

Extraction of Cellulose Nanofiber (CNF) from Japanese Banana Stem Waste by a Simple NaOH Method

Erna Mayasari, Matsue Naoto, Fukugaichi Satoru, Erni Johan

Introduction

Cellulose nanofiber (CNF) has unique characteristics for the development of new materials. The abundance, renewability and biodegradability, ecofriendly, sustainable biomaterial, mechanical properties and nanometric dimensions open up a wide range of possible properties and applications to discover.

Cellulose nanofiber are widely used in commercial product: cosmetic, food, sport tools, electronics, concrete coating and ink ball points (Figure 1).

Preparing CNF from agricultural wastes is important in the view of cost and environment. Banana stem is one of the raw material as an agricultural waste with high annual yield. According to ILO data (2020), India, China, and Indonesia the top three countries of banana production with 30,477; 11,170; 7,163 (000' tons), respectively. [4]



Figure 1. Commercial product based on the cellulose nanofiber (CNF) in Japan

Method

We used the stem of a natural Japanese banana (*Musa basjoo*) from Uchiko, Ehime. *M. basjoo* is non fruit and cheap

The dry stem sheath of *M. basjoo* was heated with 0.25 M NaOH for 5 h in oven (Figure 2).

Figure 3 shows the morphology of crude cellulose nanofibers extracted. FE-SEM: Field-emission scanning electron microscopy; TEM: Transmission Electron Microscopy.

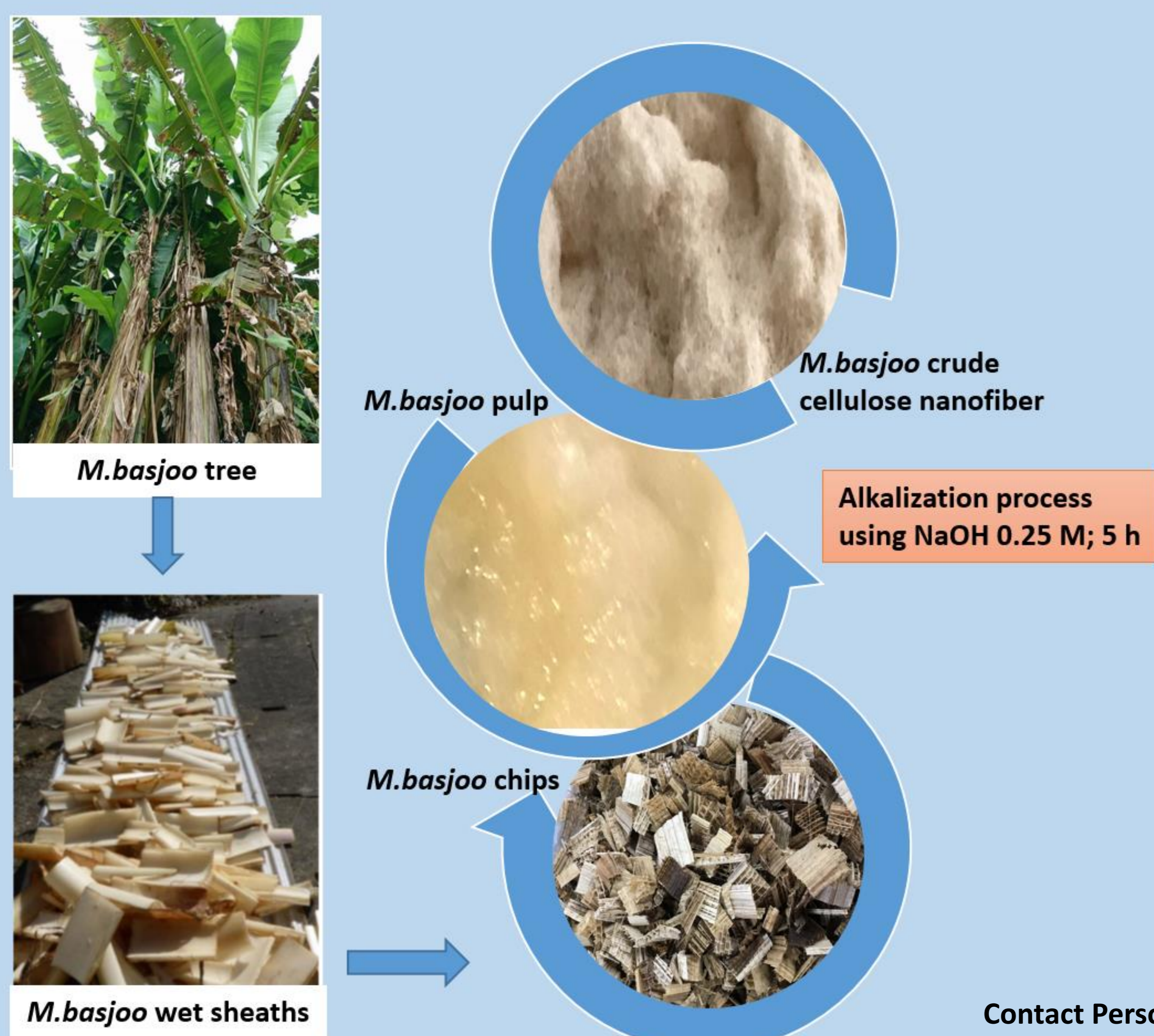


Figure 2. *M. basjoo* tree to crude cellulose nanofiber

Contact Person:
Erna Mayasari

Department of Environmental Science, Ehime University, 3-chōme-5-7 Tarumi, Matsuyama, 790-8566, Ehime, Japan.
Phone : (+81)87320521
Email : emaysa13@gmail.com

Result

The NaOH treatment removed a certain amount of lignin, hemicellulose, wax and oil. The NaOH treatment also helps in depolymerizing the native cellulose structure, defibrillating the external cellulose micro fibrils and by extension exposing the short length crystallites of the cellulose material.

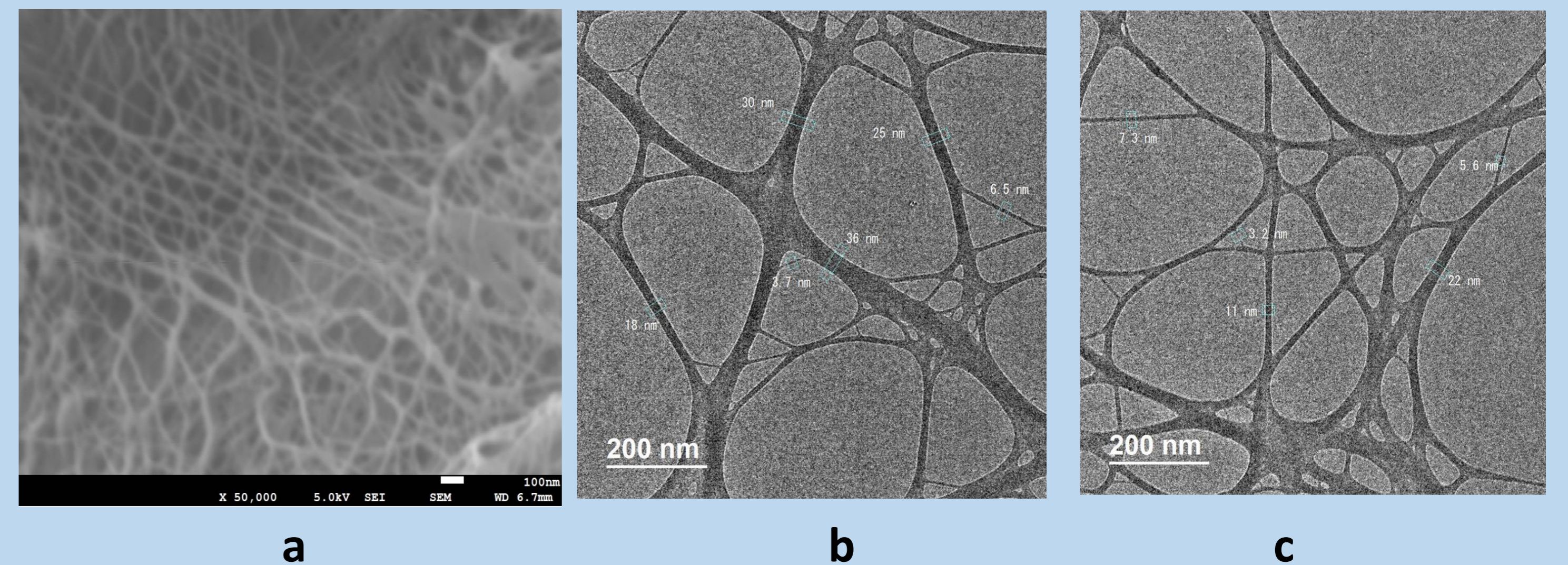


Figure 3. Crude Cellulose Nanofiber (CNF) from *M. basjoo*; FE-SEM (a); TEM (b, c)

Several species of bananas have been extensively studied to extract cellulose, but *M. basjoo* has not been identified as a CNF source, and our initial results show great hope in cellulose nanofiber utilization from *M. basjoo* stem waste. Figure 3 shows the nanofiber with diameters ranging 3.2-35 nm and the hierarchical flow of *M. basjoo* can be seen in Figure 4.

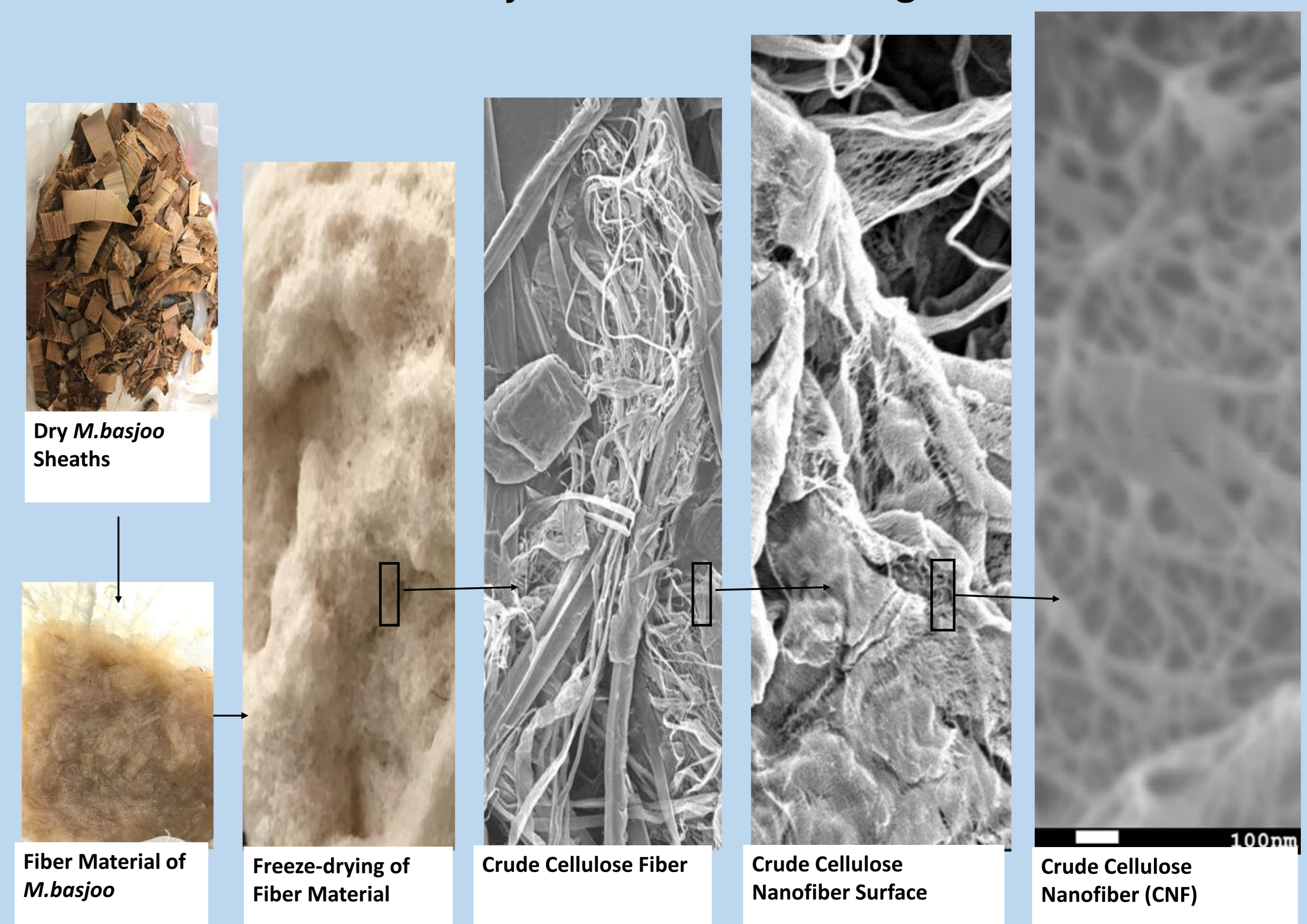


Figure 4. The Hierarchical of the crude Cellulose Nanofiber (CNF) from *M. basjoo*

Conclusion

The crude cellulose nanofiber (CNF) 3.2-35 nm was successfully extracted from *M. basjoo* using NaOH simple alkalization method.

Acknowledgment

Thank you to the Japanese government support for the Ministry of Education, Culture, Sports, Science and Technology (MEXT) scholarship.

References

- [1] Pelissari F M, Andrade-Mahecha M M, Sobral P J A, Menegalli F C, 2017, Nanocomposites based on banana starch reinforced with cellulose nanofibers isolated from banana peels, *J. Colloid Interface Sci.*, 154–16.
- [2] Nomura Y, Sasaki T, Kang H B, and Suwa R, 2017, Characteristic of Basho-fu Material from Traditional Degumming Process, *J. Fiber Sci. Technol.*, 73 (11), 317-326.
- [3] Faria L U S, Pacheco B J S, Oliveira G C, and Silva J L, 2020, Production of cellulose nanocrystals from pineapple crown fibers through alkaline pretreatment and acid hydrolysis under different conditions, *J Mater Res Materes Technol*, 9(6):12346–12353.
- [4] International Labour Organization (ILO), 2020, Wages and working conditions in the banana sector: the case of Costa Rica, Ethiopia, India, Indonesia, and Viet Nam, ISBN 978-92-2-033987-9 (PDF).