GUM GUAIAC IN FIELD TESTS FOR EXTRACELLULAR PHENOL OXIDASES OF WOOD-ROTTING FUNGI AND OTHER BASIDIOMYCETES

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SUMMARY

One hundred ninety-two species of Basidiomycetes, mostly wood-decaying or wood-inhabiting, were tested in the field with gum guaiac reagent to determine if extracellular phenol oxidases were present. Of these, 79 gave negative reactions; 113, positive. Of those with positive reactions, 110 are white-rot fungi: three species *(Phaeolus schweinitzii* (Fr.) Pat., *Tyromyces fragilis* (Fr.) Donk, and *T. subcartilagineus* (Overh.) Dom.) that gave a positive reaction are brown-rot fungi. In field tests a negative reaction did not relate as conclusively: 38 white-rot fungi failed to give a positive test.

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GUM GUAIAC IN FIELD TESTS FOR EXTRACELLULAR PHENOL OXIDASES OF WOOD-ROTTING FUNGI AND OTHER BASIDIOMYCETES[1]

By
ROBERT L. GILBERTSON, Professor of Plant Pathology,[2]
FRANCES F. LOMBARD, Botanist,[3]
and
ELMER R. CANFIELD, Research Associate[4]

A number of reagents have been used to demonstrate the presence of extracellular phenol oxidases in wood-rotting fungi. The presence or absence of these oxidases, or enzymes, has been used to separate wood-decay fungi into two broad groups, the white-rot and the brown-rot fungi. Use of these reagents is reviewed by Nobles *(45)*[5] and Harkin and Obst *(31).* The most widely used is the Bavendamm *(12)* test with tannic acid or gallic acid in agar media. This test generally requires 7 days for a conclusive result.

Nobles (45) has shown that the direct application of an alcoholic solution of gum guaiac to actively growing cultures of wood-rotting fungi gives a reliable test for extracellular phenol oxidases. This rapid and simple test for oxidase has since been utilized extensively, and has proved to be an extremely useful technique in identifying and characterizing cultures *(48).* Nobles *(46)* later reported that applying alcoholic gum guaiac to moist, active rots and growing basidiocarps causes rapid bluing with the white rots and their associated basidiocarps, and gives no reaction with brown rots and their associated basidiocarps on the relatively few species tested. It is known that the gum guaiac test is not specific for extracellular laccase. The oxidation to guaiacum blue also occurs in the presence of tyrosinase and peroxidase *(31).* Harkin and Obst *(31)* have reported that syringaldazine is an effective reagent for detecting laccase and peroxidase in cultures of wood-rotting fungi. However, the value of the gum guaiac reaction as a taxonomic character and as an aid in rapid identification of basidiocarps and cultures is not diminished by its inability to differentiate specific oxidase reactions.

The objective of this study was to determine the reaction of gum guaiac reagent on basidiocarps and on decayed wood in the field. We also have compared these reactions with those observed on these fungi in culture.

During the last 5 years the authors tested 192 freshly collected fruiting bodies of a number of wood-rotting fungi in the field in Arizona and Minnesota. The associated rot in wood was also tested in many cases.

Interpretation of the results is more difficult under field conditions than in the laboratory. Reactions on fruiting bodies with dark tissue such as those of species in the Hymenochaetaceae are difficult to interpret. The

[1] Univ. Ark. Agric. Exp. Sta. J. Art. No. 2194.

[2] Univ. of Ariz. Department of Plant Pathology, Tucson.

[3] For. Prod. Lab., For. Serv.. USDA. The Laboratory is maintained at Madison, Wis., in cooperation with the Univ. of Wis.

[4] Univ. of Idaho, College of Forestry, Wildlife and Range Sciences, Moscow.

[5] Italicized numbers in parentheses refer to Literature Cited at the end of this paper.

varied nature of the fruiting bodies of the wood-rotting Basidiomycetes also precludes any uniform procedure of applying the reagent. Thick fleshy fruiting bodies provide ample context tissue for testing, but on corticioid fungi in general the reagent must be applied directly to the hymenial surface. Because of variation in color, wood frequently does not provide a good background for discerning the reaction. Despite these problems the information gained from these tests is significant, and indicates that the gum guaiac reagent is useful for field determinations of oxidases. The positive (blue) gum guaiac reaction remains clearly visible on dried herbarium specimens; thus it provides a permanent record with little change in the color.

The alcoholic solution of gum guaiac was prepared according to Nobles' *(45)* formula (0.5 g gum guaiac dissolved in 30 cm^3 of 95 pct alcohol). The solution was applied directly to the hymenial surface and the marginal tissue of resupinate basidiocarps. Thick basidiocarps were broken, and the reagent applied to freshly exposed context tissue on hymenophore surfaces. The reagent was also applied to freshly exposed surfaces of decayed wood associated with the basidiocarps. Notes were taken in the field on the intensity and the speed of development of this reaction. The positive reactions observed in the field were rated as weak (+), moderately strong (++), or strong (+++). Information on reactions in culture are given simply as positive (+) or negative (–), because most data in the literature do not indicate the intensity of the reaction.

The reactions of the gum guaiac on cultures were determined by streaking the reagent across 3-week-old cultures on malt-agar medium. The cultures were tested by the Bavendamm method as described by Davidson and others *(23),* in which the cultures are grown on malt-agar with the addition of 0.5 percent of gallic and tannic acids. The reactions were determined after growth for 7 days. Whenever possible, oxidase tests were carried out on cultures obtained from specimens tested with gum guaiac in the field.

In tables 1 and 2, the species tested are listed with summarized information on reactions observed in the field and available data on oxidase reactions in culture. The "type of rot" listed in the two tables is based on the visual appearance and the color of the affected wood as determined by the authors and other researchers. The species listed in table 1 showed no positive reactions with either basidiocarps or decayed wood. Those in table 2 showed positive reactions on basidiocarp tissue and also on the decayed wood in those species indicated. The literature citations in the two tables refer to data published by this and other laboratories on reactions of cultures to gallic and tannic acid media or to gum guaiac.

LITERATURE CITED

1. Bagchee, K.
   1954 New and noteworthy decay in timber in India. Indian For. 80:373-378.
2. Bagchee, K., Y. N. Puri, and B. K. Bakshi.
   1954. Principal diseases and decays of oaks and other hardwoods in India—11. Indian Phytopathol. 7:18-42.
3. Bakshi, B.K.
   1955. Diseases and decays of conifers in the Himalayas. Indian For. 81:779-797.
4. Bakshi, B. K., and K. Bagchee.
   1950. Principal diseases and decays of oaks in India Indian Phytopathol. 3:124-139.
5. Bakshi, B. K., H. S. Sehgal, and B. Singh.
   1969. Cultural diagnosis of Indian Polyporaceae. 1. Genus Polyporus. Indian For. Rec. (n.s.) 2 (No. 9, For. Pathol.): 205-244.
6. Bakshi, B. K., M. Sen, and B. Singh.
   1970. Cultural diagnosis of Indian Polyporaceae. 2. Genera *Fomes* and *Trarnetes.* Indian For. Rec. (n.s.) 2 (No. 10, For. Pathol.):245-276.
7. Bakshi, B. K., and B. Singh.
   1958. The Indian species of *Merulius.* Indian Phytopathol. 11:70-75.

8. Bakshi, B. K., and B. Singh.
1960. Heart-rot and decay due to *Polyporus palustris.* Indian For. 87:116-118.

9. Bakshi, B. K., and B. Singh.
1961. New and noteworthy records of Hymenomycetes in India. Indian For. Bull. No. 235 (n.s., For. Pathol.), 10 p.

10. Bakshi, B. K., B. Singh, and T. Choudhury.
1958. Occurrence of *Merulius himantioides* in India. Indian Phytopathol. 11:25-28.

11. Bakshi, B. K., B. Singh, and S. Gibson.
1958. Occurence of *Trametes sepium* in India. Can. J. Bot. 36:603-606.

12. Bavendamm, W.
1928. Uber das Vorkommen und den Nachweis von Oxydasen bei holzzerstörenden Pilzen. Z. Pflanzenkrankh. u. Pflanzenschutz 38:257-276.

13. Boidin, J.
1951. Recherche de la tyrosinase et de la laccase chez les Basidiomycetes en culture pure. Milieux différentiels. Intérêt systématique. Rev. Mycol. 16:173-197.

14. Boidin, J.
1958. Essai Biotaxonomique sur les Hydnés Résupinés et les Corticiés. Rev. Mycol., Men. hors-sér. No. 6, 387 p.

15. Boidin, J.
1961. Hétérobasidiomycétes saprophytes et Homobasidiomycétes résupinés: VIII. *Peniophora* Cke à dendrophyses. Rev. Mycol. 26:153-172.

16. Boidin, J., P. Terra, and P. Lanquetin.
1968. Contibution a la connaissance des caracterès mycéliens et sexuels des genres *"Aleurodiscus," "Dendrothele," "Laeticorticium"* et *"Vuilleminia"* (Basidiomycètes Corticiaceae). Bull. Soc. Mycol. France 84:53-84.

17. Brotzman, H. G., and R. L. Gilbertson.
1967. *Tyromyces undosus* in North America. Mycopathol. et Mycol. Appl. 33:33-42.

18. Buckland, D.C.
1946. Investigations of decay in western red cedar in British Columbia. Can. J. Res., *C,* 24:158-181.

19. Cartwright. K. St. G., and W.P.K. Findlay.
1958. Decay of timber and its prevention. London, Her Majesty's Stat. Off. 332 p.

20. David, A.
1967 Caractéres mycéliens de quelques Trametes *(Polyporacées). Nat. Can. 94:557-572.*

21. David. A.
1969. Caractéres culturaux et cytologiques de quelques espèces rangées par Bourdot et Galzin et d'autres auteurs dans le genre *Phaeolus* (Polyporacées). Nat. Can. 96:211-224.

22. Davidson, R. W., and W. A. Campbell.
1943. Decay in merchantable black cherry on the Allegheny National Forest. Phytopathol. 33:965-985.

23. Davidson, R. W., W. A. Campbell, and D. J. Blaisdell.
1938. Differentiation of wood-decaying fungi by their reaction on gallic or tannic acid medium. J. Agric. Res. 57:683-695.

24. Davidson, R. W., W. A. Campbell, and D. B. Vaughn.
1942. Fungi causing decay of living oaks in the eastern United States and their cultural identification. U.S. Dep. Agric. Tech. Bull. 785, 65 p.

25. Davidson, R. W., and F. F. Lombard.
1953. Large-brown-spored house-rot fungi in the United States. Mycol. 45:88-100.

26. Davidson, R. W., F. F. Lombard, and R. R. Hirt.
1947. Fungi causing decay in wooden boats. Mycol. 39:313-327.

27. Domański, S.
1969. Wood-inhabiting fungi in Bialowieza virgin forests in Poland. X. *Fibuloporia subvermispora* (Pilát) Domań., *comb. nov.* and its diagnose. Acta Soc. Bot. Polon. 38:453-464.

28. Fåhraeus, G.
1949. On the oxidation of phenolic compounds by wood-rotting fungi. Ann. Roy. Agric. Coll. Sweden 16:618-629.

29. Gilbertson, R. L., and E. R. Canfield.
1972. *Poria carnegiea* and decay of saguaro cactus in Arizona. Mycol. 64:1300-1311.

30. Gilbertson, R. L., and J. L. Lowe.
1970. *Tyromyces graminicola* in North America. Mycol. 62:699-706.

31. Harkin, J. M., and J. R. Obst.
1973. Syringaldazine—an effective reagent for detecting laccase and peroxidase in fungi. Exper. 29(4).

32. Käärik, A.
1965. The identification of the mycelia of wood-decay fungi by their oxidation reactions with phenolic compounds. Stud. For. Suec. (Stockholm) No. 31, 80 p.

33. Käärik, A., and E. Rennerfelt.
1957. Investigations on the fungal flora of spruce and pine stumps. Medd. Stat. Skogsforskmingsinst. Vol. 47, No. 7, 88 p.

34. Lentz. P. L., and H. H. McKay.
1966. Delineations of forest fungi: Morphology and relationships of *Vararia.* Mycopathol. et Mycol. Appl. 29:1-25.

35. Lentz, P. L., and H. H. McKay.
1970. Sclerotial formation in *Corticium olivascens* and other Hymenomycetes. Mycopathol. et Mycol. Appl. 40:1-13.

36. Lindeberg, G.
1948. On the occurrence of polyphenol oxidases in soil-inhabiting Basidiomycetes. Physiol. Plant. 1:196-205.

37. Lombard, F. F., R. W. Davidson, and J. L. Lowe.
1960. Cultural characteristics of *Fomes ulmarius* and *Poria ambigua.* Mycol. 52:280-294.

38. Lombard, F. F., and R. L. Gilbertson.
1965. Studies of some western porias with negative or weak oxidase reactions. Mycol. 57:43-76.

39. Lombard, F. F., and R. L. Gilbertson.
1966. *Poria luteoalba* and some related species in North America. Mycol. 58:827-845.

40. Lyr, H.
1958. Uber den Nachweis von Oxydasen und Peroxydasen bei höheren Pilzen und die Bedeutung dieser Enzyme fur die Bavendamm-Reaktion. Planta 50:359-370.

41. Macrae, R.
1955. Cultural and interfertility studies in *Aporpium caryae.* Mycol. 47:812-820.

42. Matters, C. N., E.W.B. Da Costa, and N. Tamblyn.
1952. The identification of Basidiomycete fungi in culture. Morphological characters of 14 cultures of Basidiomycetes. Aust. Commonw. Sci. Ind. Res. Org. Div. For. Prod. Prog., Rep. No. 2, 33 p.

43. Maxwell, M. B.
1954 Studies in Canadian Thelephoraceae. XI. Conidium production in the Thelephoraceae. Can. J. Bot. 32:259-280.

44. Nobles, M. K.
1948. Studies in forest pathology. VI. Identification of cultures of wood-rotting fungi. Can. J. Res., C, 26:381-431.

45. Nobles, M. K.
1958. A rapid test for extracellular oxidase in cultures of wood-inhabiting Hymenomycetes. Can. J. Bot. 36:91-99.

46. Nobles, M. K.
1958. Cultural characters as a guide to the taxonomy and phylogeny of the Polyporaceae. Can. J. Bot. 36:883-926.

47. Nobles, M. K.
1965. Identification of cultures of wood-inhabiting Hymenomycetes. Can. J. Bot. 43:1097-1139.

48. Nobles, M. K.
1971. Cultural characters as a guide to the taxonomy of the Polyporaceae. p. 169-192. In Evolution in the higher Basidiomycetes. Ronald H. Petersen, ed., Univ. Tenn. Press, Knoxville, 562 p.

49. Pantidou, M.A., and J. W. Groves.
1966. Cultural studies of Boletaceae. Some species of *Suillus* and *Fuscoboletinus.* Can. J. Bot. 44:1371-1392.

50. Robak, H.
1942. Cultural studies in some Norwegian wood-destroying fungi. Medd. Vestl. Forstl. Forsoeksstn. No. 25 (Vol. 7, No. 3), 248 p.

51. Sarkar, A.
1959. Studies in wood-inhabiting Hymenomycetes. IV. The genus *Coriolellus* Murr. Can. J. Bot. 37:1251-1270.

52. Siepmann, R.
1970. Artdiagnose einiger holzzerstorender Hymenomyceten an hand von reinkulturen. III Nova Hedwigia 20:833-863.

53. Sieprnann, R.
1971. Artdiagnose einiger holzzerstorender Hymenomyceten an hand von reinkulturen. IV. Nova Hedwigia 21:843-875.

54. Siepmann, R., and H. Zycha.
1968. Artdiagnose einiger holzzerstorender Hymenomyceten an hand von reinkulturen. Nova Hedwigia 15:559-570.

55. Sundman, V., and L. Nase.
1971. A simple plate test for direct visualization of biological lignin degradation. Pap. ja Puu 53:67-71.

56. van der Westhuizen, G.C.A.
1958. Studies of wood-rotting fungi: I. Cultural characteristics of some common species. Bothalia 7:83-107.

57. van der Westhuizen, G.C.A.
1971. Cultural characters and carpophore construction of some poroid Hymenomycetes. Bothalia 10:137-327.

58. van der Westhuizen, G.C.A.
1972. Studies of wood-rotting fungi. II. Basidiomycetes from the wood-preservative field exposure test plot at Kruisfontein. Bothalia 10:517-538.

59. Zycha, H., and H. Knopf.
1966. Cultural characteristics of some fungi which cause red-stain of *Picea abies.* Lloydia 29:136-145.

Table 1.--Species that show negative reactions with gum guaiac test on basidiocarp tissue and on associated rot in the field[1]

Fungus	Type of rot	Oxidase reactions in culture			References
		Gum guaiac	Gallic acid	Tannic acid	
	POLYPORACEAE				
Coriolellus sepium (Berk.) Murr.	Brown	-	-	-	6,11,32,44-47,51
C. serialis (Fr.) Murr.	Brown	-	-	-	6,22,23,32,33,44-47,50,51,55
Daedaleopsis confragosa (Bolt. ex Fr.) Schroet.	White	+	+	+	23,24,44-47,57
Fomitopsis cajanderi (Karst.) Kotl. et Pouz.	Brown	-	- to +	- to +	23,44-47,57
F. ohiensis (Berk.) Bond. et Sing.	White	+	+	+	*,23,44,46,47
F. pinicola (Swartz. ex Fr.) Karst.	Brown	-	-	-	3,6,13,19,22,23,32,33,44-47,55,57
F. rosea (Alb. et Schw. ex Fr.) Karst.	Brown	-	- to +	- to +	3,6,13,23,26,32,44-47,55
Gloeophyllum saepiarium (Wulf. ex Fr.) Karst.	Brown	-	-	-	3,19,23,26,32,44-47,51,57
Gloeoporus dichrous (Fr.) Bres.	White	-	-	-	5,9,23,32,44-47,55,57

Laetiporus sulphureus (Bull. ex Fr.) Bond. et Sing.	Brown	-	-	-	4,5,13,19,23,24, 32,40,44-47
Poria bombycina (Fr.) Cke.	Brown	-	-	-	38
P. carnegiea Baxter	White	-	-	-	29
P. crassa (Karst.) Sacc.	Brown	nd	-	-	32,46
P. ferox Baxter	Brown	nd	nd	nd	--
P. odora (Pk.) Sacc.	Brown	-	-	-	*,[2]
P. oleagina Overh.	Brown	-	-	-	*
P. pannocincta (Rom.) Lowe	White	-	-	-	*,46
P. radiculosa (Pk.) Sacc.	Brown	-	-	-	38
P. reticulata (Pers. ex Fr.) Cke.	White	-	-	-	38
P. rhodella (Fr.) Cke.	White	-	-	-	38,46
P. sitchensis Baxter	Brown	-	-	- to +	*,[2]
P. spissa (Schw.) Cke.	White	-	-	-	*,46
P. stellae Pilát	White	+	+	+	*
P. subvermispora Pilát	Brown	+	+	+	*,27
P. tarda (Berk.) Cke.	White	-	-	-	*
P. xantha (Fr.) Cke.	Brown	-	-	-	38,44-47
Pyrofomes demidoffii (Lév.) Kotl. et Pouz.	White	+	+	+	*,46
Tyromyces graminicola Murr.	Brown	-	-	-	30

Table 1.--Species that show negative reactions with gum guaiac test on basidiocarp tissue and on associated rot in the field[1]--continued

Fungus	Type of rot	Oxidase reactions in culture			References
		Gum guaiac	Gallic acid	Tannic acid	
Tyromyces guttulatus (Pk.) Murr.	Brown	+	-	-	24,44-47
T. mollis (Pers. ex Fr.) Kotl. et Pouz.	Brown	-	-	-	*,44,46,47
T. perdelicatus Murr.	Brown	- to +	-	-	*
T. palustris (Berk. et Curt.) Murr.	Brown	-	-	-	1,5,8,24,44,46,47
T. undosus (Pk.) Murr.	Brown	-	-	-	17,46
	CORTICIACEAE				
Aleurodiscus fennicus Laur.	White	nd	nd	nd	--
Amylocorticium subsulphureum (Karst.) Pouz.	Brown?	-	-	-	*
Athelia borealis (Rom.) Parm.	White	+	+	+	*
A. byssina (Karst.) Parm.	White	nd	nd	nd	--
A. decipiens (Hoehn. et Litsch.) J. Erikss.	White	-	-	-	*
A. galzinii (Bourd.) Donk	White	- to +	-	-	*

Botryohypochnus isabellinus (Fr.) J. Erikss.	White	- to +	-	-	*
Byssomerulius hirtellus (Burt) Parm.	White	-	-	-	*
B. serpens (Fr.) Parm.	White	-	-	-	*
Dacryobolus sudans (Fr.) Fr.	Brown	-	-	-	*,14
Hyphoderma argillaceum (Bres.) Donk	White	- to +	+	-	*
Hyphodontia subalutacea (Karst.) J. Erikss.	White	nd	+	nd	14
Leucogyrophana pseudomollusca (Parm.) Parm.	White	-	-	-	*
Peniophora piceina Overh.	White	+	+	+	*
P. septocystidia Burt	White	-	- to +	-	*
Phanerochaete cremea (Bres.) Parm.	White	- to +	+	-	*,14,[3]32
P. sanguinea (Fr.) Pouz.	White	-	- to +	- to +	*,14
Phlebia subserialis (Bourd. et Galz.) Donk	White	+	+	+	*,14,[4]32
Plicatura aurea (Fr.) Parm.	Brown	-	-	-	*,[5]
Resinicium chiricahuaensis Gilbertson et Budington	White	+	+	+	*
Sistotrema raduloides (Karst.) Donk	White	+	-	-	*,45,47
Trechispora candidissima (Schw.) Bond. et Sing.	White	+	+	+	*,32,46
Cystostereum murraii (Berk. et Curt.) Pouz.	White	+	+	+	13,14,23,32,44,45, 47

Table 1.--Species that show negative reactions with gum guaiac test on basidiocarp tissue and on associated rot in the field[1]--continued

Fungus	Type of rot	Oxidase reactions in culture			References
		Gum guaiac	Gallic acid	Tannic acid	
	CONIOPHORACEAE				
Coniophera olivascens (Berk. et Curt.) Mass.	nd	-	-	-	35
C. puteana (Schum. ex Fr.) Karst.	Brown	-	-	-	13,14,22,23,28,32, 40,44,45,47,55
Serpula himantioides (Fr. ex Fr.) Karst.[6]	Brown	-	-	-	10,14,25,32,45,46
S. pinastri (Fr.) Bond.[6]	Brown	-	-	-	*,46,52,[7]
	CYPHELLACEAE				
Porotheleum fimbriatum (Pers. ex Fr.) Fr.	White	+	+	- to +	*
	HERICIACEAE				
Mucronella aggregata Fr.	nd	-	-	-	*
	HYMENOCHAETACEAE				
Inonotus glomeratus (Pk.) Murr.	White	+	+	+	23,44-47
	AGARICALES				
Amanita rubescens Fr.	nl	nd	nd	nd	--

Armillaria mellea Fr.	White	+	- to +	- to +	13,23,32,40,44,45, 47,55
Boletus edulis Bull. ex Fr.	nl	nd	nd	nd	--
Cantharellus cinnabarinus Schw.	nl	nd	nd	nd	--
Collybia velutipes (Curt.) Quél.	White	- to +	- to +	-	13,23,32,40,44,45, 47
Inocybe trechispora (Berk.) Karst.	nl	nd	nd	nd	--
Lentinellus cochleatus (Fr.) Karst.	White	+	+	+	*
Lentinus lepideus Fr.	Brown	-	- to +	- to +	23,28,32,40,44,45, 47,55
L. ponderosus O.K. Miller	Brown	-	-	-	*
Paxillus panuoides (Fr. ex Fr.) Fr.	Brown	+	- to +	- to +	*,54,58[8]
Suillus granulatus (Fr.) Kuntze	nl	-	-	-	*,36,49
Volvariella bombycina (Schaeff. ex Fr.) Sing.	nd	nd	nd	nd	--
Xerophalina campanella (Batsch ex Fr.) Kuhn. et Maire	nd	+	+	+	*,18,32,44,45
	TREMELLALES				
Dacrymyces palmatus (Schw.) Bres.	White	-	-	-	*
Exidiopsis leucophaea (Bres.) Wells	White	nd	nd	nd	--

[1] *- to +*, a weak or questionable reaction; ***, species tested for oxidase reactions in culture, but results not published; *nd*, no data available; *nl*, nonlignicolous.

Table 1.--Species that show negative reactions with gum guaiac test on basidiocarp tissue and on associated rot in the field[1]--continued

[2] Nobles (45,46) reports that *Poria odora* and *P. sitchensis* gave positive reactions.

[3] Käärik reports negative reactions with gallic and tannic acids.

[4] Käärik reports negative reaction with gallic acid.

[5] Bakshi and Singh (7) report positive reaction with tannic acid.

[6] Showed very slight positive reaction in 1 specimen.

[7] Boidin (14) reports pale reaction with gallic acid.

[8] Brown diffusion zones may occur on gallic and tannic acid agars, but also occur on malt agar. Guaiac reaction is medium to light.

Table 2.--Species that show positive reactions with gum guaiac test on basidiocarp tissue and on associated rot in the field[1]

Fungus	Type of rot	Gum guaiac reactions in field		Oxidase reactions in culture			References
		Basidio-carp	Rot (decay in wood)	Gum guaiac	Gallic acid	Tannic acid	
POLYPORACEAE							
Bjerkandera adusta (Willd. ex Fr.) Karst.	White	++	nd	+	- to +	- to +	2,5,13,19,23, 32,40,44-47, 55,57,59
Coriolus biformis (Klotsch) Pat.	White	-	+	+	-	-	*
C. hirsutus (Wulf. ex Fr.) Quél.	White	+++	nd	+	+	+	5,13,23,28,32, 40,44-47,56
Dichomitus squalens (Karst.) Reid	White	++	++	+	+	+	23,32,44-47
Hapalopilus nidulans (Fr.) Karst.	White	+	+++	+	+	+	*,13,21,32,44, 46,47
Ischnoderma resinosum (Fr.) Karst.	White	+	nd	+	+	+	23,44-47
Osteina obducta Donk	White	+	nd	-	-	-	*,23,47
Fomitopsis annosa (Fr.) Karst.	White	+++	+	+	+	+	6,18,19,23,32, 40,44-47,55

Table 2.--Species that show positive reactions with gum guaiac test on basidiocarp tissue and on associated rot in the field[1]--continued

Fungus	Type of rot	Gum guaiac reactions in field		Oxidase reactions in culture			References
		Basidiocarp	Rot (decay in wood)	Gum guaiac	Gallic acid	Tannic acid	
Fomitopsis ulmaria (Sow. ex Fr.) Bond. et Sing.	White	++	nd	+	- to +	- to +	*,19,23,32,37, 46
Phaeolus schweinitzii (Fr.) Pat.	Brown	+++	nd	+	-	-	3,5,19,23,40, 44-47[2]
Polyporus arcularius Batsch ex Fr.	White	++	++	+	+	+	*,5,23,32,40, 42,44,46,47, 56
P. elegans Bull. ex Fr.	White	-	+	+	+	+	*,46
P. spumeus var. *malicola* Lloyd	White	+	nd	+	+	+	*
Poria alachuana Murr.	White	++	++	+	+	+	*
P. cinerascens (Bres.) Sacc. et Syd.	White	+++	+++	+	+	+	*,18,32,44, 46,47
P. conferta Overh.	White	+	+	+	+	+	*
P. elongata Overh.	White	++	nd	+	+	+	*
P. eupora (Karst.) Cke.	White	++	nd	+	+	+	39,46

P. lenis (Karst.) Sacc.	White	+++	nd	+	+	+	*,[3]
P. luteoalba (Karst.) Sacc.	White	++	+++	+	+	+	39,46
P. medulla-panis (Jacq.) Bres.	White	+++	+++	+	+	+	*,23
P. nigrescens Bres.	White	+++	nd	+	+	+	23,45,46
P. radula (Pers. ex Fr.) Cke.	White	++	++	+	+	- to +	*
P. rancida Bres.	White	+	nd	nd	nd	nd	--
P. rixosa (Karst.) Karst.	White	++	nd	+	+	+	3,39,46
P. sanguinolenta (Alb. et Schw. ex Fr.) Cke.	White	++	nd	+	+	+	*,46
P. subacida (Pk.) Sacc.	White	++	+	+	+	+	23,44-47
P. subincarnata (Pk.) Murr.	White	+	nd	+	+	+	*,46
P. tenuis var. *pulchella* (Schw.) Lowe	White	+	nd	+	+	+	*,23,46
Trametes hispida Bagl.	White	+	++	+	+	+	*,13,20,23,46
T. trogii Berk.	White	+++	nd	+	+	+	*,20,46
Tyromyces albellus (Pk.) Bond. et Sing.	White	++	nd	+	+	+	23,32,44-47
T. fragilis (Fr.) Donk	Brown	+++	++	- to +	-	-	*,5,19,23, 44,46,47
T. fumidiceps Atk.	White	+	nd	-	+	+	*,46

Table 2.--Species that show positive reactions gum guaiac test on basidiocarp tissue and on associated rot in the field[1]--continued

Fungus	Type of rot	Gum guaiac reactions in field		Oxidase reactions in culture			References
		Basidio-carp	Rot (decay in wood)	Gum guaiac	Gallic acid	Tannic acid	
Tyromyces subcartilagineus (Overh.) Dom.	Brown	+++	nd	+	-	-	*,22,44,46, 47
CORTICIACEAE							
Botryobasidium ansosum (Jacks. et Rogers) Parm.	White	+	nd	nd	nd	nd	--
B. subcoronatum (Hoehn. et Litsch.) Donk	White	+++	nd	+	+	+	*,14
B. vagum (Berk. et Curt.) Rogers	White	+++	nd	-	-	-	*,14
Gloeocystidiellum citrinum (Pers.) Donk	White	+	nd	+	+	+	*
G. contiguum (Karst.) Bourd. et Galz.	White	+++	nd	+	+	+	*
G. lactescens (Berk.) Boid.	White	+++	+++	+	+	+	*,14
G. radiosum (Fr.) Boid.	White	++	nd	+	+	+	*
Hyphoderma guttuliferum (Karst.) Donk	White	++	nd	+	+	+	*

H. polonense (Bres.) Donk	White	+	nd	nd	-	nd	14
H. puberum (Fr.) Wallr.	White	+++	++	+	+	+	*,23,24,55
H. roseocremeum (Bres.) Donk	White	++	++	+	+	+	*,14
H. tenue (Pat.) Donk	White	++	nd	+	+	+	*,13,14
Hyphodontia albicans (Pers.) Parm.	White	+	nd	+	+	- to +	*
H. alutacea (Fr.) J. Erikss.	White	++	++	+	+	-	*,14
H. alutaria (Burt) J. Erikss.	White	+	+	- to +	+	+	*
H. arguta (Fr.) J. Erikss.	White	++	++	+	+	+	*,14
H. breviseta (Karst.) J. Erikss.	White	+++	++	+	+	+	*
H. pallidula (Bres.) J. Erikss.	White	+++	nd	+	+	- to +	*,14
Hypochnicium bombycinum (Sommerf. ex Fr.) J. Erikss.	White	+++	+++	+	+	+	*
H. lundellii (Bourd. ap. J. Erikss.) J. Erikss.	White	++	nd	nd	+	- to +	*,14
Laeticorticium roseum (Pers. ex Fr.) Donk	White	++	++	- to +	-	- to +	*,14,16
Metulodontia nivea (Karst.) Parm.	White	+	nd	+	+	+	*
Peniophora tamaricicola Boid. et Malençon	White	++	++	+	+	+	*,15

Table 2.--Species that show positive reactions with gum guaiac test on basidiocarp tissue and on associated rot in the field[1]--continued

Fungus	Type of rot	Gum guaiac reactions in field		Oxidase reactions in culture			References
		Basidio-carp	Rot (decay in wood)	Gum guaiac	Gallic acid	Tannic acid	
Phanerochaete carnosa (Burt) Parm.	White	+	-	- to +	+	+	*
P. eichleriana (Bourd. et Galz.) Parm.	White	+	nd	nd	+	nd	14
P. velutina (DC. ex Fr.) Jülich	White	++	+++	- to +	+	+	*,14,32
Phlebia albida Post ex Fr.	White	+	nd	+	+	+	*
P. hydnoides (Cke. et Massee) M.P. Chris.	White	+++	nd	+	+	- to +	*,32
P. livida (Fr.) Bres.	White	+	+	+	+	- to +	*,13,14
P. phlebioides (Jacks. et Deard.) Gilbertson et Budington	White	+	+	+	+	+	*
P. radiata Fr.	White	++	+	+	+	+	*,14,32
P. sulfureo-isabellina (Litsch.) Parm.	White	+	nd	nd	nd	nd	--
Radulodon americanus Ryv.	White	+	nd	+	+	+	*,45,46
Resinicium bicolor (Fr.) Parm.	White	++	++	+	+	+	*,14,32,45, 47,52,58

Subulicystidium longisporum (Pat.) Parm.	White	+	nd	nd	nd	nd	--
Trechispora farinacea (Pers. ex Fr.) Liberta	White	++	+++	nd	+	nd	14,[4]
T. submicrospora (Litsch.) Liberta	White	++	nd	nd	nd	nd	--
T. vaga (Fr.) Liberta	White	+	+	- to +	+	+	*
T. variecolor (Bourd. et Galz.) M.P. Chris.	White	+++	nd	nd	nd	nd	--
Tubilicrinis subulatus (Bourd. et Galz.) Donk	White	+	nd	nd	nd	nd	--
STECCHERINACEAE							
Fibricium greschikii (Bres.) J. Erikss.	White	++	nd	+	+	+	*
Steccherinum adustum (Schw.) Banker	White	+	nd	+	+	+	*
S. ciliolatum (Berk. et Curt.) Gilbertson	White	++	nd	+	+	+	*
S. fimbriatum (Fr.) J. Erikss.	White	+++	nd	+	+	+	*,13,14
S. fuscoatrum (Fr.) Gilbertson	White	+++	nd	+	+	+	*
S. ochraceum (Pers. ex Fr.) S.F. Gray	White	+++	+++	+	+	+	*,13,14

Table 2.--Species that show positive reactions with gum guaiac test on basidiocarp tissue and on associated rot in the field[1]--continued

Fungus	Type of rot	Gum guaiac reactions in field		Oxidase reactions in culture			References
		Basidio-carp	Rot (decay in wood)	Gum guaiac	Gallic acid	Tannic acid	
LACHNOCLADIACEAE							
Scytinostroma galactinum (Fr.) Donk	White	+++	+++	+	+	+	14,23,45
Vararia effuscata (Cke. et Ell.) Rogers et Jacks.	White	+++	+++	+	+	+	*,14,34
V. granulosa (Fr.) Laur.	White	++	nd	+	+	+	*,34,43
V. investiens (Schw.) Karst.	White	++	nd	+	+	+	*,14,34
V. pallescens (Schw.) Rogers et Jacks.	White	+++	+++	+	+	+	*,34
HERICEACEAE							
Hericium coralloides (Scop. ex Fr.) S.F. Gray	White	++	nd	+	+	+	*,14,23,32
HYMENOCHAETACEAE							
Phellinus conchatus (Pers. ex Fr.) Gill.	White	nd	++	+	+	+	23,44-47,[3]
P. ferruginosus (Schrad. ex Fr.) Bourd. et Galz.	White	nd	+	+	+	+	*,44,46,47

P. viticola (Schw. ap Fr.) Donk	White	nd	++	+	+	+	*,23,32,44, 46,47
		AGARICALES					
Agaricus silvaticus Schaeff. ex Secr.	nl	++	nl	nd	nd	nd	--
A. silvicola (Vitt.) Pk.	nl	+	nl	nd	nd	nd	--
Amanita muscaria (L. ex Fr.) Hooker	nl	+	nl	nd	- to +	-	36
A. virosa (Fr.) Quél.	nl	+	nl	nd	nd	nd	--
Amanitopsis vaginata (Bull. ex Fr.) Vitt.	nl	++	nl	nd	nd	nd	--
Cantharellus floccosus Schw.	nl	+++	nl	nd	nd	nd	--
Clitocybe cartilaginea Bres.	nl	+	nl	nd	nd	nd	--
Hygrophorus chrysodon (Fr.) Fr.	nl	++	nl	nd	nd	nd	--
Lactarius deliciosus (L. ex Fr.) S.F. Gray	nl	+++	nl	nd	+	+	36
L. volemus (Fr.) Fr.	nl	++	nl	nd	nd	nd	--
Lentinellus ursinus (Fr.) Kuhner	White	+++	nd	+	+	+	*,13
Leucopaxillus amarus (Alb. et Schw. ex Fr.) Kuhner	nl	+++	nl	nd	nd	nd	--
Pholiota aurivella (Fr.) Kummer	White	+++	nd	+	+	+	*,32,[5]

Table 2.--Species that show positive reactions with gum guaiac test on basidiocarp tissue and on associated rot in the field[1]--continued

Fungus	Type of rot	Gum guaiac reactions in field		Oxidase reactions in culture			References
		Basidio-carp	Rot (decay in wood)	Gum guaiac	Gallic acid	Tannic acid	
Pholiota bakerensis Hesler	White	+++	nd	+	+	+	*
P. curvipes (Fr.) Quél.	White	+++	nd	nd	nd	nd	--
P. spumosa (Fr.) Sing.	White	+++	nd	+	+	+	*
Pleurotus ostreatus Jacq.	White	+++	+++	+	+	+ or -	23,32,40, 45,47,55
Pluteus cervinus Fr.	White	++	nd	nd	+	+	32
Russula alutacea (Pers. ex Schw.) Fr.	nl	+++	nl	nd	nd	nd	--
R. densifolia (Secr.) Gill.	nl	+++	nl	nd	nd	nd	--
R. emetica (Pers. ex Schw.) Fr.	nl	+++	nl	nd	nd	nd	--
R. delica Fr.	nl	+++	nl	nd	nd	nd	--
R. foetens Pers. ex Fr.	nl	+++	nl	nd	nd	nd	--
R. lutea Fr.	nl	+++	nl	nd	nd	nd	--

TREMELLALES							
Aporpium caryae (Schw.) Teix.	White	++	++	+	+	+	*,41

[1] nd, no data available; - to +; weak or questionable positive reaction; *, species tested for oxidase reaction in culture, but results not published; nl, nonlignicolous species.

[2] David (21) reports positive reaction with gallic acid; Käärik (32), weakly positive reactions with gallic and tannic acids.

[3] Käärik (32) reports negative reactions with gallic and tannic acids.

[4] Käärik (32) and Käärik and Rennerfelt (33) report negative reactions with gallic and tannic acids.

[5] Siepmann (53) reports negative reaction with tannic acid.

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