

## **CHEMICAL COMPOSITION OF SELECTED SPECIES OF EXOTIC WOOD DERIVED FROM THE REGION OF AFRICA**

Agata Pawlicka, Bogusława Waliszewska

Poznań University of Life Sciences

**Abstract.** Chemical composition of selected exotic wood species derived from the area of Africa was investigated by determining the contents of: cellulose, lignin, holocellulose, pentosans and substances soluble in organic solvents, in 1% NaOH solution, in cold and hot water, as well as the contents of mineral substances. The performed investigations revealed that concentrations of the determined constituents in individual wood species varied despite similar site and climatic conditions.

**Key words:** sipo, mongoy, koto, chemical composition

### **INTRODUCTION**

Exotic wood constitutes organic material derived from overseas countries, especially those which grow in climatic zones alien for Polish conditions and which do not occur here in plant communities but are found, primarily, in tropical forests. Those forests are the oldest and richest ecosystems on our planet. Even though they occupy only 6% of the total global land area, approximately 50% to 70% of all plant and animal species found in the world live there, including about 50 000 tree species. These resources are being intensively exploited. Utilisation of exotic wood in developed countries during the last 40 years increased by over 15 times. Its share in the domestic market and, consequently, the availability of this material mainly in the form of sawn timber, elements of window woodwork, as well as veneer has also been increasing steadily. It is, perhaps, worth stressing here that exotic wood derives not only from natural forests, e.g. of the Amazon River basin or from Congo but also from plantation cultivations, for example: teak, cedrela, eucalyptus, mahogany, dibetou or okoume [Kozakiewicz 2008].

## MATERIAL AND METHODS

The experimental material comprised exotic wood which derived from the areas of Western, Central and Equatorial Africa. Broad-leaved exotic wood species selected for investigations included: *Guibourtia ehie* (mongoy), *Entandrophragma utile* (sipo) as well as *Pterygota macrocarpa* (koto). The above-mentioned tree species can be found, primarily, in such countries as: Ghana, Cameroon, Guinea, the Ivory Coast, Gabon and Nigeria.

Investigations of the selected wood species were conducted in accordance with the methodology recommended by the PN-75/50025 standard determining:

- proportion of cellulose by the Seifert's method
- lignin content by Tappi method
- holocellulose content
- content of substances soluble in organic solvents
- quantities of substances soluble in cold and hot water
- quantities of substances soluble in 1% NaOH
- amount of pentosans using the phloroglucinol method
- proportions of mineral substances.

## RESULTS AND DISCUSSION

Table 1 presents the chemical composition of the selected exotic wood species. The content of cellulose in wood of the examined species derived from Western Africa was determined at a similar, relatively low, level. The highest level of cellulose (43.13%) was determined in mongoy wood, less of this constituent (41.59%) was found in sipo wood, whereas koto wood contained 43.03% cellulose. According to Prosiński [1984], domestic wood contains from 40% to 50% cellulose. Therefore, it can be said that the determined cellulose content in the examined exotic wood species was contained within this interval.

The content of holocellulose in the analysed wood species ranged within the interval from 59.91% to 71.76%. The highest quantities of holocellulose were found in koto wood and the lowest – in mongoy wood, whereas in sipo wood, the content of this constituent reached 64.28% (Table 1). Differences in holocellulose content between individual wood species reached approximately 12% and depended on the percentage proportion of lignin in the examined wood species.

On the basis of literature data [Harzmann 1988], it can be concluded that broad-leaved tropical species exceed considerably European trees with regard to lignin content. Our own investigations showed that two species of exotic wood – sipo and mongoy – contained quite similar amounts of this wood constituent, 30.36% and 30.20%, respectively. The lowest content of lignin (22.43%) was determined in the wood of koto. The obtained results of lignin content determination in the dicotyledonous exotic wood of sipo and mongoy confirmed the thesis that exotic wood contains more of this constituent than European broad-leaved wood species. Only koto wood, with its low content of lignin, was found to contain the percentage proportion of the compound characteristic for European wood species.

Table 1. Chemical composition of selected exotic wood species  
Tabela 1. Skład chemiczny wybranych gatunków drewna egzotycznego

Kind of designation Rodzaj oznaczenia	Wood species – Gatunek drewna		
	koto	sipo	mongoy
concentration, % – zawartość, %			
Cellulose Celuloza	43.03	41.59	43.14
Holocellulose Holoceluloza	71.76	64.28	59.91
Lignin Lignina	22.43	30.36	30.20
Pentosans Pentozany	17.53	11.37	18.32
Ash Popiół	2.38	0.57	0.74

Pentosans proportions found in broad-leaved species growing in temperate zones range from 15 to 22% [Harzmann 1988], whereas in tropical dicotyledonous species – from 11 to 19%. It can be concluded, on the basis of the performed investigations, that the highest pentosan content attaining 32.18% was determined in mongoy wood, while the lowest (11.37%) was found to occur in sipo wood, so the difference in the content of these compounds reached 7%. Koto wood exhibited the content of pentosans similar to that in mongoy (15.53%). The analyses carried out on the experimental wood species confirmed literature data [Harzmann 1988] regarding the content of pentosans in broad-leaved species of tropical wood.

According to Prosiński [1984], the amount of mineral substances in domestic wood species fluctuates from 0.3 to 1.0%. The highest proportion of ash amounting to 2.38% was found in koto wood, whereas the wood of sipo and mongoy species exhibited significantly lower concentrations of mineral substances which amounted to 0.57 and 0.74%, respectively. The high content of this constituent in koto wood can be attributed to silicon compounds which were found to occur in this wood species [Noga 1998].

The content of extractive substances in the examined exotic wood species is presented in Table 2. Quantities of substances soluble both in hot and cold water in the case of the examined tropical wood species were fairly low in comparison with wood species of the European zone [Wagenführ 2007] and varied considerably among themselves. The quantity of substances soluble in cold water in European dicotyledonous species ranges from 0.6% to 7.0%, while the content of hot water-soluble substances – from 1.2 to 11%. The highest quantities of cold and hot water-soluble substances were determined in koto wood in which, respectively, 5.20% and 5.63% of these compounds were determined. Mongoy wood exhibited a high content (5.26%) of substances soluble in hot water but the amount of compounds extracted from this wood by cold water was nearly twice lower and amounted to 2.92%. The analysed sipo wood was characterised by the lowest content of both cold and hot water-soluble substances which was determined at 0.34% and 3.40%, respectively.

Table 2. Concentration of extractive substances in selected species of exotic wood  
 Tabela 2. Zawartość substancji ekstrakcyjnych w wybranych gatunkach drewna egzotycznego

Kind of solvent Rodzaj rozpuszczalnika	Wood species – Gatunek drewna		
	koto	sipo	mongoy
	concentration, % – zawartość, %		
Cold water Zimna woda	5.20	0.43	2.92
Hot water Gorąca woda	5.63	3.40	5.26
Ethyl alcohol Alkohol etylowy	3.58	4.78	5.82
1% NaOH 1% NaOH	19.10	15.75	14.12

The content of extractive substance was determined with the assistance of ethyl alcohol; hence measurement values are lower than in the case of alcohol-benzene mixture at 1:1 ratio. The highest proportions (5.82%) of substances soluble in the organic compound were determined in mongoy wood, whereas the lowest – in koto wood in which 3.58% of these compounds were found. Tropical wood of sipo species was found to contain 4.78% of alcohol-extracted substances. The content of extractive substances in the examined species of exotic wood was fairly high when ethyl alcohol alone was employed.

When analysing the content of substances soluble in 1% NaOH solution, considerable differences were determined in the percentage share of these compounds between the examined wood species. Their highest concentrations reaching 19.10% were established in koto wood, while in the case of mongoy wood, the level of alkali-soluble substances fell by 5%. Sipo wood contained 15.75% of these substances.

The performed investigations on the chemical composition of selected species of exotic wood revealed that there were differences in this respect between species derived from the same climatic region.

## CONCLUSIONS

The following conclusions can be drawn on the basis of the performed investigations on the chemical composition of the following exotic wood species: *Guibourtia ehie* (mongoy), *Entandrophragma utile* (sipo) and *Pterygota macrocarpa* (koto):

1. Cellulose content in the analysed exotic wood fluctuated at a fairly low level and ranged from 43.14% to 41.59%.

2. Differences in the concentration of holocellulose in the examined species of exotic wood amounted to about 12%.

3. Lignin proportions in sipo and mongoy woods (30.36% and 30.20%) greatly exceeded concentrations characteristic for European wood. The exception was koto wood whose content of 22.43% was the lowest value determined in the experiment and was contained within the interval of European wood.

4. The pentosan content determined in the analysed species of exotic wood corroborated literature data about percentage proportions of this constituent for broad-leaved tropical wood. Mongoy wood contained the highest amounts of pentosans (18.32%), while sipo wood – 11.37%.

5. Koto wood exhibited high content of mineral substances amounting to 2.38%. Quantities of ash in mongoy and sipo woods (0.74% and 0.57%) were similar to those found in the wood of the temperate climate region.

6. The content of substances soluble in cold water varied greatly and fluctuated from 0.43% to 5.20%, while the content of hot water-soluble substances was contained in the interval of 5.63% to 3.40%.

7. In comparison with the domestic wood species, concentrations of alcohol-soluble substances in exotic wood species were high.

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## SKŁAD CHEMICZNY WYBRANYCH GATUNKÓW DREWNA EGZOTYCZNEGO POCHODZĄCYCH Z OBSZARU AFRYKI

**Streszczenie.** Przeprowadzono badania składu chemicznego wybranych gatunków drewna egzotycznego pochodzących z terenu Afryki. Oznaczono zawartość celulozy, ligniny, holocelulozy, pentozanów, substancji rozpuszczalnych w rozpuszczalnikach organicznych, w 1-procentowym roztworze NaOH, w zimnej i gorącej wodzie oraz zawartość substancji mineralnych w wybranych gatunkach drewna. Badania wykazały, iż zawartość oznaczonych składników w poszczególnych gatunkach drewna jest zróżnicowana, mimo podobnych warunków siedliskowych oraz klimatycznych.

**Słowa kluczowe:** sipo, mongoy, koto, skład chemiczny

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