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# Bioderived Chemical Extraction from Spruce Needles – Adding Value to Forest Logging Residues

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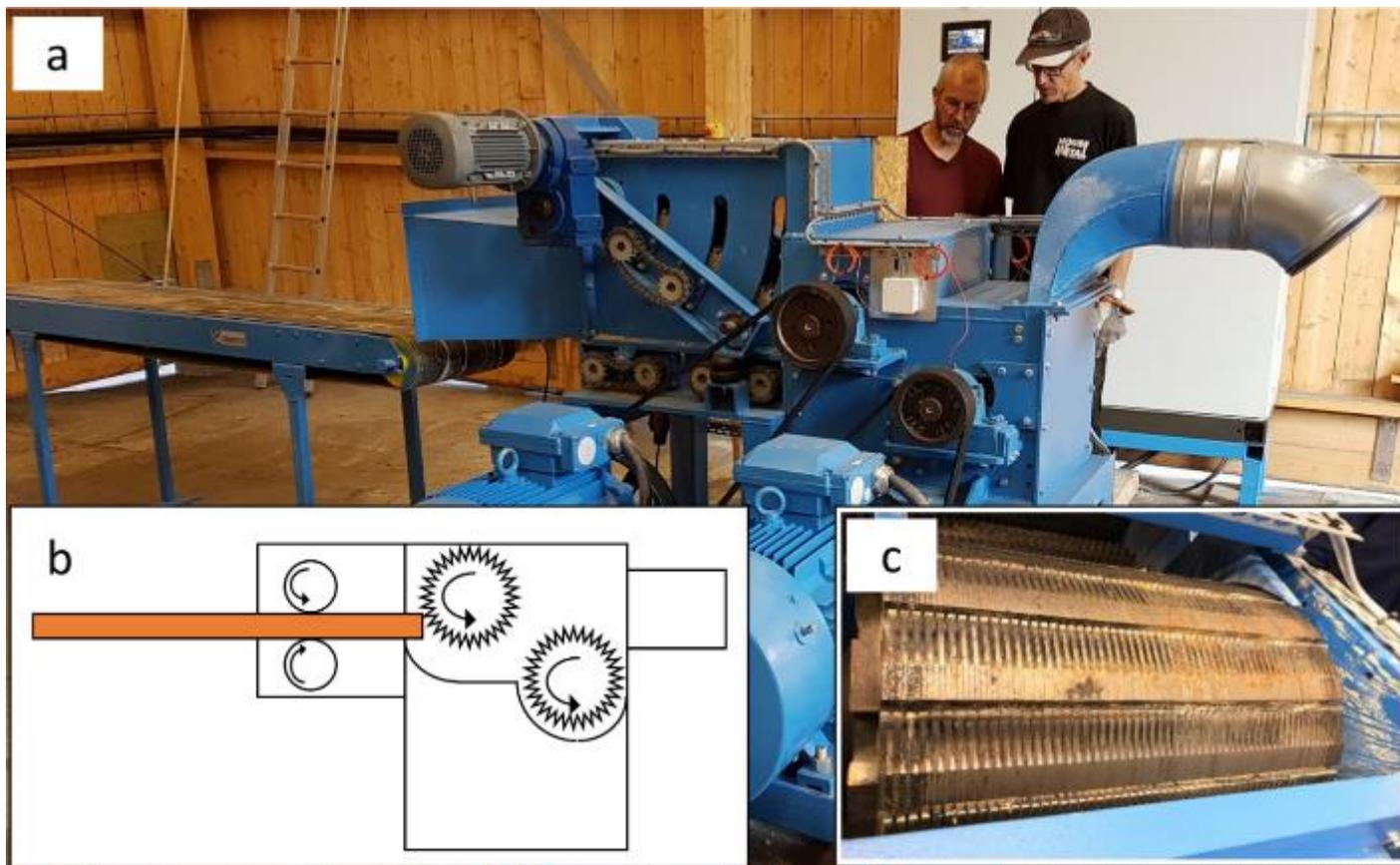
## Background of the Study

- ❖ Biochemicals are the part of the circular bioeconomy
- ❖ Biochemical from spruce needles can add value to the forest resource
- ❖ Spruce needles are strongly attached to green branches
- ❖ There is a need of good separation method
- ❖ A novel multi-blade shaft mill (MBSM) may take this challenge





# Multi-blade shaft mill (MBSM)



- ❖ Prototype of MBSM mill (a)
- ❖ The principle of operation (b)
- ❖ The multi-blade shaft (c)
- ❖ Particle size  $\propto A \times (FS) + B \times (BS)$ ;  
FS = Feeding speed and BS = Blade speed

Fig. 2: An overview of MBSM (Das et al. (2021). <https://doi.org/10.1016/j.powtec.2020.10.026>).



## Materials and Methods



Fig. 3: Fresh spruce branches.

- ❖ Logging residues
  - Spruce (*Picea abies*)  
branches





## Materials and Methods (Continued.....)



Fig. 4: Feeding of fresh spruce branches.

- ❖ Mill setting

- Target settings of BS and FS





## Materials and Methods (Continued.....)



- ❖ Sieve setting
  - Target sieve

Fig. 5: Sieving for separating needles; Sieving machine (a) and Sieve (b, c)



## Materials and Methods (Continued.....)

### ❖ Extraction

- Acetone/water
- Green solvent

### ❖ Analysis

- Chemical characterization
- Antioxidant
- Antibacterial





# Results and Discussion



Too fine milled

OK!

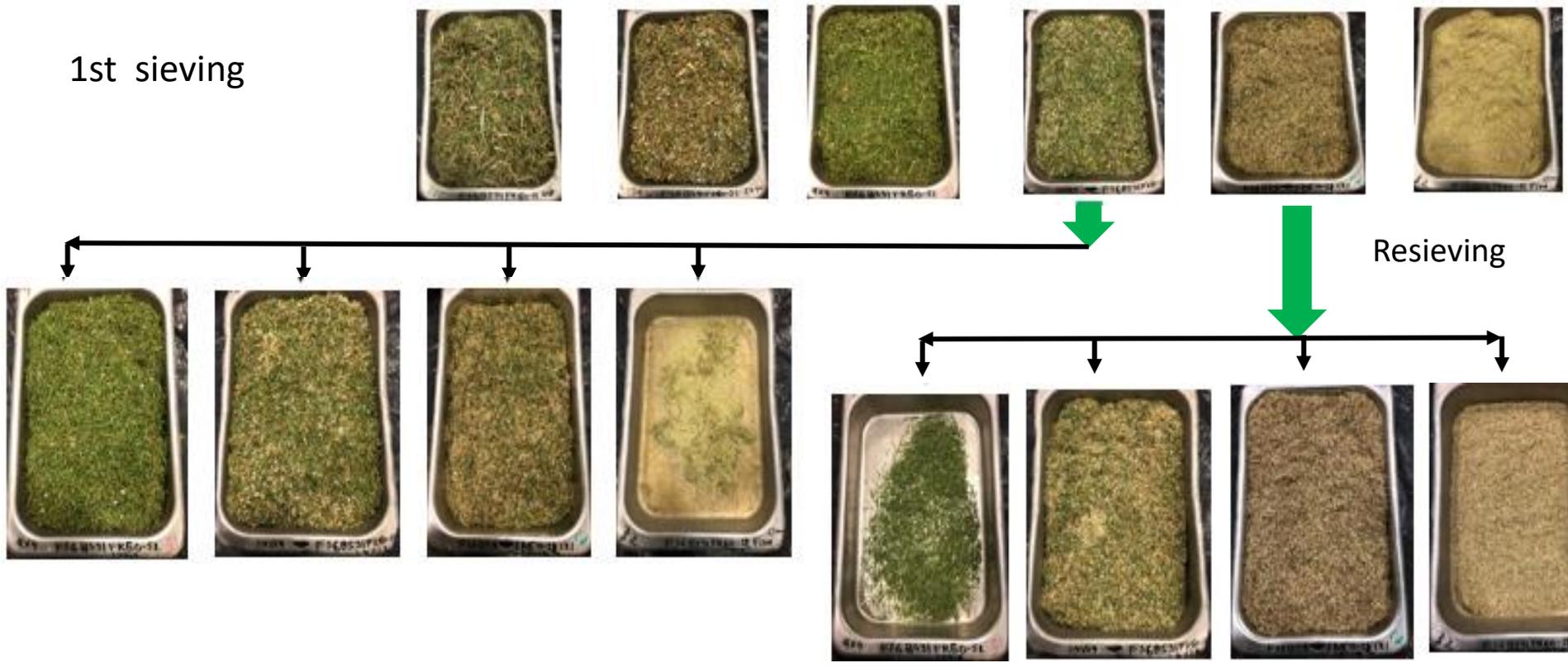
Too coarsely milled

Fig. 6: Optimum separation condition.





# Results and Discussion (Continued.....)



❖ Resieving  
➤ Recovered pure needles

Fig. 7: Observation of fractionated pure needles.





# Results and Discussion (Continued.....)

Table 1: The fractionated samples and moisture content

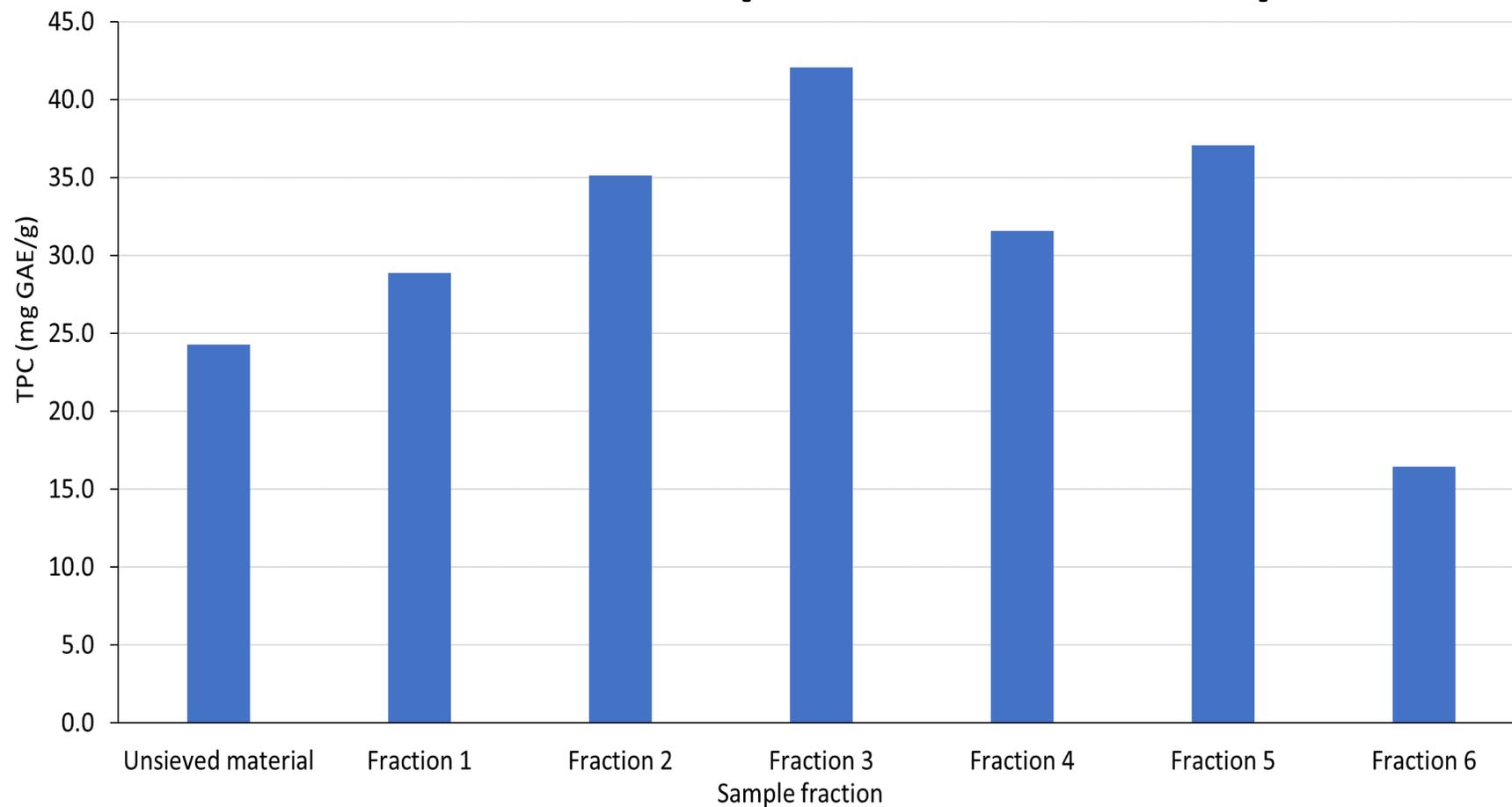
Parameter	Unsieved material	Fractionation (%)						Total (%)	Loss (%)
		Fraction 1	Fraction 2	Fraction 3	Fraction 4	Fraction 5	Fraction 6		
100	100	3.0	5.5	43.0	7.3	7.3	31.3	97.4	2.6
Std	0	0.4	0.6	3.1	0.5	0.4	3.5	1.7	1.7
MC (%)	30.5	36.5	35.9	39.3	34.5	30.0	26.5	-	-

\*Std = Standard deviation, and MC = Moisture content





## Results and Discussion (Continued.....)



❖ It had antibacterial and antioxidant properties

Fig. 8: Total phenolic content (TPC) of fractionated samples.





## Conclusions

- ❖ Spruce branches contains around 37% needles\*
- ❖ This technique separated 43% green needles
- ❖ TPC was higher in fraction containing needles
- ❖ This result supports the efficiency of MBSM
- ❖ Extracted material showed the antioxidant and antibacterial properties

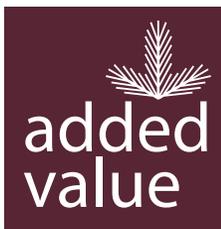
\*Lestander et al. (2022). <https://doi.org/10.1016/j.jclepro.2022.133330>





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THANK  
YOU ALL

