

NOTES ON COLOUR CHANGES IN WOOD DECAYED BY *CORIOLUS VERSICOLOR* FUNGUS

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Scots pine and beech wood was decayed by the *Coriolus versicolor* fungus. It was observed that the pine wood is darkening from 80 to 54% while the beech wood reveals increase of brightness from the 57 to 80%. The mentioned observations were found in two experimental repetitions. Any influence of such factors as access of day-light in the course of decay or degree of extraction of resinous substances on the changes of colour was not stated. It scots pine wood about three times increase of relative content of substances soluble in NaOH was observed, while in decayed beech wood those changes were slight.

The genesis of work is based on the observation that the wood of scots pine decayed by *Coriolus versicolor* is darkening while beech wood decayed by the same fungus shows increase of brightness. This is the cause to elucidate this problem.

MATERIAL AND METHODS

The experiments were performed on the beech (*Fagus sylvatica* L.) and scots pine wood (*Pinus silvestris* L.). The wood for investigations was taken from peripheral parts of stem on the height 3 - 6 m above the ground level. The test pieces 3 × 20 × 30 mm were sampled. The scots pine samples were taken only from the sapwood. The culture of *Coriolus versicolor* L. ex Fr. Quel. (= *Trametes versicolor* L.: Fr. Quel. = *Polystictus versicolor* L. ex Fr.) was taken from collection of cultures of the Institute of Forest and Wood Protection of Agricultural University in Warsaw. The wood decay by *C. versicolor* was made in two repetitions. First repetition was conducted in the humidity chamber at relative humidity 65 - 70%, temperature 22°C and diffused daylight. The second repetition of the tests were made in the same parameters in the humidity chamber in the diffused daylight and in total darkness in incubator. The wood samples were divided onto two groups. The first one was completely extracted in the ethanol-benzene (1:1) mixture. The second group was unextracted. The decayed wood was ground to the particles of 0.5 - 1.0 mm. For the colour measurements Momcolor D three-stimulus colorimeter made in Hungary was used. Brightness measurements were made in comparison with white standard which is 100% of brightness. The length of dominant wave and excitation cleanes were calculated according to formulas given in the Polish Standard PN-65/N-01252.

Table 1
 Contents of main chemical components and colour and beech wood after decay by *Coriolius versicolor* fungus
 Zawartość głównych składników chemicznych i barwa drewna sosny i buka rozłożonych przez grzyb *Coriolius versicolor*

Wood Drewno	Time of decay — Czas rozkładu (days — dni)	Mass loss — Ubytek masy Δm [%]	Chemical composition in % of decomposed wood — Skład chemiczny w % drewna rozłożonego			Brightness Jasność [%]	Cleanses of excitation — Czyszczenie — tość pobudzenia [Pe]	Length of dominant wave — Długość fali dom. λ_d [nm]
			solubles subst. r. NaOH	lignin lignina	holocellulose — holoceluloza			
Scots pine	0	0	5.72	27.64	67.42	79.8	0.38	577.0
	10	0.5	—	—	—	61.0	0.33	581.0
	30	6.0	18.96	20.84	65.84	56.8	0.39	580.8
	70	14.0	20.87	20.42	63.22	57.1	0.39	580.8
	150	26.6	—	—	—	54.4	0.41	582.5
Sosna	300	28.7	24.27	19.75	61.87	53.2	0.41	682.5
	0	0	12.95	23.51	69.49	57.1	0.25	585.0
Beech	10	3.0	18.78	21.12	64.19	51.5	0.25	585.0
	30	24.0	20.81	20.65	63.99	66.5	0.25	585.0
Buk	50	33.0	21.81	19.60	61.60	71.7	0.25	579.1
	120	63.0	27.41	17.47	60.51	80.0	0.25	579.1
	190	81.0	—	—	—	80.3	0.22	582.3

RESULTS AND DISCUSSION

Conducted tests revealed that there are significant differences in colour of scots pine and beech wood subjected to decay by the *C. versicolor* fungus (Tab. 1, Fig. 1). With the prolongation of decay time of scots pine wood the decrease of brightness from 79.8 to 53.9% occurs. Particularly intensive decrease of brightness takes place in first 30 days of fungus activity, when the mass loss is about 6% and the decrease of brightness from the 79.8 to 56.8%. The action of *C. versicolor* on beech wood affects

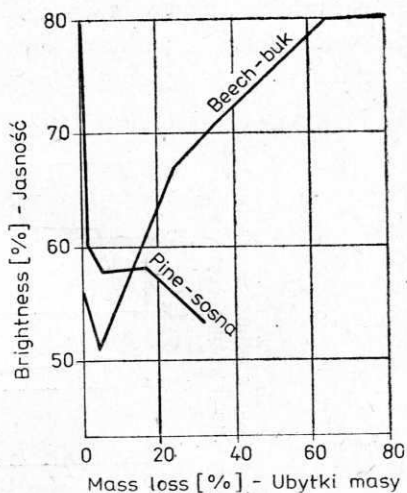


Fig. 1. The changes in brightness of scots pine and beech wood decayed by *C. versicolor* in dependence on its degree of decay

Rys. 1. Zmiany jasności drewna sosny i buka rozłożonego przez grzyb *C. versicolor* w zależności od stopnia jego rozkładu

increase of brightness. The exception is only first period of *C. versicolor* activity in which after the first 10 days of beech wood decay decrease of brightness from 57.1 to 51.5% was found. Intensive increase of brightness of this wood was found after the period from 30 to 120 days where the mass losses were 24 to 63% respectively. In period from 120 to 190 days of decay the increase of brightness was not stated despite the increase of mass loss from 63 to 81%. The excitation changes in scots pine and beech wood was nearly unchanged, only the small changes of dominant wave length (λd) take place (Tab. 1).

The changes in the lignine and holocellulose content in wood subjected to the action of *C. versicolor* are very similar (Dziurzyński 1981) and did not correspond with the changes of colour (Tab. 1). Results of IR absorbance of the 1743 cm^{-1} band and the heat of combustion (Tab. 2) are in accordance with data found in literature (Kirk, Chang 1974, Dobry, Dziurzyński, Rypáček 1986). Increase of absorbance of 1743 cm^{-1} band reveals that wood decayed by *C. versicolor* is oxidized.

The second repetition of these tests show that completely extracted wood is alike in this respect to the unextracted wood. Extracted scots pine wood test pieces are slightly lighter while the extracted beech wood samples are slightly darker than unextracted test pieces of these two wood species. The diffuse daylight has small effect, but it should be stated that the test pieces in incubator, without access of light,

are characterised by the lower brightness and the mass losses are lower in analogical periods of decay. The moisture content of decayed scots pine and beech wood was higher than the fiber saturation point. For each time of decay moisture content has at both species the same numerical quantity. Only in case of scots pine wood subjected to decay by the period of 300 days moisture content lowered to about 15%. This data show that the moisture could not be the cause of various colour changes of wood in the course of their decay by *C. versicolor*.

The chemical compounds of wood essential for the fungal decay are both polysaccharides (Rypáček 1977, 1977) and lignin (Faix, Mozuch, Kirk 1985). Some insight into the changes in chemical compounds of wood can be obtained basing on the results of determination of soluble in $0.1 \text{ mol dm}^{-3} \text{ NaOH}$. From Fig. 2 it appears clear that the quantity of solubles in $0.1 \text{ mol dm}^{-3} \text{ NaOH}$ in the course of pine wood

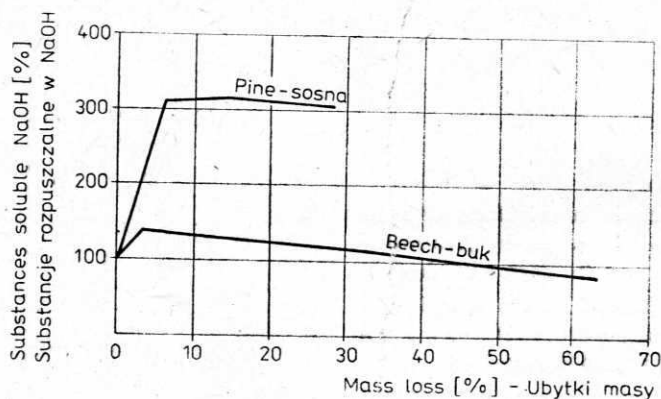


Fig. 2. Content of substances soluble in $0.1 \text{ mol dm}^{-3} \text{ NaOH}$ in scots pine and beech wood decayed by *C. versicolor* in respect to the undecayed wood (Dziurzyński 1981)

Rys. 2. Zawartość substancji rozpuszczalnych w $0.1 \text{ mol dm}^{-3} \text{ NaOH}$ w drewnie sosny i buka rozłożonym przez *C. versicolor* w stosunku do drewna nie rozłożonego (Dziurzyński 1981)

decay increases threefold in respect to undecayed wood. In the process of beech wood decay the quantity of solubles in NaOH in respect to undecayed wood changes slightly. These results reveal higher depolymerisation degree of chemical compounds of scots pine wood than the compounds in the beech wood. The higher contents of substances soluble in NaOH in decayed pine wood can be explained by inhibition of further decay of these substances (Rypáček, Rypáčkova 1975). In beech wood the depolymerised products are not accumulated. These products in beech wood are immediately metabolised. The speed of decay of pine wood has also the inhibitory effect of its decay. The pine wood is decayed with the speed 8 times lower than the wood of beech (Tab. 1). Hydrolysis and oxidation products from chemical compounds of wood get into secondary reactions of condensation. These reactions can cause darkening of pine wood. Analogical causes of such darkening are observed in pro-

Table 2

IR absorbance A_{1743}/A_{1378} band (Dziurzyński, Supiński, Surmiński 1988) and the heat of combustion (Dziurzyński 1981) of wood after decay by *C. versicolor* fungus
Absorbancja w podczerwieni pasma A_{1743}/A_{1378} (Dziurzyński, Supiński, Surmiński 1988) i ciepło spalania (Dziurzyński 1981) drewna rozłożonego przez grzyb *C. versicolor*

Wood Drewno	Mass loss Ubytek masy Δm (%)	IR absorbance – Absorbancja w podczerwieni A_{1743}/A_{1378}	Heat of combustion – Ciepło spalania kJ/kg
Scots pine Sosna	0	0.339	20 120
	6.0	0.510	19 580
	14.0	0.530	19 550
	28.7	0.583	19 700
Beech	0	0.743	19 920
	3.0	0.813	19 860
	24.0	0.820	19 960
Buk	33.0	0.800	19 800
	63.0	0.835	19 570

cesses of alkaline pulping of wood (Surewicz 1959). Coloured substances excreted by the fungus mycelium, enzymes and toxins, are also important (Hřib 1984). The mentioned observations are in controversy with the case of darkening of beech wood decayed by *C. versicolor* fungus noticed by Seifert (1966). Thus the observed colour changes can be due to specific characteristics of *C. versicolor* inoculates used.

Praca wpłynęła do Redakcji
w maju 1988

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ПРИМЕЧАНИЯ ОБ ИЗМЕНЕНИЯХ ОКРАСКИ ДРЕВЕСИНЫ РАЗЛОЖЕННОЙ ГРИБОМ *CORIOLUS VERSICOLOR*

Резюме

Древесину сосны и бука подвергли разложению грибом *Coriolus versicolor*. Замечено, что светлота разложенной древесины сосны уменьшается с 80 до 54%, в то время как светлота древесины бука увеличивается с 57 до 80%. Эти наблюдения были сделаны в двух сериях опытов. Установлено, что на изменения окраски древесины не оказывают влияния такие факторы, как наличие дневного света во время разложения и степень извлечения смолистых веществ. Нет также взаимозависимости между окраской древесины а содержанием в ней лигнина и холоцеллюлозы, а также между окраской древесины а теплоотой сгорания и инфракрасном поглощением при 1743 см^{-1} . Установлено, что в разложенной древесине сосны два-три раза увеличивается содержание веществ, растворимых в $0,1 \text{ моль дм}^{-3} \text{ NaOH}$. В древесине бука такой рост не выступает. Эти результаты указывают на то, что химические компоненты в древесине сосны являются гораздо больше деполимеризованными чем в древесине бука.

NOTATKI O ZMIANACH BARWY DREWNA ROZŁOŻONEGO PRZEZ GRZYB *CORIOLUS VERSICOLOR*

Streszczenie

Drewno sosny i buka poddano rozkładowi przez grzyb *Coriolus versicolor*. Zaobserwowano, że jasność rozłożonego drewna sosny maleje od 80 - 54%, podczas gdy jasność drewna buka rośnie od 57 - 80%. Obserwacje te stwierdzono w dwóch powtórzeniach. Stwierdzono brak wpływu na zmiany barwy drewna takich czynników jak: obecność światła dziennego podczas rozkładu, stopień wyekstrahowania substancji żywicznych. Brak też współzależności między barwą drewna a zawartością w nim ligniny, holocelulozy oraz absorbancją w podczerwieni przy 1743 cm^{-1} i ciepłem spalania. Stwierdzono, że w rozłożonym drewnie sosny 2 - 3-krotnie zwiększa się zawartość substancji rozpuszczalnych w $0,1 \text{ mol dm}^{-3} \text{ NaOH}$. W drewnie buka wzrost taki nie występuje. Wyniki te wskazują, że składniki chemiczne w drewnie sosny są znacznie bardziej zdepolimeryzowane niż w drewnie buka.

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