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Drying of firewood – the effect of harvesting time, tree species and shelter of stacked wood

Thomas Nord-Larsen [a,*], Andreas Bergstedt [a], Ole Farver [b], Niels Heding [a]

[a] University of Copenhagen, Forest and Landscape, 23 Rolighedsvej, DK-1958 Frederiksberg C, Denmark
[b] University of Copenhagen, Faculty of Pharmaceutical Sciences, 2 Universitetsparken, DK-2100 Copenhagen Ø, Denmark

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ABSTRACT

Firewood represents a renewable source of energy and is the main source of energy for about half the World's population. When burning firewood in domestic stoves, combustion and thus energy efficiency is dependent on the moisture content of the wood. In Denmark, it is generally recommended that moisture content should be no more than 180 g kg^{-1} total weight. This study aims to assess the effect of species, harvesting time and shelter on the drying of stacked firewood. After felling, the moisture content declined to a relative stable level for all species. The rate of drying depended on the felling time, tree species, and the presence of shelter. The lower asymptotic moisture content depended mainly on the presence of shelter and averaged 188 g kg^{-1} total weight for frames left in the open and 154 g kg^{-1} total weight for frames covered by a shelter. It is concluded that Norway spruce felled during the early summer may obtain an acceptable moisture content at the onset of the heating season. Deciduous trees should be felled during the winter or early spring and stored under shelter to be suitable for burning before the heating season. Shelter was found to be of great importance to maintain an acceptable moisture content of firewood in storage during winter.

1. Introduction

Burning of fossil fuels is a major cause of increasing atmospheric carbon dioxide (CO_2), which in turn is a major cause of global warming (climate change). Burning biomass also releases greenhouse gases during combustion. However, burning biomass that has been grown in sustainable wood production systems can significantly reduce greenhouse gas emissions, compared to emissions from non-renewable energy sources. This is because unlike fossil fuels, biomass is a renewable resource and the CO_2 release from burning biomass can be re-sequestered in subsequent rotations of the growth and harvest cycle.

Today, the global production of energy from biomass totals about 50 EJ, which corresponds to 10% of the annual global primary energy consumption. Of the total bioenergy production, 87% are produced from woody biomass [1]. For approximately half of the World's population, wood or other biomass is the main source of energy [2]. In Europe the annual primary energy production from biomass totals 3.7 EJ or about 10% of the total primary energy production [3]. More than 75% of the primary bioenergy production within the EU is based on woody biomass.

In Denmark, about one quarter of the primary energy consumption from biomass comes from firewood burned in domestic stoves [4]. When the firewood is burned, many different chemical compounds are released including acetic acid and tar. To obtain full combustion of these compounds to water, carbon dioxide and ashes the temperature has to be at least 700 °C. When the firewood has a high moisture content

* *Corresponding author*. Tel.: +45 35331758.
E-mail address: tnl@life.ku.dk (T. Nord-Larsen).
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such temperature is not reached since part of the energy is used for evaporating the water and because the vapor ousts the air needed for the combustion.

The result is inefficient use of the energy and the emission of unpleasant or even harmful air pollution. In a study on energy efficiency and emissions from different domestic wood fired stoves, stoves were stoked with wet (300–350 g water kg^{-1} total weight) and dry (160–180 g water kg^{-1} total weight) wood [5]. Wet wood was found to reduce energy efficiency while increasing the emissions of carbon monoxide (CO), total hydrocarbon (THC), volatile organic components (VOC) and polycyclic aromatic hydrocarbons (PAH) with 300–900% relative to dry wood. Measurements carried out by the Danish National environmental Research Institute (DMU), shows that wood stoves are one of the main sources of pollution with harmful airborne particles [6] and dioxin [7] in urban areas. Based on these conclusions the Environmental Protection Agency of Denmark recommends that firewood with higher moisture content than 180 g kg^{-1} total weight should never be used in domestic stoves [8].

In order to obtain a sufficiently low moisture content it has been recommended that firewood is left to dry for up to two years [9]. Often this is not possible due to immediate needs for firewood or due to limited storage capacity. This study aims to evaluate the time needed for drying firewood to an acceptable moisture content, depending on tree species, time of felling and sheltering of the stacked wood.

2. Materials and methods

Firewood for this experiment was harvested from March 2007 to October 2008 with intervals ranging from one to five months depending on the time of year. Harvested species included Norway spruce (*Picea abies* (L.) H. Karst.), beech (*Fagus sylvatica* L.), pendunculate oak (*Quercus robur* L.) and sycamore maple (*Acer pseudoplatanus* L.) (Fig. 1). The firewood was cut as part of an ordinary thinning operation in four forest stands in compartments 185 and 210 in the Northern part of Grib Forest, Denmark with stand ages ranging from 25 to 65 years (Table 1). Immediately after felling the stem part of the trees (with diameter exceeding approx. 10 cm) was cut into lengths of 33 cm and transported to the storage facility about 30 km south-east of the forest.

At the storage facility, the firewood was split into pieces with a size of 7–10 cm (width of cleaved surface) suitable for

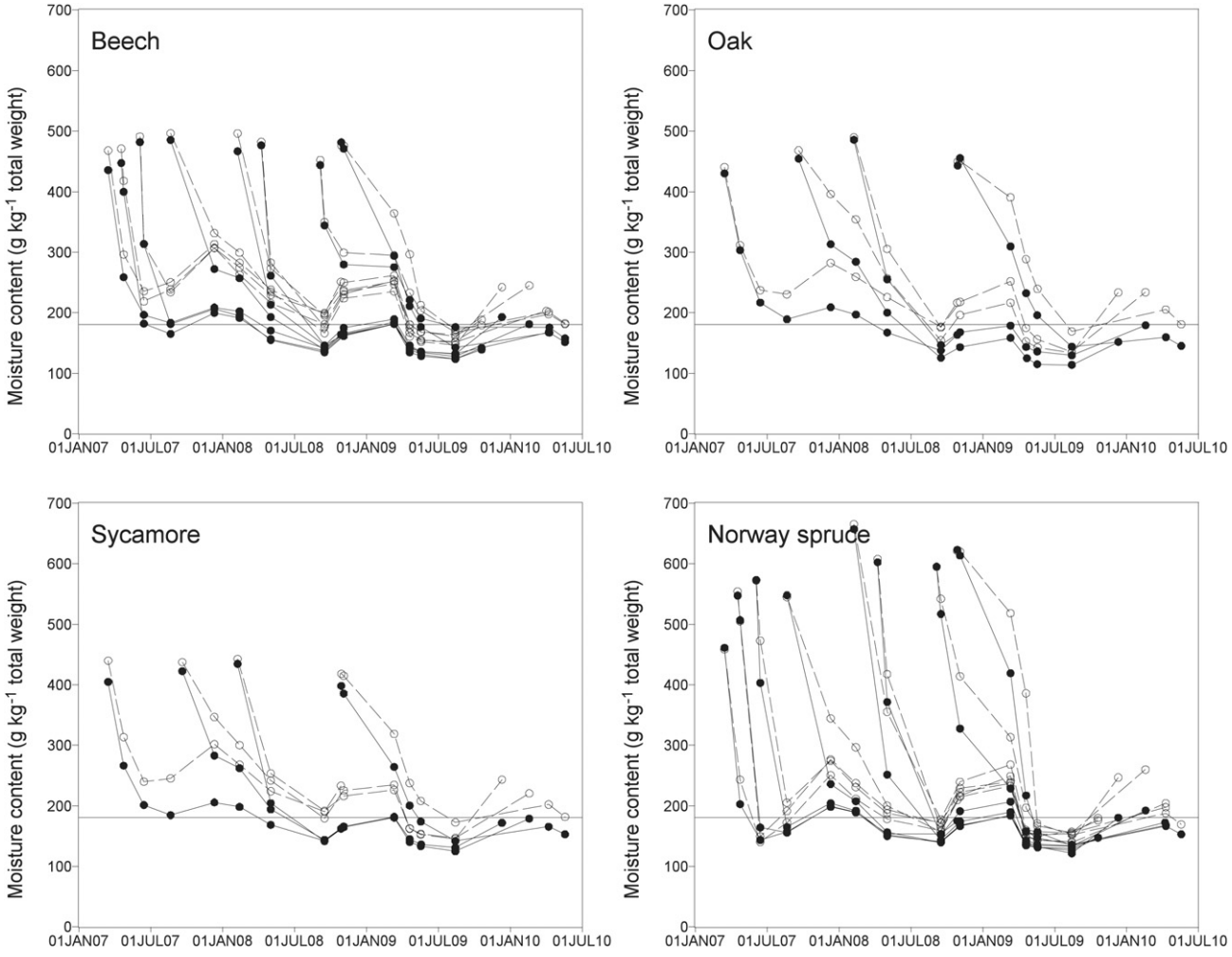

Fig. 1 – The relationship between time and moisture content (F_t) for the four species included in the experiment. Legend: ● are sheltered frames, ○ are unsheltered frames. Horizontal line represents a moisture content of 180 g kg^{-1} total weight.