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WOOD SPECIES OF THE CENTRAL AFRICAN REPUBLIC: ASH AND SILICA CONTENT

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Abstract

Data on ash and silica content of 28 Central African hardwoods and one monocotyledon (*Dracaena mannii*) are presented. Ash content varied considerably. Most of the values were in the range 0.3 - 1.4 %. The highest value was noted for *Desplatsia floribunda* (4.54 %) and the lowest for *Pachyleasma tessmannii* (0.07 %). In most species, silica was present only in trace amounts (less than 0.01 %). More than 0.1 % silica was found only in the *Gambea beguei* (0.128 %) and *Manilkara fouilloyana* (0.138 %).

Key words: *Central African wood species, ash content, silica content, Albizzia adianthifolia, Anthostema aubryanum, Blighia welwitschii, Celtis zenkeri, Combretodendron africanum, Croton aubrevillei, Desplatsia floribunda, Detarium macrocarpum, Dracaena mannii, Ficus sp., Gambea beguei, Gambea boukokoensis, Macaranga barteri, Manilkara fouilloyana, Marquesia excelsa, Morinda lucida, Oldfieldia africana, Pachyleasma tessmannii, Parkia filicoidea, Polyalthia suaveolens, Rauvolfia macrophylla, Stemonocoleus micranthus, Swartzia fistuloides, Tessmannia africana, Tessmannia lescrauwetii, Treculia africana, Tridesmostemon omphalocarpoides, Xylopia hypolampsa*

LESNE VRSTE CENTRALNOAFRIŠKE REPUBLIKE: VSEBNOST PEPELA IN SILIKATOV

Izvleček

Izmerjena je bila vsebnost pepela in silicijevega dioksida za 28 tropskih afriških listavcev in ene enokaličnice (Dracaena mannii). Vsebnost pepela je močno variirala. Večina zabeleženih vrednosti se je gibala med 0,3-1,4 %. Najvišja vrednost je bila zabeležena pri Desplatsia floribunda (4,54 %) in najnižja pri Pachyleasma tessmannii (0,07 %). Pri večini vrst je bil SiO_2 določen le v sledeh (manj kot 0,01 %). Njegova vsebnost nad 0,1 % je bila izmerjena le pri Gambea beguei (0,128 %) in Manilkara fouilloyana (0,138 %).

Ključne besede: *Centralnoafriške lesne vrste, vsebnost pepela, vsebnost silikatov, Albizzia adianthifolia, Anthostema aubryanum, Blighia welwitschii, Celtis zenkeri, Combretodendron africanum, Croton aubrevillei, Desplatsia floribunda, Detarium macrocarpum, Dracaena Mannii, Ficus sp., Gambea beguei, Gambea boukokoensis, Macaranga barteri, Manilkara fouilloyana, Marquesia excelsa, Morinda lucida, Oldfieldia africana, Pachyleasma tessmannii, Parkia filicoidea, Polyalthia suaveolens, Rauvolfia macrophylla, Stemonocoleus micranthus, Swartzia fistuloides, Tessmannia africana, Tessmannia lescrauwetii, Treculia africana, Tridesmostemon omphalocarpoides, Xylopia hypolampsa*

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VSEBINA
CONTENTS

1 INTRODUCTION
UVOD

In general, wood possesses a characteristic composition. The same major components are present in all woods. The kinds and amounts of certain minor components are determined to a great extent by species. Small variations are found from tree to tree and in different parts of the same tree (BROWNING 1967).

In summative analysis, ash is often not included but just lignin, cellulose, hemicelluloses and extractives. Summation of ash changes the result from about 99 % to 101 % for most temperate-zone woods. Greater error could arise for tropical woods.

Inorganic substances largely appear in the ash, but some could be volatilised during ashing. In the absence of volatile components, the residue after incineration should be used as test sample, and the major inorganic constituents can be determined by conventional gravimetric or volumetric methods.

It is possible to use some spectrophotometric methods, atomic absorption spectroscopy, potentiometric, complexometric and redox titrimetry, etc. More sophisticated methods include activation analysis and ray emission spectroscopy. By combination of different analytical techniques, special studies can be done (SJÖSTROM / ALEN 1998).

The inorganic components in wood are various salts of carbonates, silicates, phosphates and oxalates, so that the major components of wood ashes are calcium, potassium, sodium, magnesium, iron, silica, phosphate, sulphate, chloride, and carbonate. The components are not distributed uniformly throughout the tissue, but are typically localised with respect to cell structure.

Silica is rarely present in more than trace amounts in temperate climate woods, but can vary in tropical woods from a mere trace to as much as 9 % (SANDERMANN 1966, TORELLI / ČUFAR 1995). More than 0.5 % of silica in wood is harmful to cutting tools (PETTERSON 1984, GOTTWALD 1973), and the machinability of wood is decisively influenced if the silica content is 1-3%. Silica has similar effect on the boring apparatus of marine animals. Even low-density woods are difficult to machine when their silica content is high (NOACK / FRÜHWALD 1977). The cutting process is affected chiefly by basic density, silica content and moisture content. Their influence, however, is intensified by a number of accompanying parameters, such as wood texture (interlocked grain), bark, accessory substances and by

various anomalies. Silica often results in nasal irritation on many people. Some investigators have attempted to evaluate the diagnostic value of siliceous inclusions (AMOS 1952, WELLE 1976). It is recognized that silica levels can vary within a single tree and within one species depending on location and growth conditions.

2 MATERIAL AND METHODS
MATERIAL IN METODE

Test trees were taken from the extreme southwest part of the République Centrafricaine near the triple border with the République Populaire du Congo and République Fédérale du Cameroun. The location is situated approximately between 2º46" and 3º00" north latitude and east of the Sangha River (left bank) and covers the regions of the Kenie, Massapoula and Yobe river basins. For each randomly selected test tree, 10 samples were taken from the peripheral part of the heartwood when present or from stem periphery in species without colored heartwood (Table 1). The number of test trees is given in Table 1.

Determination of ash content of the oven-dry wood and silica content is described in the literature (BROWNING 1967, SIEBER 1951).

3 RESULTS AND DISCUSSION
REZULTATI IN DISKUSIJA

The results of ash content and silica content are shown in Table 1. Ash content varied considerably. Most of the values were in the range of 0.30 to 1.40 % and rarely above 2.00 %. Especially high values were noted for *Desplatsia floribunda* Burret (4.54 %), *Oldfieldia africana* Benth. & Hook. f. (2.42 %) and monocotyledon *Dracaena mannii* Baker (2.08 %). Two species had low ash content: *Pachyleasma tessmannii* Harms (0.07 %) and *Stemonocoleus micranthus* Harms (0.17 %). Most of the species tested contained an insignificant amount of silica, less than 0.01 % based on the oven-dry weight of the wood. Somewhat higher values were determined in *Oldfieldia africana* Benth. & Hook. f. (0.02 %), and *Desplatsia floribunda* Burret (0.04 %). Only two species contained significant, though not critical, amounts of silica: *Manilkara fouilloyana* Aubrev. & Pellegr. (0.14 %) and *Gambea beguei* Aubrev. & Pellegr. (0.13 %).

Table 1: Wood species of the Central African Republic: ash and silica content

Preglednica 1: Lesne vrste centralnoafriške republike: vsebnost pepela in silikatov

Botanical and common names	Family	No. of trees tested	Oblig. colored heartwood	Density ρ_0 kg/m^3	Ash content of the oven-dry wood Average [%]	Silica content	
						of the ash Average [%]	of the oven-dry wood Average [%]
Albizzia adianthifolia (Schumach.) W.F. Wight ebamba, sakandi	Mimosaceae	1	*	590	*0.77*	0.71	0.005
Anthostema aubryanum Baill -	Euphorbiaceae	1	—	317	*1.20*	0.81	0.010
Blighia welwitschii (Hiern) Radlk. botoko, wotoko	Sapindaceae	1	*	897	*1.33*	0.95	0.012
Celtis zenkeri Engl. Ngombe, gbolo, kakala, ohia	Ulmaceae	5	—	707	*0.67*	0.87	0.006
Combretodendron africanum (Welw.) Exell dosso, mbosse, abale	Lecythidaceae	5	*	841	*0.32*	0.82	0.003
Croton aubrevillei J. Leonardi molinga, tesso	Euphorbiaceae	5	—	673	*0.48*	0.83	0.004
Desplatsia floribunda Burret korou	Tiliaceae	1	—	492	*4.54*	0.92	0.042
Detarium macrocarpum Harms eboto, alen	Caesalpiniaceae	5	*	647	*0.68*	0.86	0.006
Dracaena mannii Baker geke, lobe	Dracaenaceae	5	—	338	*2.08*	0.66	0.014
Ficus sp. -	Moraceae	1	—	604	*1.84*	0.76	0.013
Gambea beguei Aubr. Et Pellegr. -	Sapotaceae	1		662	*1.23*	10.85	0.128

Table 1: Wood species of the Central African Republic: ash and silica content - continuation

Preglednica 1: Lesne vrste centralnoafriške republike: vsebnost pepela in silikatov - nadaljevanje

Botanical and common names	Family	No. of trees tested	Oblig. colored heartwood	Density ρ_0 kg/m^3	Ash content of the oven-dry wood Average [%]	Silica content	
						of the ash Average [%]	of the oven-dry wood Average [%]
Gambea boukokoensis Aubr. Et Pellegr. libele-yongue	Sapotaceae	1	—	710	*0.46*	0.88	0.004
Macaranga barteri Műll.-Arg. -	Euphorbiaceae	1	—	442	*0.80*	1.15	0.009
Manilkara fouilloyana Aubrev.&Pellegr fou, mounguinza	Sapotaceae	5	*	904	*0.61*	18.28	0.138
Marquesia excelsa (Pierre) R.E. Fries -	Dipterocarpaceae	1	—	607	*1.77*	0.51	0.010
Morinda lucida Benth. dongbolongoya	Rubiaceae	1	—	654	*1.12*	0.70	0.008
Oldfieldia africana Benth.&Hook. f. ndombo	Euphorbiaceae	5	—	370	*2.42*	0.81	0.020
Pachylesma tessmannii Harms duoma ya zaba, dogabela, gabela	Caesalpiniaceae	5	*	751	*0.07*	1.95	0.002
Parkia filicoidea Welw. zigna ou zien	Mimosaceae	1	—	471	*1.12*	0.93	0.010
Polyalthia suaveolens Engler et Diels bapo, etounga	Annonaceae	1	—	783	*0.86*	0.87	0.007
Rauvolfia macrophylla Stapf. -	Apocynaceae	1	—	564	*0.73*	1.03	0.008
Stemonocoleus micranthus Harms tengi	Caesalpiniaceae	1	*	586	*0.17*	1.44	0.002

Table 1: Wood species of the Central African Republic: ash and silica content - continuation

Preglednica 1: Lesne vrste centralnoafriške republike: vsebnost pepela in silikatov - nadaljevanje

Botanical and common names	Family	No. of trees tested	Oblig. colored heartwood	Density ρ_0 kg/m^3	Ash content of the oven-dry wood Average [%]	Silica content	
						of the ash Average [%]	of the oven-dry wood Average [%]
Swartzia fistuloides Harms pau rossa	Caesalpiniaceae	5	*	1017	*0.37*	0.94	0.003
Tessmannia africana Harms paka, wamba, tou-nzeng	Caesalpiniaceae	5	*	910	*0.47*	0.77	0.004
Tessmannia lescrauwaetii (De Wild.) Harms gama, tou-nzeng	Caesalpiniaceae	5	*	910	*0.47*	0.72	0.004
Treculia africana Decaisne -	Moraceae	1	—	674	*1.04*	0.97	0.010
Tridesmostemon omphalocarpoides Engl. bongoforo	Sapotaceae	1	*	1093	*0.62*	0.77	0.005
Xylopia hypolampsa Mildbr.&Diels -	Annonaceae	5	—	790	*0.88*	0.68	0.006

Legend: * = Oblig. colored heartwood present; - = Oblig. colored heartwood not present

4 POVZETEK

V okviru slovensko ameriškega projekta YO-FS-74-JB-10 so bile raziskane biološke, fizikalne, kemične in mehanske lastnosti lesov 28 neznanih in manj znanih lesnih vrst iz Centralnoafriške republike. Silikati se le izjemoma pojavljajo v lesovih zmernega pasu, medtem ko so pri tropskem drevju redna akcesorna sestavina, ki lahko v ekstremnih primerih doseže 9 % mase absolutno suhega lesa. Vsebnost, večja od 0,5 %, že škodljivo deluje na rezila, vsebnost nad 1 % pa je ekonomsko kritična zaradi visoke obrabe. Silikati

se v lesu lahko pojavljajo v najrazličnejših oblikah, ki imajo lahko tudi določeno lesno diagnostično oziroma identifikacijsko vrednost (AMOS 1952, WELLE 1976). Najdemo jih v aksialnem in trakovnem parenhimu in le redko v trahejah in vlaknih.

Raziskane vrste iz ekvatorialne Afrike imajo zelo nizko vsebnost silikatov, ki je z vidika obdelave in predelave lesa neškodljiva. Vsebnost pepela preiskanih vrst je bila med 0,07 % (*Pachyleasma tessmannii* Harms) in 4,54 % (*Desplatsia floribunda* Burret). Vsebnost silicijevega dioksida je bila med 0,002 % (*Pachyleasma tessmannii* Harms) in 0,138 % (*Manilkara fouilloyana* Aubrev. & Pellegr.).

5 REFERENCES
VIRI

AMOS, L., 1952. Silica in timbers.- Commonwealth Scientific and Industrial Research Organization, Australia, Bulletin No. 267:55 s.

BROWNING, B. L., 1967. Methods of wood chemistry.- New York, John Wiley and Sons, s. 12, s. 302.

GOTTWALD, H., 1973. Die Bedeutung der Holzanatomie für die Voraussage von Holzeigenschaften.- Holzforschung 27,2: 48-51.

NOACK, D. A. / FRÜHWALD, A., 1977. The influence of wood properties on wood processing.- IUFRO - Joint Meeting of the Subject Group S 5.04 and the Project Group 5.01. Merida, Venezuela.

PETTERSEN, R. C., 1984. The chemical Composition of Wood.- V: ROWELL, R. (ed.), The Chemistry of Solid Wood. Washington, D. C., American Chemical Society, s. 57-126.

SANDERMANN, W., 1966. Holzinhaltstoffe, ihre Chemie und Biochemie.- Naturwissenschaften 53,20: 513-525.

SIEBER, R., 1951. Die Chemisch-Technischen Untersuchungs-Methoden der Zellstoff- und Papier-Industrie.- Berlin, Springer-Verlag, s. 13.

SJÖSTRÖM, E. / ALEN, R., 1998. Analytical methods in wood chemistry, pulping, and papermaking.- Springer, s. 287-288.

TORELLI, N. / ČUFAR, K., 1995. Mexican tropical hardwoods. Comparative study of ash and silica content.- Holz als Roh - und Werkstoff 53: 61-62.

WELLE, B. J. H. ter 1976. Silica grains in woody plants of the Neotropis, especially Surinam.- V: Wood Structure in Biological and Technological Research: 107-142.

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