The Effect of Fractioning of Forest Biomass on Cellulose, Lignin and Fermentable Sugars Contents

When fermenting biomass into ethanol and similar products the content of cellulose, lignin and fermentable sugars in the feedstock is important for the product yield. By sieving and gravimetric fractioning the contents of these compounds can be affected. The desired result of these treatments is to raise the content of cellulose and sugars and lower the content of lignin. A general conclusion from these experiments is that sieving to remove small particle fractions <1,0-1,9 mm improves the feedstock quality from the point of view of fermentation. With these treatments a raw material richer in celluloses and sugars but poorer in lignin is produced which will increase the product yield. This is obvious for both of the studied biomass assortments, stumps and small trees.

Cellulose

The experiments carried out in Forest Refine have shown (figure 1) that the cellulose content of the finest fraction (<1,0 mm) is significantly lower than that of bigger fractions. This can also be seen in figure 2 where sieving has raised the cellulose content. The gravimetric method has shown too high standard deviation, (STDAV).

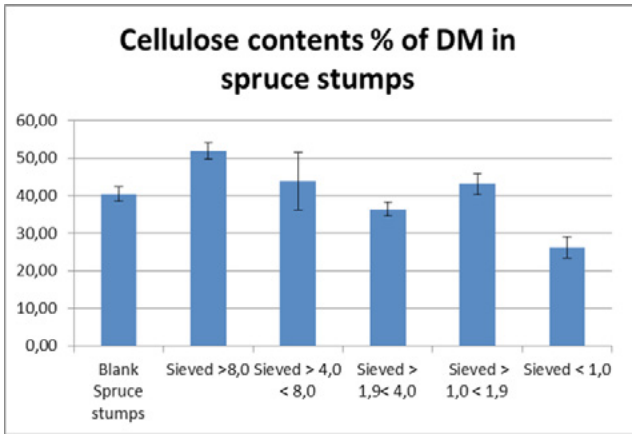

Figure 1. Effect of sieving on cellulose content in spruce stump assortments.

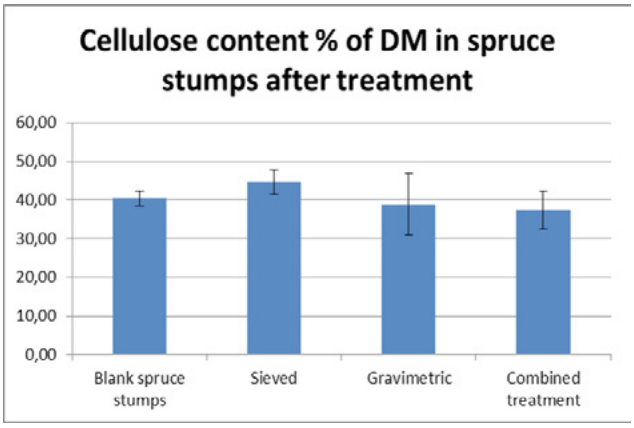

Figure 2. Effect of fractioning on cellulose contents of spruce stump assortments.

When looking at small trees from thinning operations (figure 3) it can be seen that the fine particles have lower cellulose content than bigger particles, and that it is significantly lower for pine compared to spruce. It is therefore justified to sort these particles out. As shown in figure 4 the STDAV for all the treatments are too high to make conclusions.

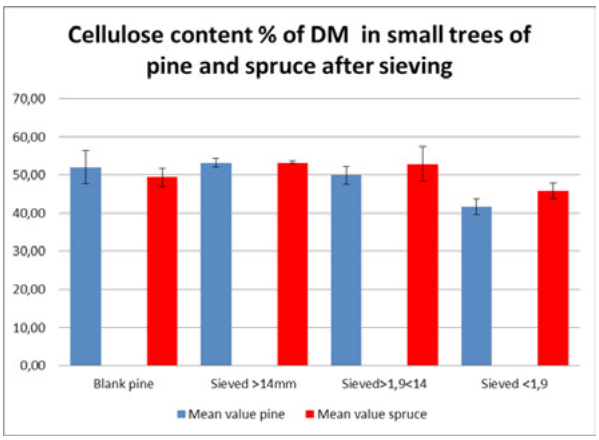

Figure 3. Cellulose content % of DM in small trees of pine and spruce after sieving.

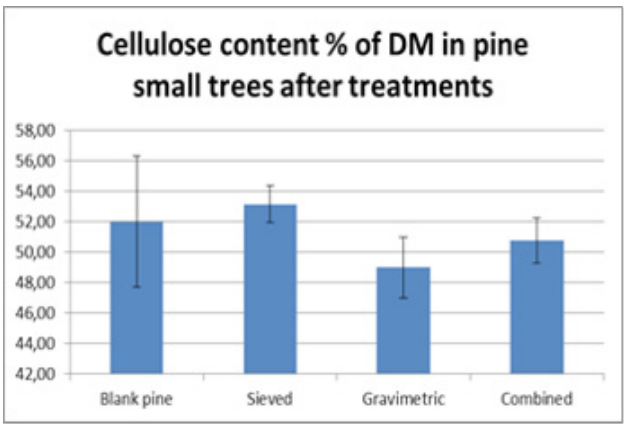

Figure 4. Cellulose content % of DM in small trees of pine after fractioning.

Lignin

When studying the effect of fractioning on the lignin content it is obvious that the small particles have the highest concentration of lignin. Also on the account of lignin it is of interest to sort out this fraction.

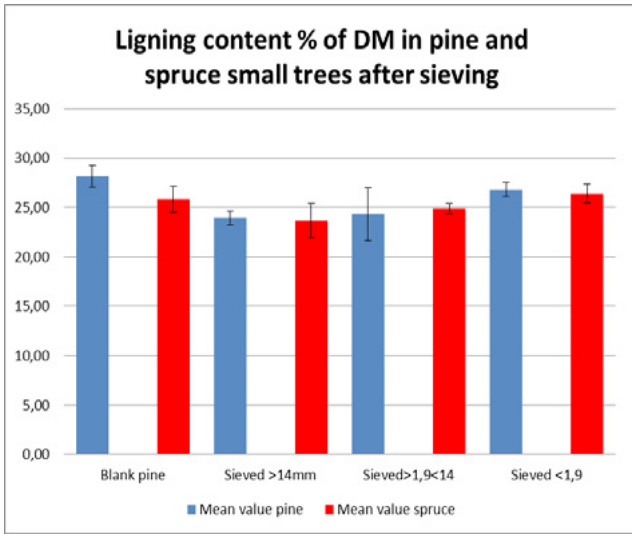

Figure 5. Lignin content, % of DM in small trees after sieving.

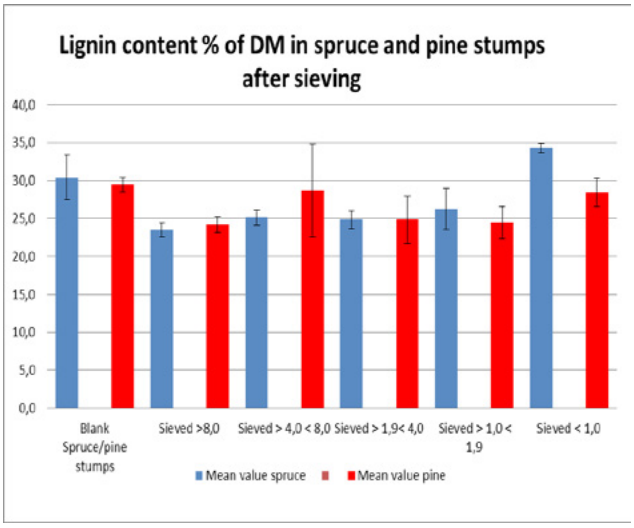

Figure 6. Lignin content, % of DM in stumps after sieving.

Sugars

The current study has focused on the composition of different sugars in two forest biomass assortments, stumps and small trees. Both the total sugar content in the different fractions and the combinations of pentoses and hexoses have been analysed. For the fermentation the hexoses are most interesting since they are easier to ferment than pentoses. In figure 7 and figure 8 it is shown that the total sugar content in both stumps and small trees varies between 25-32 % and there is a slight trend that the smallest particles have the lowest concentration of sugars.

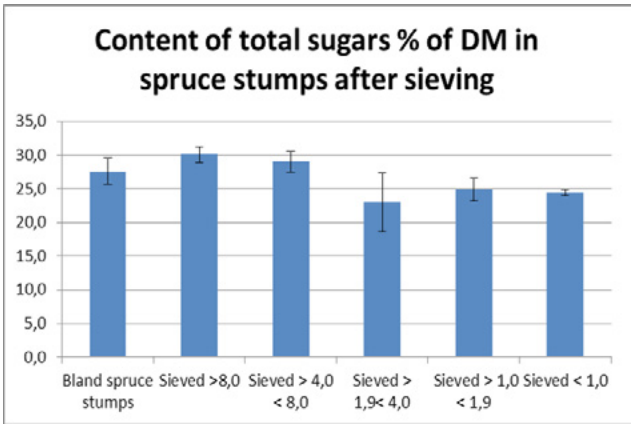

Figure 7. Content of total % of DM sugars in spruce stumps after sieving.

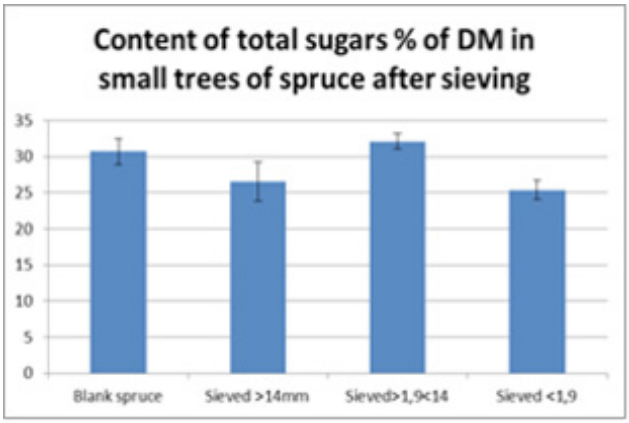

Figure 8. Content of total sugars % of DM in small trees after fractioning treatment.

Fractioning costs

The cost for fractioning treatments can be calculated from table 1. A condition for the estimated capacities and costs is that moisture content in biomass does not exceed 25%.

Table 1. Data from manufacturer

Method	Model	Capacity Ton DM / h	Power consumption (electric) Kwh / ton DM	Investment SEK
Scereener	Mogensen SEL 24	12-15	1,0 ± 1	700 000
Gravimetric screener	Fransson Recycling	12-15	5-8	800 000

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European Union
European Regional Development Fund
Botnia-Atlantica
Cross-border cooperation over mountain and sea
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Länsstyrelsen Västernorrland
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KESKI-POHJANMAAN LIITTO
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