Macromol. Rapid Commun.* 21 (9): 542–556.
- Ebringerova, A., Hromadkova, Z., Malovikova, A., and Hribalova, V. 2002. Immunomodulatory activity of acidic xylans in relation to their structural and molecular properties. *Int. J. Biol. Macromol.* 30: 1–6.
- Edzwald, J. K. 1993 Coagulation in drinking water treatment: particles, organics and coagulants. *Water Sci. Technol.* 27(11): 21–35.
- Fang, T.J., Liao, B.C., and Lee, S.C. 2010. Enhanced production of xylanase by *Aspergillus carneus* M34 in solid-state fermentation with agricultural waste using statistical approach. *New Biotechnol.* 27 (1): 25–32.
- Fontes, C.M., Gilbert, H.J., Hazlewood, G.P., Clarke, J.H., Prates, J.A., McKie, V.A., Nagy, T., Fernandes, T.H., and Ferreira, L.M. 2000. A novel *Cellvibrio mixtus* family 10 xylanase that is both intracellular and expressed under noninducing conditions. *Microbiol.* 146 (Pt 8): 1959–1967.
- Gómez-Gómez, E., Roncero, I., Di Pietro, A., and Hera, C. 2001. Molecular characterization of a novel endo- β -1,4-xylanase gene from the vascular wilt fungus *Fusarium oxysporum*. *Curr. Genet.* 40 (4): 268–275.
- Gómez-Gómez, E., Ruíz-Roldán, M.C., Di Pietro, A., Roncero, M.I.G., and Hera, C. 2002. Role in pathogenesis of two endo- β -1,4-xylanase genes from the vascular wilt fungus *Fusarium oxysporum*. *Fungal Genet. Biol.* 35 (3): 213–222.
- Gómez, S., Payne, A.M., Savko, M., Fox, G.C., Shepard, W.E., Fernandez, F.J., and Vega, M.C. 2016. Structural and functional characterization of a highly stable endo- β -1,4-xylanase from *Fusarium oxysporum* and its development as an efficient immobilized biocatalyst. *Biotechnol. Biofuels* 9:191.



- Garrote, G., Domínguez, H., and Parajó, J.C. 2002. Autohydrolysis of corncob: study of nonisothermal operation for xylooligosaccharide production. *J. Food Engineer.* 52: 211-218.
- Gervais, P. and Molin, P. 2003. The role of water in solid-state fermentation. *Biochem. Eng. J.* 13 (2): 85–101.
- Gokhale, D.V., Patil, S.G., and Bastawde, K.B. 1998. Potential application of yeast cellulase free xylanase in agrowaste material treatment to remove hemicellulose fractions. *Bioresour. Technol.* 63: 187–191.
- Gupta, V.K., Gaur, R., Gautam, N., Kumar, P., Yadav, I.J., and Darmwal, N.S. 2009. Optimization of xylanase production from *Fusarium solani* F7. *American J. Food Technol.* 4: 20-29.
- Ho, H.L. and Lau, L.Y. 2014. Bioprocessing of agricultural wastes as optimised carbon source and optimisation of growth conditions for xylanase production by *Aspergillus brasiliensis* in agitated solid state fermentation (ssf). *J. Biodivers. Biopros. Dev.* 1 (3): 125
- Ho, H.L. and Sali, S.A. 2014. Bioprocessing of agricultural residuals for the optimum production of extracellular xylanase by *Aspergillus brasiliensis* in solid state fermentation (SsF). *J. Biodivers. Biopros. Dev.* 1(2): 121.
- Hsu, C.K., Liao, J.W., Chung, Y.C., Hsieh, C.P., and Chan, Y.C. 2004. Xylooligosaccharides and fructooligosaccharides affect the intestinal microbiota and precancerous colonic lesion development in rats. *J. Nutrition* 134: 1523–1528.
- Jaroszuk-Scisel, J. and Kurek, E. 2012. Hydrolysis of fungal and plant cell walls by enzymatic complexes from cultures of *Fusarium* isolates with different aggressiveness to rye (*Secale cereale*). *Arch Microbiol.* 194 (8): 653–665.
- Jiang, S.X., Zhao, S., Lu, C.Y., Xue, J.L., Duan, C.J., and Feng, J.X. 2017. A combined process is used for efficient isolation and purification of xylobiose from xylanase-hydrolysed sugarcane bagasse xylan hydrolysate. *Ind. Crops Prod.* 109: 637–643.
- Jing, L. and Chase, H.A. 2010. Applications of membrane techniques for purification of natural products. *Biotechnol. Letters, Springer Verlag* 32 (5): 601-608.
- Jorge, I., de la Rosa, O., Navas-Cortes, J.A., Jimenez-Diaz, R.M., and Tena, M. 2005. Extracellular xylanases from two pathogenic races of *Fusarium oxysporum* f. sp. *ciceris*: enzyme production in culture and purification and



- characterization of a major isoform as an alkaline endo-beta-(1,4)-xylanase of low molecular weight. *Antonie Van Leeuwenhoek* 88(1): 48–59.
- Juturu, V. and Wu, J.C. 2012. Microbial xylanases: engineering, production and industrial applications. *Biotechnol. Advances* 30: 1219-1227.
- Kanimozhi, K. and Nagalakshmi, P.K. 2014. Xylanase production from *Aspergillus niger* by solid state fermentation using agricultural waste as substrate. *Int. J. Curr. Microbiol. App. Sci* 3(3): 437-446.
- Kar, S., Mandal, A., das Mohapatra, P.K., Mondal, K.C. and Pati, B.K. 2006. Production of cellulose-free xylanase by *Trichoderma reesei* SAF3. *Braz. J. Microbiol.* 37:462-464.
- Katrivesis, F. K., Karela, A. D., Papadakis, V. G., and Paraskeva, C. A. 2019. Revisiting of coagulation-flocculation processes in the production of potable water. *J. Water Process Engineer.* 27: 193-204.
- Kiran, E.U., Akpınar, O., and Bakir, U. 2013. Improvement of enzymatic xylooligosaccharides production by the co-utilization of xylans from different origins. *Food Bioprod. Process.* 91: 565–574.
- Kocabas, D.S. and Ozben, N. 2014. Co-production of xylanase and xylooligosaccharides from lignocellulosic agricultural wastes. *RSC Adv* 4: 26129–26139.
- Kocabas, D.S., Güderb, S., and Özben, N. 2015. Purification strategies and properties of a low-molecular weight xylanase and its application in agricultural waste biomass hydrolysis. *J. Mol. Cat. B: Enzymatic* 115: 66–75.
- Knob, A. and Carmona, E.C. 2008. Xylanase production by *Penicillium sclerotiorum* and its characterization. *World Appl. Sci. J.* 4(2):277–283.
- Kulkarni, N., Shendye, A., and Rao, M. 1999. Molecular and biotechnological aspects of xylanases. *FEMS Microbiol. Rev.* 23: 411–456.
- Kulkarni, P. and Gupta, N. 2013. Screening and evaluation of soil fungal isolates for xylanase production. *Rec. Res. Sci. Technol.* 5: 33–36.
- Kumar, V. and Satyanarayana, T. 2011. Applicability of thermo-alkali-stable and cellulase-free xylanase from a novel thermo-haloalkaliphilic *Bacillus halodurans* TSEV1 in producing xylooligosaccharides. *Biotechnol. Lett.* 33: 2279-2285.
- Kumar, G.P., Pushpa, A., and Prabha, H. 2012. A review on xylooligosaccharides. *Int. Res. J. Pharm.* 3: 71–74.



- Kwon, H.W., Yoon, J.H., Kim, S.H., Hong, S.B., Cheon, Y., and Ko, S.J. 2007. Detection of extracellular enzymes activities in various *Fusarium spp.* *Mycobiol.* 35(3): 162–165.
- Lai, T.T., Pham, T.T.H., Adjallé, K., Brouillette, F., and Barnabé, S. 2015. Strategies for using pulp and paper sludges as culture media for xylanase production with *Bacillus pumilus*. *Waste Biomass Valor.* 6(6): 1103-1113.
- Lakshmi, G.S., Rao, C.S., Rao, R.S., Hobbs, P.J., and Prakasham, R.S. 2009. Enhanced production of xylanase by a newly isolated *Aspergillus terreus* under solid state fermentation using palm industrial waste: A statistical optimization. *J. Biochem. Engineer.* 48: 51–57.
- Lakshmi, G.S., Suvarna, G., and Prakasham, P. L. 2011. Sustainable bioprocess evaluation for xylanase production by isolated *Aspergillus terreus* and *Aspergillus fumigatus* under solid-state fermentation using oil palm empty fruit bunch fiber. *Curr. Trends Biotechnol. Pharm.* 5(4): 1434–1444.
- Li, Y., Qi, B.K., Luo, J.Q., and Wan, Y.H. 2016. Effect of alkali lignins with different molecular weights from alkali pretreated rice straw hydrolyzate on enzymatic hydrolysis. *Bioresour. Technol.* 200: 272–278.
- Liu, K.X., Li, H.Q., Zhang, J., Zhang, Z.G., and Xu, J. 2016. The effect of non-structural components and lignin on hemicellulose extraction. *Bioresour. Technol.* 214: 755–760.
- Manisseri, C. and Gudipati, M. 2012. Prebiotic activity of purified xylobiose obtained from ragi (*Eleusine coracana*, Indaf-15) bran. *Indian J. Microbiol.* 52: 251–257.
- Mardawati, E., Kresnowati, M.T.A.P, Purwadi, R., Bindar, Y., and Setiadi, T. 2018. Fungal Production of xylanase from oil palm empty fruit bunches via solid state cultivation. *Int. J. Adv. Sci. Eng. Inf. Technol.* 8 (6): 2539-2546.
- Mazeau, K. and Wyszomirski, M. 2012. Modelling of Congo red adsorption on the hydrophobic surface of cellulose using molecular dynamics. *Cellulose* 19 (5): 1495-1506.
- Mäkeläinen, H., Juntunen, M., and Hasselwander, O. 2009. Prebiotic potential of xylo-oligosaccharides. In: Charalampopoulos, D., Rastall, R.A. (Eds.). *Prebiotics and Probiotics Science and Technology*. New York: Springer. pp. 245–258.
- Moura, A., Gullon, P., Deminguez, H., and Parajo, J.C. 2006. Advances in the manufacture, purification and application of xylooligosaccharides as food additives and nutraceuticals. *Proc. Biochem.* 41: 1913–1923.



- Moura, P., Barata, R., Carvalheiro, F., Gírio, F., Loureiro-Dias, M.C., and Esteves, M.P. 2007. In vitro fermentation of xylooligosaccharides from corncobs autohydrolysis by *Bifidobacterium* and *Lactobacillus* strains. *LWT – Food Sci. Technol.* 40:963–972.
- Moure, A., Gullo'n, P., Domínguez, H., and Parajó, J.C. 2006. Advances in the manufacture, purification and applications of xylo-oligosaccharides as food additives and nutraceuticals. *Process Biochem.* 41: 1913–1923.
- Nelson, N. 1944. A photometric adaptation of the Somogyi method for the determination of glucose. *J. Biol. Chem.* 153: 375–380.
- Okazaki, M., Fujikawa, S., and Matsumoto, N. 1990. Effect of xylooligosaccharide on growth of *Bifidobacterium*. *J. Jpn. Soc. Nutr. Food Sci.* 43: 395–401.
- Okeke, B.C. and Obi, S.K.C. 1995. Saccharification of agrowaste materials by fungal cellulases and hemicellulases. *Bioresour. Technol.* 51: 23–27.
- Okeke, B.C. 2014. Cellulolytic and xylanolytic potential of high β -glucosidase producing *Trichoderma* from decaying biomass. *Appl. Biochem. Biotechnol.* 174: 1581–1598.
- Okeke, B.C., Hall, R.W., Nanjundaswamy, A., Thomson, M.S., Deravi, Y., Sawyer, L., and Prescott, A. 2015. Selection and molecular characterization of cellulolytic–xylanolytic fungi from surface soil-biomass mixtures from Black Belt. *Microbiol. Res.* 175: 24–33.
- Panagiotou, G., Kekos, D., Macris, B.J., and Christakopoulos, P. 2003. Production of cellulolytic and xylanolytic enzymes by *Fusarium oxysporum* grown on corn stover in solid state fermentation. *Ind. Crop. Prod.* 18: 37-45.
- Pandey A., Soccol, C.R., and Mitchell, D. 2000. New development in solid state fermentation: I—bioprocesses and products. *Process Biochem.* 35: 1153–1169.
- Pang, P.K. and Che-Omar, I. 2005. Xylanase production by local fungal isolate *Aspergillus niger* USMA11 via solid state fermentation using palm kernel cake (PKC) as substrate. *Songklanarin J. Sci. Technol.* 27(1):325–336.
- Parajó, J.C., Garrote, G., Cruz, J.M., and Dominguez, H. 2004. Production of xylooligosaccharides by autohydrolysis of lignocellulosic materials. *Trends Food Sci. Technol.* 15: 115–120.
- Patel, S. and Goyal, A. 2011. Functional oligosaccharides Production, properties and applications. *World J. Microbiol. Biotechnol.* 27: 1119–1128.



- Pathak, P., Bhardwaj, N.K., and Singh, A.K. 2014. Production of crude cellulase and xylanase from *Trichoderma harzianum* PPDDN10 NFCCI-2925 and its application in photocopier waste paper recycling. *Appl. Biochem. Biotechnol.* 172 (8): 3776–3797.
- Peng, F., Ren, J.L., Xu, F., Bian, J., Peng, P., and Sun, R.C. 2009. Comparative study of hemicelluloses obtained by graded ethanol precipitation from sugarcane bagasse. *J. Agric. Food Chem.* 57: 6305–6317.
- Polizeli, M.L.T.M., Rizzatti, A.C.S., Monti, R., Terenzi, H.F., Jorge, J.A., and Amorim, D.S. 2005. Xylanases from fungi: properties and industrial applications. *Appl. Microbiol. Biotechnol.* 67: 577–591.
- Prade, R.A. 1995. Xylanases: from biology to biotechnology. *Biotech. Genet. Eng. Rev.* 13: 100–131.
- Rajagopalan, G., Shanmugavelu, K., and Yang, K.L. 2017. Production of prebiotic-xylooligosaccharides from alkali pretreated mahogany and mango wood sawdust by using purified xylanase of *Clostridium* strain BOH3. *Carbohydr. Polym.* 167: 158–166.
- Ramanjaneyulu, G. and Reddy, B.R. 2016. Optimization of xylanase production through response surface methodology by *Fusarium sp.* BVKT R2 isolated from forest soil and its application in saccharification. *Front Microbiol.* 7: 1450.
- Richana, N. 2002. Produksi dan prospek enzim xilanase dalam pengembangan bioindustri di Indonesia. *Buletin AgroBio* 5(1): 29-36.
- Rohaeni, E.S., Amali, N., Darmawan, A., Subhan, A., and Sumanto. 2005. Potensi dan prospek penggunaan limbah jagung sebagai pakan ternak sapi di lahan kering Kabupaten Tanah Laut, Kalimantan Selatan. Lokakarya Nasional Tanaman Pakan Ternak. Jakarta.
- Romanowska, I., Polak, J., and Bielecki, S. 2006. Isolation and properties of *Aspergillus niger* IBT-90 xylanase for bakery. *App. Microbiol. Biotechnol.* 69: 665–671.
- Roosheroe, I.G., Sjamsuridzal, W., and Oetari, A. 2014. *Mikologi Dasar dan Terapan (Edisi ke-2)*. Indonesia: Yayasan Obor Indonesia.
- Rycroft, C.E., Jones, M.R., Gibson, G.R., and Rastall, R.A. 2001. A comparative in vitro evaluation of the fermentation properties of prebiotic oligosaccharides. *J. Appl. Microbiol.* 91: 878–887.



- Saha, B.C. 2003. Hemicelluloses bioconversion. *J. Ind. Microbiol. Biotechnol.* 30: 279–291.
- Samanta, A.K., Jayapal, N., Kolte, A.P., Senani, S., Sridhar, M., Suresh, K.P., and Sampath, K.T. 2012. Enzymatic production of xylooligosaccharides from alkali solubilized xylan of natural grass (*Sehima nervosum*). *Bioresour. Technol.* 112: 199–205.
- Samanta, A.K., Jayapal, N., Kolte, A.P., Senani, S., Sridhar, M., Mishra, S., Prasad, C.S., and Suresh, K.P. 2013. Application of pigeon pea (*Cajanus cajan*) stalks as raw material for xylooligosaccharides production. *Appl. Biochem. Biotechnol.* 169: 2392–2404.
- Samanta, A.K., Jayapal, N., Jayaram, C., Roy, S., Kolte, A.P., Senani, S., and Sridhar, M. 2015. Xylooligosaccharides as prebiotics from agricultural by-products: Production and applications. *Bioact. Carbohydr. Diet. Fibre* 5: 62–71.
- Sanz, M.L., Polemis, N., Morales, V., Corzo, N., Drakoularakou, A., Gibson, G.R., and Rastall, R.A. 2005. In vitro investigation into the potential prebiotic activity of honey oligosaccharides. *J. Agric. Food Chem.* 53: 2914–2921.
- Sharma, M., Chadha, B.S., and Saini, H.S. 2010. Purification and characterization of two thermostable xylanases from *Malbranchea flava* active under alkaline conditions. *Bioresour. Technol.* 101: 8834–8842.
- Shenef, A., El-Tanash, A., and Atia, N. 2010. Cellulase production by *Aspergillus fumigatus* grown on mixed substrate of rice straw and wheat bran. *Res. J. Microbiol.* 5 (3): 199–211.
- Singh, S., Madlala, A.M., and Prior, B.A. 2003. *Thermomyces lanuginosus*: properties of strains and their hemicellulases. *FEMS Microbiol. Rev.* 27: 3–16.
- Singh, R.D., Banerjee, J., Sasmal, S., Muir, J., and Arora, A. 2018. High xylan recovery using two stage alkali pre-treatment process from high lignin biomass and its valorisation to xylooligosaccharides of low degree of polymerization. *Bioresour. Technol.* 256: 110–117.
- Singhania, R.R., Patel, A.K., Soccol, C.R., and Pandeya, A. 2009. Recent advances in solid-state fermentation. *Biochem. Eng. J.* 44: 13–18.
- Sluiter, A., Hames, B., Ruiz, R., Scarlata, C., Sluiter, J., Templeton, D., and Crocker, D. 2008. *Determination of Structural Carbohydrates and Lignin in Biomass: Laboratory Analytical Procedure (LAP)*. NREL, Golden CO. NREL/TP-510-42618. (Revised July 2011).



- Somogyi, M., 1952. Notes on sugar determination. *J. Biol. Chem.* 195: 19–23.
- Sukara, E. and Tobing, I.S.L 2008. Industri berbasis keanekaragaman hayati, masa depan Indonesia. *Vis Vitalis* 1(2): 1-12.
- Sunna, A. and Antranikian, G. 1997. Xylanolytic enzymes from fungi and bacteria. *Crit. Rev. Biotechnol.* 17: 39–67.
- Suwa, Y., Koga, K., Fujikawa, S., Okazaki, M., Irie, T., and Nakada, T. 1999. *Bifidobacterium bifidum* proliferation promoting composition containing xylooligosaccharide. U.S Pat. 5939309.
- Taherzadeh, M.J. and Karimi, K. 2007. Acid-based hydrolysis processes for ethanol from lignocellulosic materials: a review. *Bioresour.* 2 (3): 472-499.
- Tan, S.S., Li, D.Y., Jiang, Z.Q., Zhu, Y.P., Shi, B., and Li, L.T. 2008. Production of xylobiose from the autohydrolysis explosion liquor of corn cob using *Thermotoga maritima* xylanase B (Xyn B) immobilized on nickel-chelated Eupergit C. *Bioresour. Technol.* 99: 200–204.
- Thomas, L., Larroche, C., and Pandey, A. 2013. Current developments in solid-state fermentation. *Biochem. Eng. J.* 81: 146–161.
- Tortora, G.J. 2013. *Microbiology: An Introduction*. USA: Pearson.
- Tuohy, K.M., Rouzaud, G.C.M., Brück, W.M., and Gibson, G. R. 2005. Modulation of the human gut microflora towards improved health using prebiotics — Assessment of efficacy. *Curr. Pharm. Des.* 11, 75–90.
- Uday, U.S.P, Majumdar, R., Tiwari, O.N., Mishra, U., Mondal, A., Bandyopadhyay, T.K., and Bhunia, B. 2017. Isolation, screening and characterization of a novel extracellular xylanase from *Aspergillus niger* (KP874102.1) and its application in range peel hydrolysis. *Int. J. Biol. Macromol.* 105(1): 401-409.
- Umsza-Guez, M.A., Díaz, A.B., Ory, Id, Blandino, A., Gomes, E., and Caro, I. 2011. Xylanase production by *Aspergillus awamori* under solid state fermentation conditions on tomato pomace. *Braz. J. Microbiol.* 42 (4): 1585–1597.
- Vázquez, M.J., Alonso, J.L., Domínguez, H., and Parajó, J.C. 2000. Xylooligosaccharides: manufacture and applications. *Trends Food Sci. Technol.* 11: 387–393.
- Van Craeyveld, V., Swennen, K., Dornez, E., Van de Wiele, T., Marzorati, M., Verstraete, W., Delaedt, Y., Onagbesan, O., Decuypere, E., Buyse, J., DeKetelaere, B., Broekaert, W.F., Delcour, J.A., and Courtin, C.M. 2008.



- Structurally different wheat-derived arabinoxylooligosaccharides have different prebiotic and fermentation properties in rats. *J. Nutr.* 138: 2348–2355.
- Waino, M. and Ingvorsen, K. 2003. Production of β - xylanase and β - xylosidase by the extremely halophilic archaeon *Halorhabdus utahensis*. *Extremophiles* 7:87–93.
- Walia, A., Mehta, P., Chauhan, A., and Shirkot, C.K. 2013. Optimization of cellulase-free xylanase production by alkalophilic *Cellulosimicrobium* sp. CKMX1 in solid-state fermentation of apple pomace using central composite design and response surface methodology. *Ann. Microbiol.* 63:187–198.
- Walia, A., Mehta, P., Chauhan, A., Kulshrestha, S., and Shirkot, C.K. 2014. Purification and characterization of cellulase-free low molecular weight endo β -1,4 xylanase from an alkalophilic *Cellulosimicrobium cellulans* CKMX1 isolated from mushroom compost. *World J. Microbiol. Biotechnol.* 30:2597–2608.
- Wan Azelee, N.I., Md Jahim, J., Ismail, A.F., Fuzi, S.F.Z.M, Rahman, R.A., and Md Illias, R. 2016. High xylooligosaccharides (XOS) production from pretreated kenaf stem by enzyme mixture hydrolysis. *Ind. Crop. Prod.* 81: 11–19.
- Wang, X., Zhuang, J., Fu, Y., Tian, G., Wang, Z., and Qin, M. 2015. Separation of hemicellulose-derived saccharides from wood hydrolysate by lime and ion exchange resin. *Bioresour. Technol.* 206: 225–230.
- Westbye, P., Köhnke, T., Glasser, W., and Gatenholm, P. 2007. The influence of lignin on the self-assembly behaviour of xylan rich fractions from birch (*Betula pendula*). *Cellulose* 14 (6): 603–613.
- Whistler, R.L. and Durso, D.F. 1950. Chromatographic separation of sugars on charcoal. *J. Am. Chem. Soc.* 72: 677–679.
- Wong, K.K.Y., Tan, L.U.L., and Saddler, J.N. 1988. Multiplicity of beta-1,4-xylanases in microorganisms: Functions and applications. *Microbiol. Rev.* 52: 305–317.
- Xin, F. and Gang, A. 2010. Horticultural waste as the substrate for cellulase and hemicellulase production by *Trichoderma reesei* under solid-state fermentation. *Appl. Biochem. Biotechnol.* 162: 295–306.
- Xu, Q., Chao, Y.L., and Wan, Q.B. 2009. Health benefit application of functional oligosaccharides. *Carbohydr. Polym.* 77: 435–441.



- Yang, R., Xu, S., Wang, Z., and Yang, W. 2005. Aqueous extraction of corncob xylan and production of xylooligosaccharides. *LWT Food Sci. Technol.* 38: 677–682.
- Yang, Q., Gao, Y., Huang, Y., Xu, Q., Luo, X.M., Liu, J.L., and Feng, J.X. 2015. Identification of three important amino acid residues of xylanase Afxyn A from *Aspergillus fumigatus* for enzyme activity and formation of xylobiose as the major product. *Process Biochem.* 50: 571–581.
- Yegin, S., Oguz, A., Sayit, B., and Yekta, S. 2016. Exploitation of agricultural wastes and by-products for production of *Aureobasidium Pullulans* Y-2311-1 xylanase: Screening, bioprocess optimization and scale up. *Waste Biomass Valor.* 8: 999-1010.
- Yoon, K.Y., Woodams, E.E., and Hang, Y.D., 2006. Enzymatic production of pentoses from the hemicellulose fraction of corn residues. *LWT-Food Sci. Technol.* 39: 387– 391.
- Yopi, Tasia, W., and Melliawati, R. 2017. Cellulase and xylanase production from three isolates of indigenous endophytic fungi. *IOP Conf. Series: Earth and Environmental Science* 101: 1-8.
- Zeng, H., Xue, Y., Peng, T., and Shao, W. 2007. Properties of xylanolytic enzyme system in *Bifidobacteria* and their effects on the utilization of xylooligosaccharides. *Food Chem.*, 101: 1172–1177.