PREPARATION AND PROPERTIES OF NANOCELLULOSE FROM REED STALKS

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Objectives

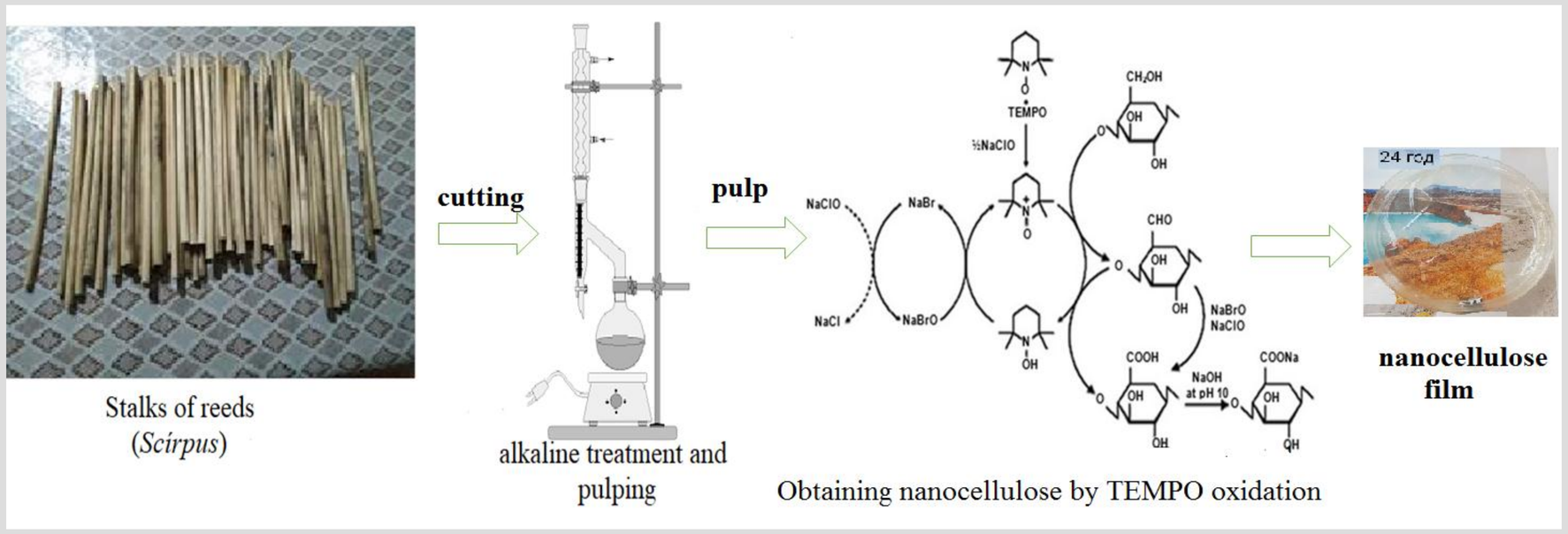
Cellulose is the most abundant organic compound on Earth. Cellulose is used as a raw material in the pulp and paper, chemical, pharmaceutical, and construction industries. Recently, cellulose has been considered as a source of nanocellulose production. Nanocellulose has nanosized particles and unique properties: high elasticity and specific surface area, high transparency and chemical resistance, biodegradability and biocompatibility, relatively low production costs with synthetic polymers and light weight.

Objectives: To obtain organosolvent pulp from reed stalks in an environmentally friendly method, suitable for the production of nanocellulose. To investigate the production of nanocellulose by action oxidizing reagent 2,2,6,6-tetramethylpiperidine-1-oxyl (TEMPO). To analyze the properties of the obtained nanocellulose from reed stalks.

Preparation of nanocellulose

Reeds (*Scírpus*) are a perennial plant up to 4 m tall. To obtain nanocellulose at the first stage, reed stalks were extracted with NaOH solution with a concentration of 30-50 g/l, duration 60-240 min, the ratio of liquid to solid 10:1 at a temperature of 97±2 ˚C. Cellulose cooking was performed with a solution of glacial acetic acid and 30% solution of hydrogen peroxide in a ratio of 70:30 at a temperature of 97 ± 2˚C, duration 30 – 120 min. The organosolvent pulp have 0.39 % lignin and 0.02 % ash.

Nanocellulose were obtained by the action of reagents 2,2,6,6-tetramethylpiperidine-1-oxyl (TEMPO), sodium bromide and sodium hypochlorite at a temperature of 20 and 40 °C according to the technology.

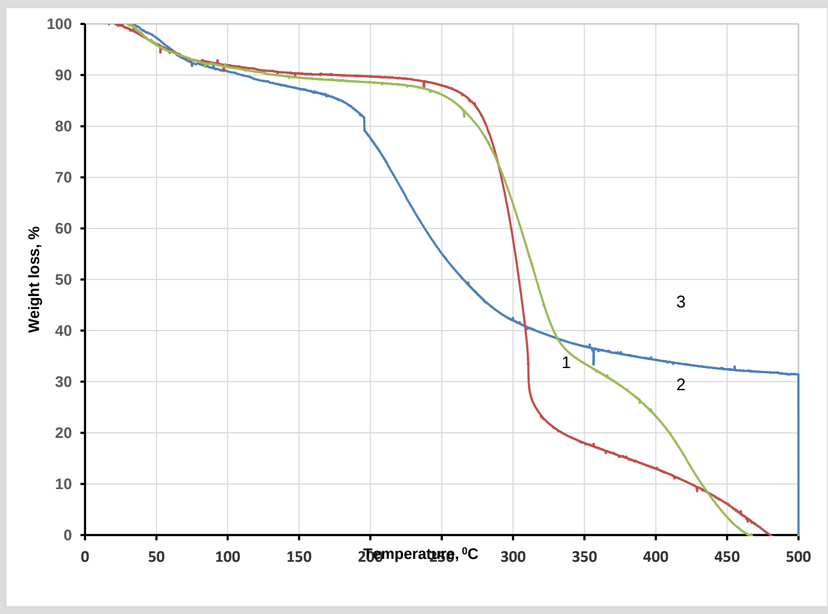


Scheme of nanocellulose preparation from reed stalks

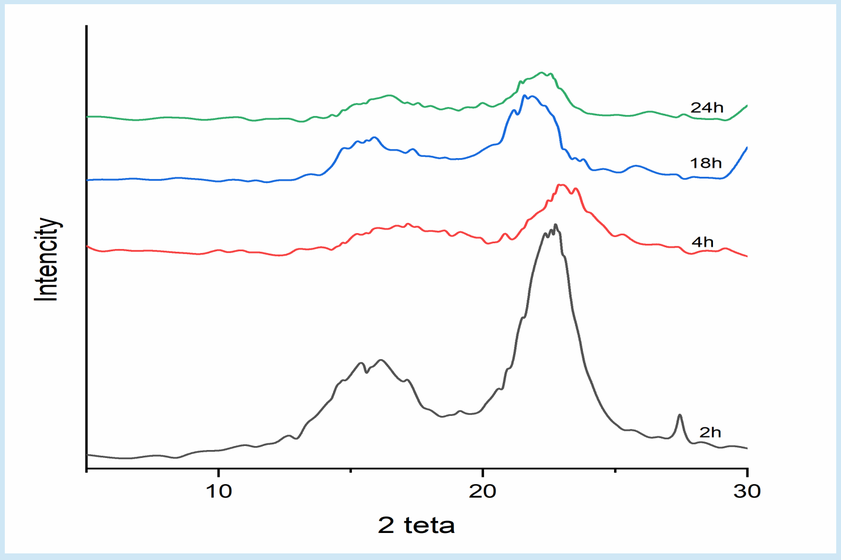
Properties of nanocellulose

Dependence of the indices of nanocellulose on the duration of the oxidation process with the TEMPO

Oxida-tion duration, h	Density, g/см³	Tensile strength, MPa	Content – COOH, %	Transparency, %
2	0.61	5.05	1.03	28.5
4	0.90	12.5	1.74	35.7
8	1.1	23.2	2.14	45.7
15	1.25	36.7	2.78	56.4
18	1.32	60.3	4.00	72.8
20	1.48	55.5	1.47	78.3
24	1.75	75.4	5.30	80.2



Gravimetric curves of thermal analysis:
1 - stem of reeds; 2 - organosolvent pulp;
3 - TEMPO-oxidized nanocellulose



X-ray diffraction patterns of the nanocellulose from reeds for different duration of oxidation

Crystallinity index of nanocellulose for different duration of TEMPO oxidation: 2 hours - 78.8%; 4 hours - 73.5%; 18 hours - 65.9% and 24 hours - 70.5%

Conclusion

1. It has been established that organosolvent pulp from reeds is suitable for the production of nanocellulose since the residual the lignin and mineral content is less than 1%.
2. It is shown that with an increase in the oxidation process of organosolvent pulp by the TEMPO reagent, the density, tensile strength, the content of COOH-groups and the transparency of nanocellulose films increase.
3. Nanocellulose from reed stalks is recommended for use in the production of composite materials and consumer goods.