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Conversion of Japanese red cedar (*Cryptomeria japonica*) into a feed for ruminants by white-rot basidiomycetes

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Abstract

The potential of five white-rot fungi to convert Japanese red cedar (*Cryptomeria japonica*) into feed for ruminants was determined. *Pleurotus ostreatus* (ATCC 66376), *Pholiota nameko* (IFO 30373), *Dichomitus squalens* (CBS 432.34), *Lentinula edodes* (IFO 6654) and *Ceriporiopsis subvermispora* (ATCC 90467) were inoculated into chips of cedar sapwood. *L. edodes* was cultured at 25 °C, and the other fungi at 28 °C, for 4, 8, 12, or 20 weeks. The in vitro organic matter (OM) digestibility (IVOMD) in cedar wood cultured without fungus were between 0.047 and 0.068, while it was elevated to 0.446 by culturing with *C. subvermispora* and to 0.281 by culturing with *L. edodes* for 20 weeks. In contrast, the IVOMD were 0.200, or lower, in cedar wood cultured with *P. ostreatus*, *P. nameko*, or *D. squalens*. The in vitro gas production (IVGP) in cedar wood cultured with *P. ostreatus*, *P. nameko*, or *D. squalens* was 37 ml/g OM, or lower, while that in cedar not inoculated with fungus was between 4 and 17 ml/g OM. In contrast, the IVGP in cedar wood cultured with *C. subvermispora* for 20 weeks increased

Abbreviations: OM, organic matter; IVOMD, in vitro organic matter digestibility; IVGP, in vitro gas production; ND, neutral detergent; NDF, neutral detergent fiber; ADF, acid detergent fiber; ADL, acid detergent lignin; VFA, volatile fatty acid

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to 107 ml/g OM, and that in cedar wood cultured with *L. edodes* increased to 58 ml/g OM. Lignin degradability in cedar wood cultured with *C. subvermispora* and *L. edodes* for 20 weeks were 0.578 and 0.288, respectively. These changes in IVOMD and IVGP demonstrate that a selective white-rot fungus, *C. subvermispora* has the ability to convert cedar wood into feed for ruminants, although further increase is required before the cultured cedar wood would have widespread feed potential.

Keywords: Japanese red cedar; In vitro digestibility; *Ceriporiopsis subvermispora*; Lignin; Delignification

1. Introduction

The Japanese livestock industry is largely dependent on imported feed. Some Japanese beef cattle farms use rice straw imported from China due to insufficient domestic supplies. Since Japanese beef cattle fattening systems typically feed high concentrate diets for more than 400 days, rice straw is critical to maintenance of normal rumen function. However, there is an abundance of potentially available biomass in the forests of Japan, as approximately half of Japanese forests are softwood plantations and most require tree thinning. Currently, sufficient tree thinning is not completed due to a reluctance to sell domestic trees and de-populate mountain villages. However, the growing demand for thinning of Japanese red cedar (*Cryptomeria japonica*) forests has become an especially urgent issue because sound growth of cedar is arrested by a high planting rate. A possible solution is to use cedar wood as a feed for beef cattle, if costs were competitive, thereby providing a stable feedstuff supply and improving forest management.

Steaming and/or explosion treatment improves the digestibility of broadleaf trees and allows their use as ruminants feeds. Cedar, however, is a conifer and the content of lignin is higher and includes more condensed structures than in hardwood lignin. Therefore, the feed value of conifer for cattle is low, even if treated by processes such as steaming and explosion (Bender et al., 1970). Furthermore, steaming and explosion generate aldehydes, which have pesticidal and bactericidal effects (Britton, 1978, Ikumo et al., 1987). A safe, environmentally-friendly method for lignin removal using white-rot fungi has been previously reported (Kirk and Moore, 1972; Zadrazil, 1985; Akin et al., 1996), as white-rot fungi are the most efficient known lignin degraders, and some of them have the potential to delignify softwood. However, there are no reports of wood-rot fungi with a selectivity to degrade lignin in Japanese cedar wood, and most of white-rot fungi degrade lignin and cellulose simultaneously. A selective white-rot fungus, *Ceriporiopsis subvermispora* is known to selectively degrade lignin in softwood and hardwood. Owing to its unique wood decay pattern, this fungus has been used in biopulping (Messner and Srebotnik, 1994) and pretreatment of beech wood for ethanol fermentation (Itoh et al., 2003).

In the present study, five white-rot fungi, including the selective white-rot fungus *C. subvermispora* were used to convert Japanese red cedar into feed for ruminants, and effects of the biological treatments on feedstuff production were compared.