NOTE

KRAFT PULPING PROPERTIES OF NEW ZEALAND-GROWN PICEA ABIES AND PICEA SITCHENSIS

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ABSTRACT

The kraft pulping properties of New Zealand-grown **Picea abies** (L.) Karst and **Picea sitchensis** (Bong.) Carr were compared with **Pinus radiata** D. Don. At kappa number 30, kraft pulp yield was approximately 48% from **P. sitchensis** and 46% from **P. abies.** Handsheet properties of the **P. sitchensis** pulps were similar to those from **Pinus radiata** of equivalent wood density but the **P. abies** pulps were somewhat inferior. Pulps from the 72-year-old **P. sitchensis** trees examined were approximately equivalent in yield and strength to those from 25-year-old **Pinus radiata**.

INTRODUCTION

Because of their slow growth rate compared with *Pinus radiata, Picea* spp. have not been grown extensively in New Zealand and, as a result of the small amounts available, the kraft pulping potential of New Zealand-grown *Picea* spp. has not been examined. However, as it is an important pulpwood species in the Northern Hemisphere, its pulp properties have recently been examined and compared with those of *Pinus radiata.* The results of an examination of the kraft pulping properties of New Zealand-grown *Picea abies* (Norwegian spruce) and *Picea sitchensis* (North American spruce) are discussed here.

MATERIALS AND METHODS

Wood Samples

Butt logs from three 72-year-old *P. abies* trees and from three *P. sitchensis* trees from Whakarewarewa Forest were debarked, sawn into slabwood (outer 25 growth rings) and corewood, and chipped. The samples from the three trees of each species were combined to give a corewood and slabwood sample for each species. Chips retained on the 16-, 19- and 26-mm Williams screens were used in the pulping studies.

Kraft Pulping

Chips were kraft pulped in a 10-litre Werverk rotatory digester under the following conditions:

Active alkali charge (as Na_20)	18%
Liquor : wood ratio	4 : 1
Sulphidity	24%
Time to 170°C	90 min

The H-factors required to produce pulps of the required kappa number of about 30 are given in Table 1.

Pulps were screened and, after yield and kappa number determinations, were beaten in a PFI mill for 2000, 4000, 8000 and 16 000 revolutions. Handsheets were then prepared and tested by Appita standard methods.

RESULTS

Pulp Yield

Chip properties and pulp yields are given in Table 1. The basic densities of the corewood and slabwood chips of both species were similar, corewood chips having a density of 370 kg/m^3 and slabwood a density of 420 kg/m^3. Corewood and slabwood of both species contained only 1–2% acetone soluble extractives. This level of extractives is only about half that normally encountered for *Pinus radiata,* but is about the same as found in Northern Hemisphere *Picea* (Assarsson & Akerlund 1966).

TABLE 1—Chip properties and pulp yields from **P. abies** and **P. sitchensis**

	P. abies		**P. sitchensis**	
	Corewood	Slabwood	Corewood	Slabwood
Chip density (kg/m^3)	370	420	372	421
Acetone extractives (%)	1.3	1.2	2.0	1.1
Total yield (%)	46.4	46.2	47.7	48.8
Screened yield (%)	46.0	46.0	47.3	48.7
Kappa No.	32.0	32.0	26.7	29.1
H-Factor	1840	1869	1820	2020

Pulp yields were similar to those reported for Scandinavian spruce grown in Sweden (Annergren *et al.* 1963). The *P. sitchensis* corewood and slabwood pulps were obtained in 1–2% higher yield than the *P. abies* pulps, total yields of pulp from *P. sitchensis* corewood and slabwood being 47.7% and 48.8% respectively. Pulp yields from *P. sitchensis* were approximately the same as from *Pinus radiata* of the same basic density.

Handsheet Properties

Handsheet evaluation data for the *P. abies* and *P. sitchensis* pulps are presented in Table 2.

TABLE 2—Pulp evaluation data for **P. abies** and **P. sitchensis** pulps - corewood values are followed by slabwood values in parentheses

	P. abies PFI beating revs.								**P. sitchensis** PFI beating revs.							
	2000		4000		8000		16 000		2000		4000		8000		16 000	
Freeness (Csf)	683	(722)	657	(692)	557	(593)	359	(324)	670	(700)	625	(675)	490	(535)	225	(220)
Tear (mN.m²/g)	15.8	(25.4)	14.3	(21.1)	12.3	(19.4)	11.9	(17.2)	18.4	(24.4)	16.6	(23.2)	16.4	(21.3)	15.2	(18.9)
Burst (kPa.m²/g)	6.5	(4.9)	7.3	(6.2)	8.4	(6.9)	8.8	(7.7)	7.0	(5.8)	7.8	(6.6)	8.1	(7.3)	8.6	(8.0)
Sheet density (kg/m³)	661	(597)	699	(624)	721	(650)	744	(680)	626	(593)	665	(617)	690	(648)	711	(674)
Tensile index (Nm/g)	74.0	(59.8)	80.2	(70.6)	86.2	(75.7)	91.0	(83.8)	74.1	(69.5)	84.2	(76.3)	87.8	(80.7)	90.8	(85.6)
Stretch (%)	3.6	(2.9)	3.4	(3.1)	3.4	(3.3)	3.8	(3.6)	3.0	(2.9)	3.3	(3.2)	3.5	(3.2)	3.5	(3.5)
Young's Modulus (MN/m²)	3800	(3400)	4200	(3700)	4500	(4000)	4700	(4400)	3200	(3000)	3700	(3300)	3900	(3600)	4100	(3600)
Scatt. coeff. (m²/kg)	22.5	(20.9)	20.4	(18.4)	17.0	(16.6)	15.7	(15.2)	21.7	(20.0)	18.2	(18.4)	17.8	(17.0)	17.1	(16.7)
Absorp. coeff. (m²/kg)	10.7	(10.2)	11.0	(9.7)	10.3	(9.6)	10.4	(9.3)	10.8	(10.7)	9.8	(10.4)	10.1	(10.4)	9.9	(10.6)

The tear/tensile relationships for the two species are shown in Fig. 1. Slabwood pulps of both species produced handsheets with higher tear strength at a given tensile strength than corresponding corewood pulps. At a given tensile strength the *P. sitchensis* corewood and slabwood handsheets had tear strengths approximately 2 $mN.m^2/g$ higher than the equivalent *P. abies* pulps. Tear strengths of the *P. sitchensis* pulps were approximately the same as those obtained from *Pinus radiata* wood of similar density (Kibblewhite & Lloyd 1983).

When compared at similar beating treatment, similar sheet density, or similar burst strength the *P. sitchensis* pulps were always stronger than the equivalent *P. abies* pulps. Because of the range of sheet densities obtained it is not possible to compare all handsheets at a single sheet density without interpolation.

In Table 3 the pulps are compared after 4000 revolutions in the PFI mill. Sheet densities for *P. abies* pulps at this level of beating were higher than for *P. sitchensis* pulps. The same trend was found at all levels of beating. Tear, tensile, and burst strengths of the *P. sitchensis* pulps were higher than those of *P. abies* pulps at 4000 revolutions of beating (Table 3). When the pulps were compared at a fixed sheet density or burst strength the differences were even greater.

As expected, corewood pulps had greater tensile and burst strengths than the slabwood pulps when compared at the same level of beating treatment, sheet density, or burst strength. At 4000 PFI revolutions of beating, both corewood pulps gave hand-

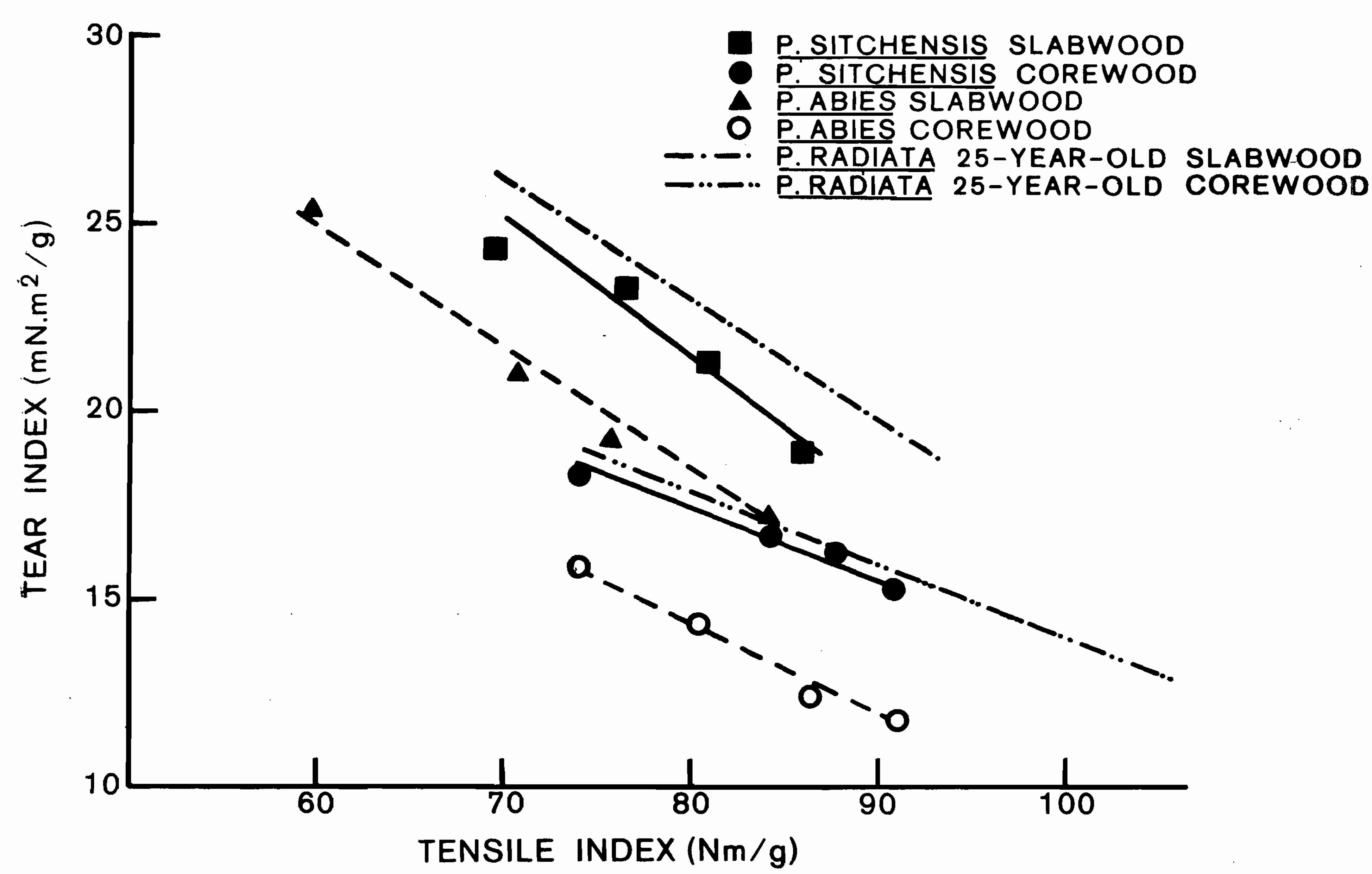

FIG. 1—Tear/tensile relationships for **Picea** and **Pinus radiata** slabwood and corewood pulps.

sheets with tensile indices of approximately 80 Nm/g whereas the equivalent slabwood values were about 70 Nm/g.

The tear/tensile data obtained by Annergren *et al.* (1963) for Scandinavian spruce kraft pulps fall within the range of the equivalent values reported here for *P. abies* slabwood and corewood pulps. The Scandinavian pulps were obtained from wood with a basic density of 400 kg/m^3, compared with 420 kg/m^3 for the slabwood and 370 kg/m^3 for the corewood used in the present study.

Scattering coefficients for slabwood handsheets from both species were similar, being approximately 17 m^2/kg at 650 kg/m^3 sheet density. At this level of sheet density the respective scattering coefficients for the *P. abies* and *P. sitchensis* corewood pulps were 23 and 21 m^2/kg.

TABLE 3—Handsheet properties after 4000 PFI beating revolutions

	P. abies		P. sitchensis	
	Corewood	Slabwood	Corewood	Slabwood
Sheet density (kg/m^3)	693	624	659	619
Tear index (mN.m^2/g)	14.2	22.1	17.2	22.9
Tensile index (Nm/g)	80.0	68.6	81.5	74.2
Burst index (kPa.m^2/g)	7.4	6.0	7.6	6.5
Stretch (%)	3.5	3.1	3.2	3.1
Scatt. Coeff. (m^2/kg)	20.1	18.7	19.4	18.6

CONCLUSIONS

In view of these results, it seems that kraft pulp from New Zealand-grown *P. abies* has about the same strength properties as pulp from Scandinavian wood of the same basic density, but the properties of handsheets produced are somewhat inferior to those produced from *Pinus radiata* of equivalent density.

On the other hand, pulps from *P. sitchensis* are approximately equivalent in yield and strength to those from *Pinus radiata.*

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