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Supplementary Material

Physicochemical characteristics controlling the flammability of live *Pinus banksiana* needles in central Alberta, Canada

Rodrigo Campos-Ruiz[A,B,*], *Marc-André Parisien*[C] and *Mike D. Flannigan*[A,B]

[A]Department of Renewable Resources, University of Alberta, Edmonton, AB, T6G 2R3, Canada

[B]Canadian Partnership for Wildland Fire Science, Department of Renewable Resources, University of Alberta, Edmonton, AB, T6G 2R3, Canada

[C]Northern Forestry Centre, Natural Resources Canada, Edmonton, AB, T6H 3S5, Canada

*Correspondence to: Email: rcampos@ualberta.ca

Supplementary material

Table S1. Monthly weather data for temperature and precipitation for the sampling period of the study.

Maximum and minimum temperatures indicate extremes. Source: Edmonton Woodbend weather station (ID: 1872), Alberta, located at 1.65 km from the study site.

Month	Maximum temperature (C°)	Minimum temperature (C°)	Mean temperature (C°)	Precipitation (mm)
June	32.5	3	15	36
July	33.5	4	18.2	80.2
August	30	1	15.8	28
September	26	-2.5	9.7	76.3

Fig. S1. Modified setup for the cone calorimeter flammability testing.

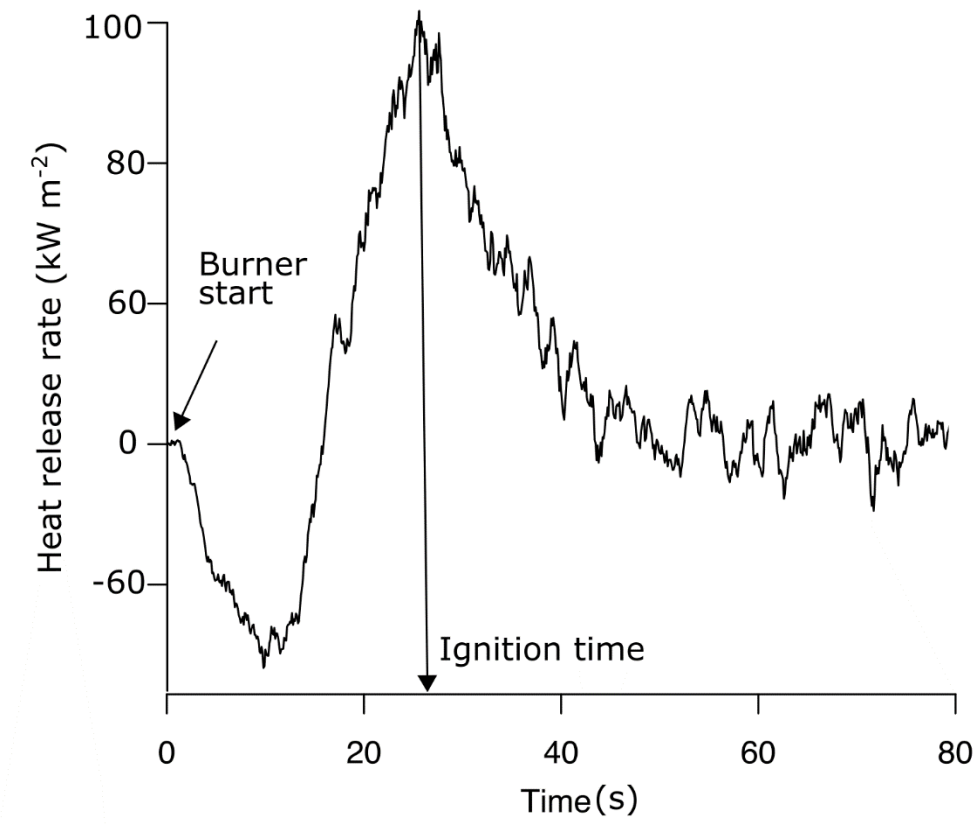

Figure S2. Determination for ignition time (IT) was assessed visually and confirmed with the heat differential heat release rate curve. IT matches the first, and usually the highest peak of HRR.

Table S2. Detailed methods for the extraction and calculation of the chemical composition of jack pine needles

Compound/ element		Extraction	Equipment
Nitrogen	N	Samples were oven-dried at 70ºC and finely ground. Then, they were subject to oxygen-rich combustion to produce dioxide and nitrogen gas (CO2, N2) that can be quantified.	Costech 4010 calorimeter and EAS Clarity data collection software
Carbon	C		
Soluble sugars	SS	Samples were oven-dried and finely milled. Then, hot ethanol was used to separate the sugars from the rest of the tissues, and an anthrone/sulphuric acid reagent was added	Determined calorimetrically (Thermo Scientific Evolution 300 UV/Vis spectrometer) using the anthrone reagent
Starch	ST	After removing soluble sugars, the sample is boiled to gelatinize the starch, and then the starch is hydrolyzed into glucose using an amyloglucosidase enzyme.	Determination of glucose by calorimetry (Thermo Scientific Evolution 300 UV/Vis spectrometer)
Lipids	LI	Samples were frozen with liquid nitrogen and ground. An hexan solvent was added and the mix was later filtered to analyze. The total lipid content does not include terpenes.	Agilent Masshunter 7890/5975C gas chromatography spectrometer and NIST2014 spectral database
Terpenes	TE		

Table S3. Results for the repeated measures ANOVA for the effects of the month of collection and needle's age on jack pine needles' flammable characteristics (*n* = 96).

Transformations (if any) are indicated in parenthesis under the variable name, and *P*-values <0.05 are shown in bold. The *P-value* was adjusted for the false discovery rate

Variable	**Factor**	***F* (3,2,6)**	***P***
	Flammability		
Ignition time (Squared root)	Month	36.24	**<0.001**
	Age	45.70	**<0.001**
	Month × Age	28.21	**<0.001**
Peak heat release rate (log)	Month	11.23	**<0.001**
	Age	16.19	**<0.001**
	Month × Age	2.80	**0.02**
Effective heat of combustion	Month	13.26	**<0.001**
	Age	0.21	0.80
	Month × Age	1.64	0.16
Average mass loss rate	Month	2.55	0.09
	Age	3.01	0.07
	Month × Age	1.98	0.09

Table S4. Results for the repeated measures ANOVA for the effects of month of collection and age of the needle on the foliar moisture content and form characteristics of jack pine needles (*n*=96).

Transformations (if any) are indicated in parenthesis under the variable name, and *P*-values <0.05 are shown in bold. The *P-value* was adjusted for the false discovery rate

Variable	**Factor**	***F* (3,2,6)**	***P***
	Moisture content		
Moisture content (log)	Month	12.13	**<0.001**
	Age	94.50	**<0.001**
	Month × Age	14	**<0.001**
	Morphology		
Curvature	Month	1.30	0.20
	Age	4	**<0.01**
	Month × Age	2.60	**<0.05**
Form coefficient (logit)	Month	9.54	**<0.001**
	Age	149.35	**<0.001**
	Month × Age	22.42	**<0.001**
Surface area to volume ratio	Month	57.43	**<0.001**
	Age	54.42	**<0.001**
	Month × Age	66	**<0.001**

Table S5. Results for the repeated measures ANOVA for the effects of month of collection and age of the needle on jack pine needles' chemical characteristics (*n*=96).

Transformations are indicated in parenthesis under the variable name, and *P*-values <0.05 are shown in bold. The *P-value* was adjusted for the false discovery rate.

Variable	Factor	*F* (3,2,6)	*P*
	Chemistry		
Carbon (logit)	Month	14.3	**<0.001**
	Age	10.34	**<0.001**
	Month × Age	3.32	**<0.05**
Nitrogen (logit)	Month	16	**<0.001**
	Age	61.21	**<0.001**
	Month × Age	34.75	**<0.001**
Starch (logit)	Month	71	**<0.001**
	Age	61.40	**<0.001**
	Month × Age	20.32	**<0.001**
Soluble sugars (logit)	Month	4.60	**<0.05**
	Age	1	0.38
	Month × Age	2.55	**<0.05**
Lipids (logit)	Month	26.22	**<0.001**
	Age	64.40	**<0.001**
	Month × Age	3.72	**<0.05**
Terpenes (logit)	Month	4.80	**<0.05**
	Age	32.43	**<0.001**
	Month × Age	5.86	**<0.001**

Table S6. Correlation coefficients of the NMDS variables with their ordination axes, and the result of the premutation test.

Coefficients (*r*) indicate the correlation of each variable with the ordination axes.

Variable	Acronym	Axis 1 (x axis)	Axis 2 (y axis)	*r*	*P*
Ignition time	IGT	-0.98	0.19	0.76	0.01
Heat release rate	HRR	0.50	-0.86	0.46	0.01
Effective heat of combustion	EHC	-0.21	-0.97	0.63	0.01
Mass loss rate	MLR	0.52	0.85	0.37	0.01
Foliar moisture content	FMC	-0.92	-0.37	0.96	0.01
Form coefficient	FCO	-0.86	0.50	0.78	0.01
Curvature	CRV	0.92	0.37	0.32	0.03
Surface-area-to-volume ratio	SVR	0.98	0.19	0.68	0.01
carbon	C	0.99	-0.02	0.52	0.01
Starch	ST	0.16	-0.98	0.56	0.01
Soluble sugars	SS	0.79	0.61	0.16	0.32
Nitrogen	N	-0.94	0.33	0.69	0.01
Lipids	LI	0.06	-0.99	0.47	0.01
Terpenes	TE	0.99	0	0.46	0.01