Enzyme mediated nanofibrillation of cellulose by the synergistic actions of an endoglucanase, lytic polysaccharide monooxygenase (LPMO) and xylanase

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Supplementary Information

Table S1. The gross fiber properties (fiber length and fiber width) of bleached Kraft pulp (BKP) before and after 3 hours treatment with various enzyme.

Sample	Fiber length (μm)	Fiber width (μm)
Control	761.3 ± 28.9	21.0 ± 0.3
EG	765.1 ± 15.3	20.8 ± 0.8
EG + AA9	753.8 ± 23.3	20.7 ± 1.0
EG + EX	748.6 ± 31.2	20.5 ± 0.3
EG + EX + AA9	746.9 ± 30.8	20.6 ± 0.5

EG: endoglucanase; AA9: lytic polysaccharide monooxygenase auxiliary activity family 9 enzyme; EX: endoxylanase. The experiment were performed in triplicate and the mean values and errors bars were calculated.

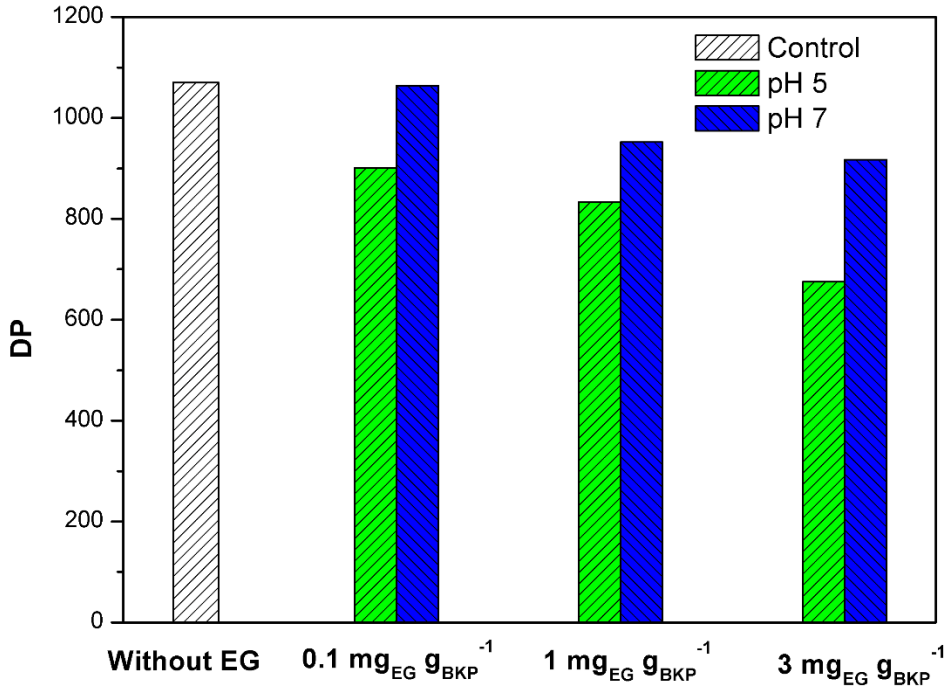
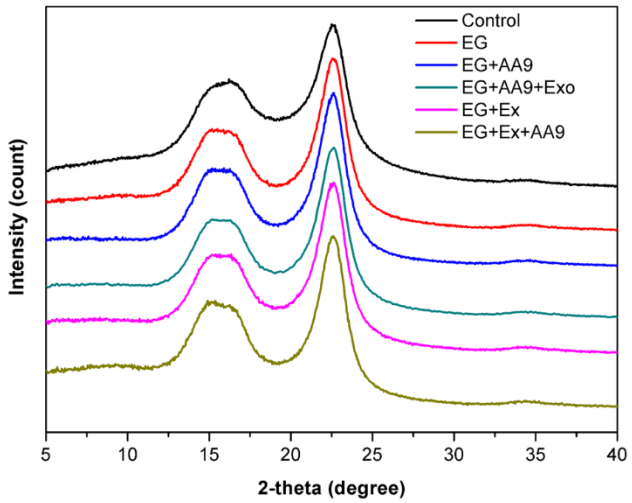


Fig. S1 Reduction in the degree of polymerization (DP) of bleached Kraft pulp (BKP) after 3 hours endoglucanase (EG) treatment at different enzyme loadings at pH 5.0 and 7.0.



Sample	Segal CrI (%)	Crystal size (nm)
Control	53.5	2.5
EG	60.8	3.8
EG + AA9	63.2	4.0
EG + AA9 + Exo	59.7	3.8
EG + EX + AA9	71.1	3.9
EG + EX	66.0	3.8

Fig. S2 Changes in fiber crystallinity index (CrI) and crystal size (τ) of bleached Kraft pulp (BKP) after various enzyme treatments.

EG: endoglucanase; AA9: lytic polysaccharide monooxygenase auxiliary activity family 9 enzyme; EX: endoxylanase; Exo: exoglucanase Cel6A.

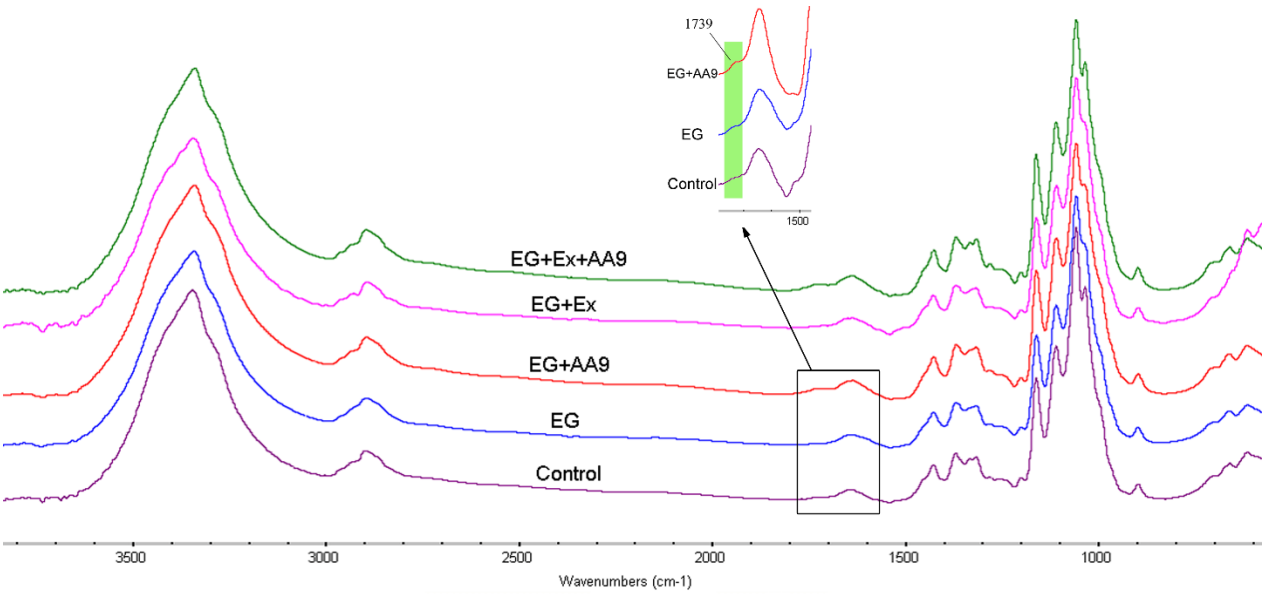


Fig. S3 FT-IR spectrometry of bleached Kraft pulp (BKP) treated by various enzyme combinations.

EG: endoglucanase; AA9: lytic polysaccharide monooxygenase auxiliary activity family 9 enzyme; EX: endoxylanase.

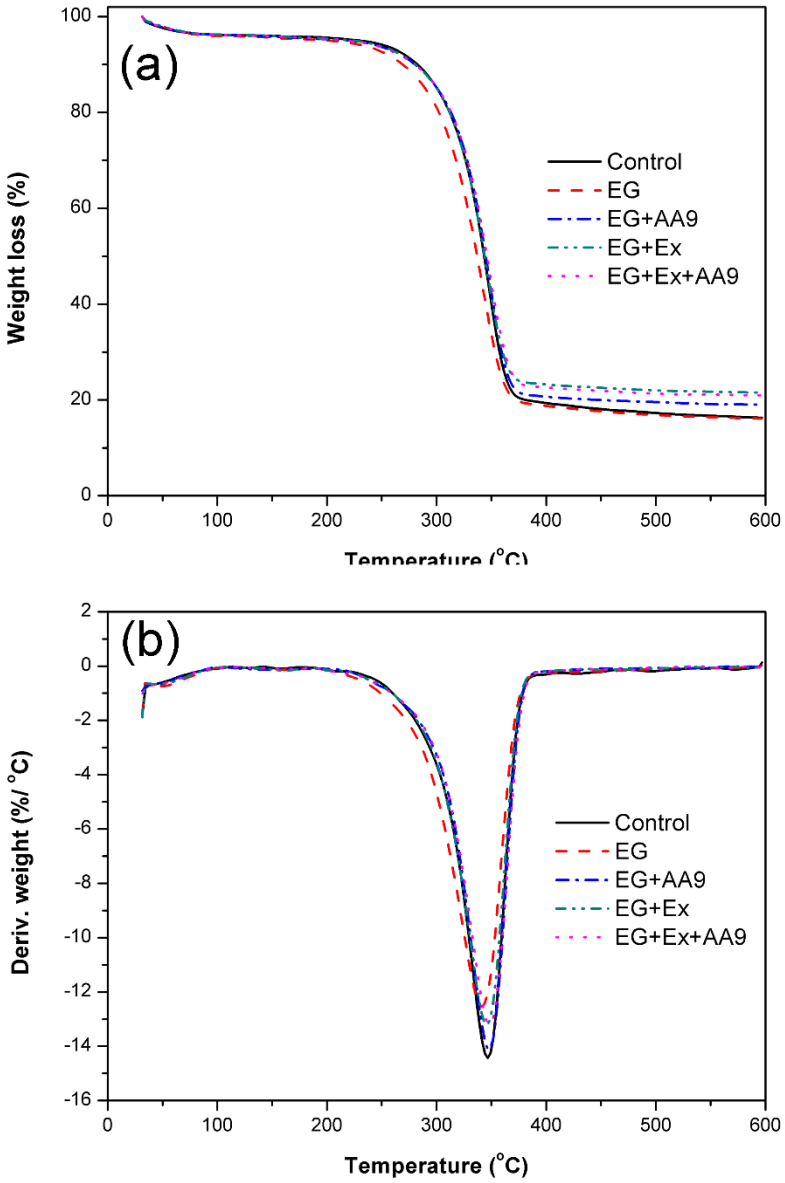


Fig. S4 TGA (a) and DTG (b) curves of enzymatically pretreated bleached Kraft pulp (BKP) after sonication and assessed by thermal gravimetric analysis (TGA).

EG: endoglucanase; AA9: lytic polysaccharide monooxygenase auxiliary activity family 9 enzyme; EX: endoxylanase.

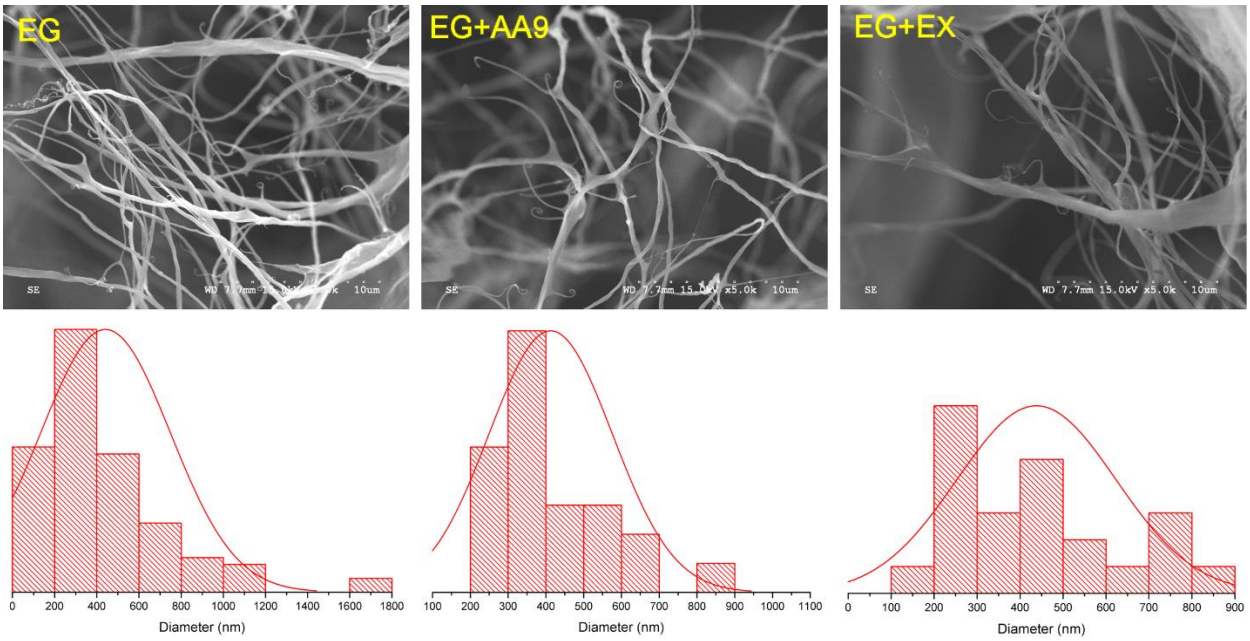


Figure S5. SEM images of enzymatically pretreated bleached kraft pulp (BKP) fiber suspension after sonication process (A) and the fiber width distribution of pretreated sample (B).
EG: endoglucanase; AA9: lytic polysaccharide monooxygenase auxiliary activity family 9 enzyme; EX: endoxylanase.