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MACROSCOPIC FUNGI USED BY INDIGENOUS PEOPLE IN BRAZIL: A REVIEW OF AND PERSPECTIVES ON THE CULTIVATION OF EDIBLE SPECIES

FUNGOS MACROSCÓPICOS USADOS POR INDÍGENAS NO BRASIL: REVISÃO E PERSPECTIVAS DE CULTIVO DAS ESPÉCIES COMESTÍVEIS

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Resumo

O conhecimento acerca de uso de fungos pelos povos indígenas brasileiros ainda é escasso e necessita ser investigado. Muitas espécies não estão em listas e seus usos podem significar alternativas de cultivo inclusive em escala comercial. Realizando um levantamento do que já se publicou sobre uso de fungos por diferentes etnias indígenas do Brasil, elaborou-se uma lista de espécies e potenciais de cultivo para cada taxon. Encontrou-se o primeiro relato de 1560 e há um total de 45 espécies identificadas atualmente, 10 a mais do que no último levantamento realizado. 14 gêneros são discutidos com potencial de cultivo comercial, destacando-se *Polyporus indigenus* e *Polyporus sapurema*. Para todas as espécies as necessidades ambientais e nutricionais são apresentadas de modo a facilitar o cultivo aos interessados.

Palavras-chave

cogumelos; nutrição; ameríndios; etnomicologia.

Abstract

Knowledge on the use of fungi by indigenous people in Brazil is still scarce and needs to be better investigated. Many species are not recorded and their uses could lead to alternatives for cultivation, even on a commercial scale. By conducting a survey of what has already been published on the use of fungi by different indigenous ethnic groups in Brazil, we prepared a list of species and cultivation potential for each taxon. We found a total of 1560 records; a total of 45 species are currently identified, 10 more than registered in a previous survey. Fourteen genera are reviewed for their potential for commercial cultivation, with an emphasis on *Polyporus indigenus* and *Polyporus sapurema*. For all species, environmental and nutritional needs are presented below to facilitate the cultivation of these species for those who are interested.

Keywords

mushrooms; nutrition; Amerindians; ethnomycology

INTRODUCTION

Ethnomycology was defined as a branch of Ethnobotany that is dedicated to the study of the role of mushrooms, in the broadest sense, in the past of mankind (Wasson, 1980). In the case of Brazil, a country with one of the highest concentrations of indigenous peoples in the past and with a rich biodiversity, it is to be expected that there is a very large list of species used for medicinal and culinary purposes, among others, by these

ethnic groups.

However, Brazilian indigenous peoples have been classified as non-mycophilic in the first scientific works on the subject (FIDALGO, 1965 and 1968). However, subsequent research has confirmed the common use of mushrooms as food of at least some tribes, especially among the Yanomami (FIDALGO and PRANCE, 1975; FIDALGO & HIRATA, 1978; PRANCE, 1984; VARGAS-ISLA et al., 2013). On the contrary, the South American Andean peoples are extremely mycophilic (MAPES et al., 2002; GÓES-NETO & BANDEIRA, 2001). Mushroom consumption is reported in the interior of the Colombian Amazon (VASCO-PALACIOS et al., 2008), in Peru (BARDALES, 1997) and Venezuela, (ZENT et al., 2004) and Ecuador, as for example (MURRA, 1946).

It is possible that this knowledge has been lost, especially with the extermination of many ethnic groups and with the significant reduction of others, in addition to the interference of the reeducation works carried out by the colonizers. As a result, it is possible that the knowledge was repressed, so that the remnants started to eat the same as the Europeans were used to eat: chicken meat, cattle and other livestock, rice, beans, etc. This has been the case since the 1940s, when these foods were already on the daily menu of many tribes (SAMPAIO, 1944).

More recent reviews of the species used by Indigenous people in Brazil are presented by GÓES-NETO & BANDEIRA (2001) and by VARGAS-ISLA et al. (2013), but just a few data are presented regarding the possibility of cultivation.

How many species are still used, what are their current and past uses and what is the possibility of growing them, are some of the problems raised by the authors and which we intend to clarify from this review. Therefore, the intention is to contribute to the scarce knowledge that exists today about edible fungi and to stimulate more research with the ethnic groups still occurring in Brazil and the possible cultivation of the species used.

MATERIAL AND METHODS

A bibliographic review of Ethnomycology in Brazil was carried out in search of publications, books, beginning in the 15th century to the present day, using internet resources (Web of Science) and printed material from different authors. The cultivation possibilities were based on methods already used for commercial mushroom production worldwide and/or on substrate availability data and research carried out with each species.

RESULTS AND DISCUSSION

A total of 45 species were found in references in the specific literature (Table 1), a number higher than that mentioned before in FIDALGO & POROCA (1986 - 21 species), GÓES-NETO & BANDEIRA (2003-28 species) and VARGAS-ISLA et al. (2013 - 34 species), authors of revisions along the same lines. Other species are mentioned without taxonomic identification, and must correspond to additional species also used as food and/or drugs.

The Jesuit priest ANCHIETA (1560), in letters gathered during the first 7 years of mission in Brazil, described a flexible stone, which was foldable and yet capable of sharpening swords. VIÉGAS (1959) considers it to be a fungus (*Polyporus sapurema*), mainly based on data collected from a specimen found in São Paulo and whose sclerotium showed the same characteristics described by the priest. In his letters, however, he does not report the use of mushrooms or his sclerotia as food. But this is, therefore, the first report on the use of macroscopic fungi in Brazil.

SPIX & MARTIUS (1823) recorded the consumption of mushrooms by the Maués, in addition to the use of the "vermelhão do urupê" (*Boletus sanguineus* = *Pycnoporus sanguineus*), which "appears suddenly in rotten trees and often only lasts for a month, a special virtue to stop uterine bleeding, a knowledge perhaps acquired by the "paulistas" (people from São Paulo state – Brazil) from the Indigenous people. Although they still claim that it is a "mistake to judge that this practical knowledge of the healing virtues of plants has been inherited, by tradition, from the primitive American Indians by the present generations".

ROQUETE-PINTO (1917) mentions the use of mushrooms as food by the Nhambiquara Indigenous in Rondônia: "They also eat, the *Tagnanls* and *Tauitês*, a certain mushroom that the others do not use (*Polyporus* sp.)". A mushroom, wood ear (*Polyporus* sp.) is mentioned as used as food, by the Indigenous of the northern mountains, including a figure and which is mentioned as *Gloeoporus conchoides* Mont. (FIDALGO, 1965) and which currently corresponds to *Gloeoporus thelephoroides*. This also supports the fact that the Indigenous ate not only fleshy representatives of the Agaricales and Boletales orders, for example, but also the Polyporales.

The mushroom itself is not always what is used for food. Some fungi are especially interesting as food, due to the size they reach, highlighting the sclerotium of *Polyporus indigenus*, which can weigh up to 60 kg, having been found in the opening of the soil for construction of houses, roads and crops in the states of the Amazon, Pará, Roraima, Rondônia and Mato Grosso (MARAVALHAS, 1962 and 1965; ARAÚJO & SOUZA, 1978). The sclerotia can be sliced and fried or chopped and prepared like a stew, being used for a long time by the caboclos of the Amazon, who probably had this information from native people. The so called "Indian bread" was considered different from the species that forms sclerotia and found in southeastern and southern Brazil: *Polyporus sapurema* (ENGLER, 1900; BRADE, 1930; GONÇALVES, 1937; AGUIAR & SOUZA, 1981).

Several indigenous mycological names have been cataloged and certain tribes even have a taxonomic classification and have an epithet to name all the higher fungi, even if they differ in shape and color. The criteria for the classification of fungi among several indigenous peoples, including the Caiabi, Txicão, Txucarramãe, Tupi-Guarani and Yanomami, are like those of classical taxonomy. *ka nigrèg*, in the Kaigang language, for example, means mushrooms that grow on decaying wood or stick ears (Haverroth, 1997). The Yanomami, probably because they have the best-known and oldest mushroom consumption, have a broad knowledge of ethnoclassification of fungi, which in some cases is similar to phylogenetic classification. In some cases, a special word is used only for edible species (FIDALGO & POROCA, 1986; CARDOSO et al., 2010).

The ethnic groups that consume mushrooms in general do not cultivate them, only performing the collection work in their forays into the forest or from fallen trunks in their plantations. The edible mushrooms found in the region of Awaris are collected mainly in the opened areas for plantation called "roça" and when abandoned and in initial regeneration, when they call it "capoeira". When a new plantation area is opened, the first mushrooms that are born on the dead trunks are called siokoniamo (*Panus neostrigosus, Panus strigellus, Panus velutinus, Lentinus bertieri, Lentinus crinitus*), hiwala amo (*Pleurotus djamor*), kotopo amo (*Polyporus tricholoma*) e atapa amo (*Polyporus philippinensis*). Mushrooms are eaten "in natura" or boiled/roasted (VARGAS-ISLA et al., 2013; SANUMA et al., 2016).

Only one project involving the Yanomami Indians (Sonöma subgroup) works with

the collection and dehydration of mushrooms from the Amazon rainforest and subsequent marketing, mainly involving restaurants in São Paulo - Brazil. 21 species are collected: *Panus neostrigosus, Panus strigellus, Panus velutinus, Lentinus bertieri, Lentinus concavus, Lentinus crinitus, Favolus brasiliensis, Favolus striatulus, Coriolus zonatus, Hydnopolyporus fimbriatus, Lentinula raphanica, Trametes ochracea, Pleurotus albidus, Pleurotus concavus, P. djamor, Lentinula raphanica, Polyporus alveolares, P. aquosus, P. phillipinensis, P. aff. thailandensis, P. tricholoma*, all described in a book (SANUMA et al., 2016). This book with the description of the main species was awarded the Jabuti Award in 2017, in the Gastronomy category. It is a bilingual production in the Sanöma and Portuguese languages, and the research has a partnership between Sanöma professors and several research institutions (NISHIKIDO, 2019; DIÓGENES, 2018).

SILVA-NETO et al. (2020) point to the mushroom *Favolus brasiliensis* as one of the species most collected and consumed by the Yanomani tribe. The authors bromatologically characterized this species, in order to better understand its nutritional and food potential.

Table 1 - Macroscopic fungi used by Brazilian Indigenous natives according to bibliographic references.

Species	Ethnical group	Use	Indian name	Old scientific name reported in literature	Reference
Agaricus sp.	Tucano	As food			Berkeley, 1856; Vargas-Isla et al., 2013;
Auricularia fuscosuccinea (Mont.) Henn.	Txicao Txucarramáe	As food	apco-pilao pidjo		Fidalgo & Hirata, 1979; Góes-Neto & Bandeira, 2003; Vargas-Isla et al. (2013);
Collybia pseudocalopus (Henn.) Singer	Yanomami	As food	nainamoamok		Prance, 1984; Góes-Neto & Bandeira, 2003; Vargas-Isla et al., 2013;
Collybia subpruinosa (Murr.) Dennis	Yanomami	As food	hlamilimamok		Prance, 1984; Góes-Neto & Bandeira, 2003; Vargas-Isla et al., 2013;
Coriolopsis daedaleoides (Berk.) Ryvarden	Yanomami	As food	atapamo	*Datronia daedaloides* (Berk.) Ryv.	Góes-Neto & Bandeira, 2003

Favolus brasiliensis (Fr.) Fr.	Yanomami	As food	waikasö amo	*Favolus tessellatus* Mont.; *Hexagona subcaperata* (Murr.) Sing.	Prance, 1972, 1973, 1984; Sanuma et al., 2016; Silva-Neto et al., 2020;
Fistulilna sp. (?)	Tucano		Dich-thybaki	*Humirium* sp.	Berkeley, 1856; Berkeley, 1856; Fidalgo, 1965; Vargas-Isla et al., 2013;
Geastrum saccatum Fr.	Not reported	For bleeding and uterine disorders	Not reported	*Geaster saccatus*	Pardal, 1937; Góes-Neto & Bandeira, 2003
Gloeoporus thelephoroides (Hook.) Cunn.	Nambiquara	As food	arezi acebi	*Polyporus* sp.; *Gloeoporus conchoides* Mont.	Roquette-Pinto (1917); Roquette-Pinto (1938); Fidalgo,1965; Fidalgo,1968; Vargas-Isla et al. (2013); Fidalgo,1965; Fidalgo, 1968 Góes-Neto & Bandeira,2003 ; Vargas-Isla et al., 2013;
Gymnopilus earlei Murr.	Yanomami	As food	alamok		Prance, 1984; Góes-Neto & Bandeira, 2003; Vargas-Isla et al., 2013;
Gymnopilus hispidellus Murr.	Yanomami	As food	Pida-pida-lhamo		Góes-Neto & Bandeira, 2003
Hydnopolyporus fimbriatus (Cooke) D. A. Reid	Yanomami	As food	sikimö amo olomai tili amo	*Coriolus zonatus* (Nees) Quél.; *Hydnopolyporus palmatus* (Hook.) Fidalgo	Prance, 1984; Góes-Neto & Bandeira, 2003; Sanuma et al., 2016;
Lactocollybia aequatorialis Singer	Yanomami Txicão	As food	Hamimamo-amwai (name wrongly aplied since this is a *Pleurotus albidus* according to Sanuma et al., 2016; apco-taguo		Góes-Neto & Bandeira, 2003; Vargas-Isla et al., 2013;
Lentinula raphanica (Murrill) Mata & R.H. Petersen	Yanomami	As food	naönaö amo	*Lentinus glabratus* Mont.	Sanuma et al., 2016; Vargas-Isla et al., 2013 (as L. glabratus);

Lentinus bertieri (Fr.) Fr.	Yanomami	As food	siokoni amo		Sanuma et al., 2016;
Lentinus concavus (Berk.) Corner	Yanomami	As food	ploplolemö amo	*Pleurotus concavus* (Berk.) Sing.	Prance, 1984; Góes-Neto & Bandeira, 2003; Sanuma et al., 2016;
Lentinus crinitus (L.) Fr	Yanomami Txicão	As food	shiocoiniamo siokoni amo		Fidalgo & Hirata, 1979; Góes-Neto & Bandeira, 2003; Sanuma et al., 2016;
Lentinus cubensis Berk. & M.A. Curtís	Yanomami	As food	nainaiamo		Góes-Neto & Bandeira, 2003
Lentinus strigosus (Schwein.) Fr.	Yanomami	As food	shioconiamo		Góes-Neto & Bandeira, 2003;
Lentinus velutinus Fr. = Panus velutinus	Yanomami	As food	shioconiamo siokoni amo		Góes-Neto & Bandeira, 2003; Vargas-Isla et al., 2013; Sanuma et al., 2016;
Leucocoprinus cepistipes (Sowerby) Pat.	Yanomami	As food	brokemamok	*Lepiota cheimonoceps* (Berk. & M.A.Curt.) Sacc. *Leucocoprinus cheimonoceps* (Berk. & M. A. Curtís) Singer	Prance, 1984; Góes-Neto & Bandeira, 2003; Vargas-Isla et al., 2013;
Marasmius yanomami	Yanomami	Basketry			Yanomami et al. (2019)
Neoclitocybe byssiseda (Rick) Sing.	Yanomami	As food	hodohkuk		Góes-Neto & Bandeira, 2003
Panus lecomtei (Fr.) Corner	Yanomami	As food	shio-koni-amo	*Panus rudis* Fr.	Vargas-Isla et al., 2013;
Panus neostrigosus Drechsler-Santos & Wartchow	Yanomami	As food	siokoni amo		Sanuma et al., 2016;
Panus strigellus (Berk.) Overh.	Yanomami	As food	siokoni amo		Sanuma et al., 2016;
Pholiota bicolor (Speg.) Singer	Yanomami	As food	inishiamo		Góes-Neto & Bandeira, 2003
Pleurotus albidus (Berk.) Pegler	Yanomami	As food	hami amo	*Lentinus* sp.	Fidalgo & Prance, 1976; Prance, 1984; Sanuma et al., 2016;
Pleurotus djamor (Rumph. ex. Fr.) Boedijn	Yanomami	As food	hiwala amo		Sanuma et al., 2016;
Polyporus alveolaris (DC) Bondartsev & Singer	Yanomami	As food	hassamo	*Favolus striatulus* Ellis & Everh.	Góes-Neto & Bandeira, 2003

Polyporus aquosus Henn.	Yanomami	As food	sama amuku samasamani amo		Vargas-Isla et al., 2013; Sanuma et al., 2016;
Polyporus indigenus I. Araújo and M. A. Souza.	Amazonian tribes	As food	"Amazonian indian bread" Pão do Índio		Maravalhas (19621965); Aguiar and Souza (1981); Góes-Neto & Bandeira, 2003
Polyporus pes-simiae Berk.	Nambiquara	As food	coatá-pô		Fidalgo, 1965; Fidalgo, 1968
Polyporus philippinensis Berk.	Yanomami	As food	atapa amo	Favolus brunneolus Berk & M.A.Curtis cvonsidered as Echinochaete brachypora (Mont.) Ryvarden is in fact this species	Góes-Neto & Bandeira, 2003; Sanuma et al., 2016;
Polyporus sapurema Möller	several Brazilian Indian tribes	As food	"Indian bread" Pão do Índio		Anchieta (1560); Hennings, 1897; Engler, 1900; Brade, 1930; Gonçalves, 1937; Sampaio, 1944; Viégas, 1942, 1959; Fidalgo, 1965; Fidalgo, 1968; Aguiar & Souza, 1981; Vargas-Isla et al., 2013;
Polyporus tenuiculus (Beauvais) Fr.	Yanomami	As food	alamokayay atapaamo adamasik mafcomkuk		Góes-Neto & Bandeira, 2003
Polyporus aff. *Thailandensis* Sotome (do 94omplex *P. tricholoma*)	Yanomami	As food	Hasasömökali amo	*Polyporus* sp de Prance, 1984;	Sanuma et al., 2016;
Polyporus tricholoma Mont.	Yanomami TupiGuarani	As food and medicinal	corobamo urupé-piranga kotopo amo		Góes-Neto & Bandeira, 2003; Vargas-Isla et al., 2013; Sanuma et al., 2016;
Pycnoporus sanguineus (L. ex Fr.) Murr.	Tupiguarani Caiabi Txucarramáe	Hemoptise For bleeding and uterine disorders	urupé-piranga uepó-piren pinhamak-cameri urupê-tauá	*Boletus sanguineus* de Spix & Martius (1823); *Polyporus coccineus* Fr.	Martius, 1844; Peckolt & Peckolt, 1888; Chernoviz, 1890; Pardal, 1937; Fidalgo & Hirata, 1979;

					Góes-Neto & Bandeira, 2003; Vargas-Isla et al. (2013);
Trametes cubensis (Mont.) Sacc.	Txucarramáe	As food	pinhamak-aca		Fidalgo & Hirata, 1979; Góes-Neto & Bandeira, 2003; Vargas-Isla et al. (2013);
Trametes cupreorosea (Berk.) Lloyd	Erigpaktsa	Menstrual disorders			Fidalgo (1965) baseado em comunicação pessoal de Margareth Mee de 1962
Trametes ochracea (Pers.) Gilb. & Ryvarden	Yanomami	As food		*Coriolus zonatus* (Nees) Quélet	Vargas-Isla et al. (2013);
Trichaptum perrotetti (Lev.) Ryvarden	Txicao	As food	pidjo		Góes-Neto & Bandeira, 2003
Trichaptum trichomallum (Berk. & Mont.) Murrill	Txucarramãe	As food			Fidalgo & Hirata, 1979; Vargas-Isla et al. (2013);
Sem identificação		Sopmes species were eaten			Piso and MarcGrave (1648)
Sem identificação		Mushrooms and other fungi as food for pregnant womans			Spix and Martius (1823-1831)
Sem identificação	Nambikwara	Cooked to be used as food			Strauss (1946)
?? orelhas-de-pau	Kayapó	Used as food if nothing better			Banner (1957)

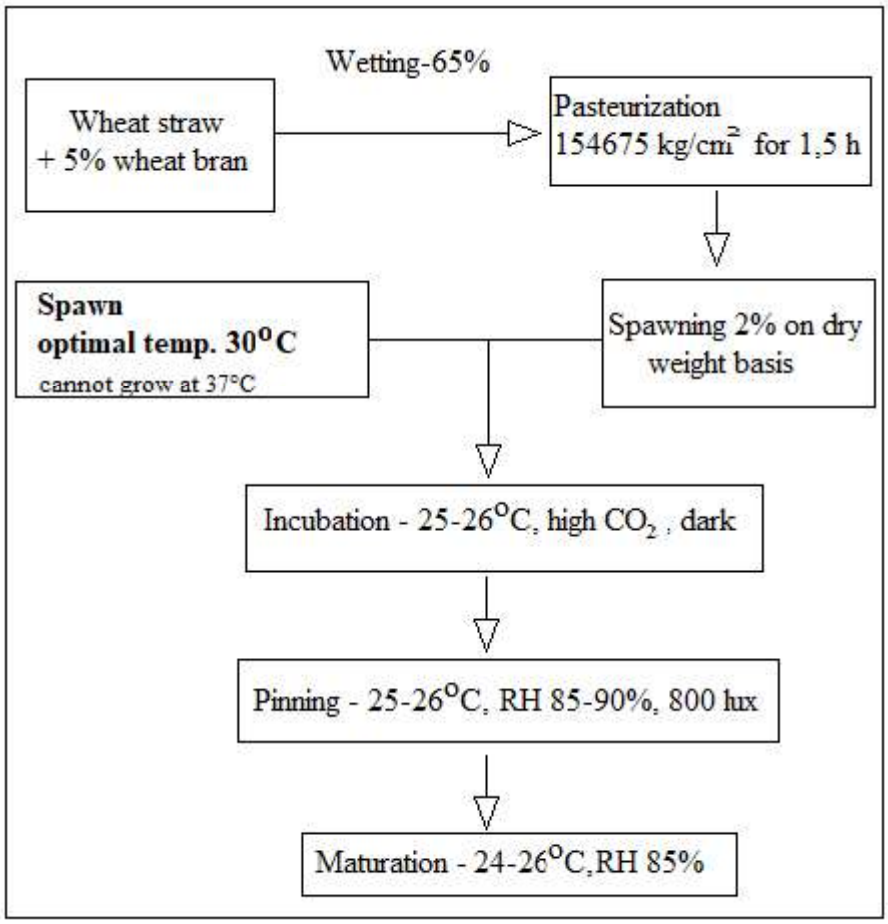
POSSIBILITY OF CULTIVATION OF SPECIES CONSUMED BY BRAZILIAN INDIGENOUS NATIVES:

Auricularia fuscosuccinea

Strangely this is the only species of the genus cited as used by the Brazilian Indigenous natives, but it is believed that all of them are, since the gelatinous consistency and absence of stipe, with basidiomas growing laterally, in wood, characterizing the genus and allowing its easy distinction in the interior of the forest. In this way perhaps all the

different species can be called by the same name. The consumption of *Auricularia polytricha* (Mont.) Sacc and *A. delicata* (Mont.) Henn. is mentioned for the Venezuelan Amazon (ZENT et al., 2004). Cultivation is common in Asian countries, even for its medicinal qualities (Chang et al., 1993). *Auricularia* spp. Are cultivated commercially on corncob and coffee pulp, but it is more susceptible to contamination than *Pleurotus*, making cultivation difficult (PALM & CHAPELA, 1997). Details of a cultivation protocol and necessary conditions are shown in Figure 1.

Figure 1 - Flow chart for *Auricularia* spp. production.



Adapted from SHARMA et al., (2020).

Collybia spp.

The species of this genus are redistributed, especially in the genus *Gymnopus*, but withiot data about cultivation techniques. *Collybia pseudocalopus* and *Collybia subpruinosa* are the species consumed by the Yanomami's, although many others occur in the Amazon, some difficult to differentiate (SINGER, 1986).

Coriolopsis daedaleoides

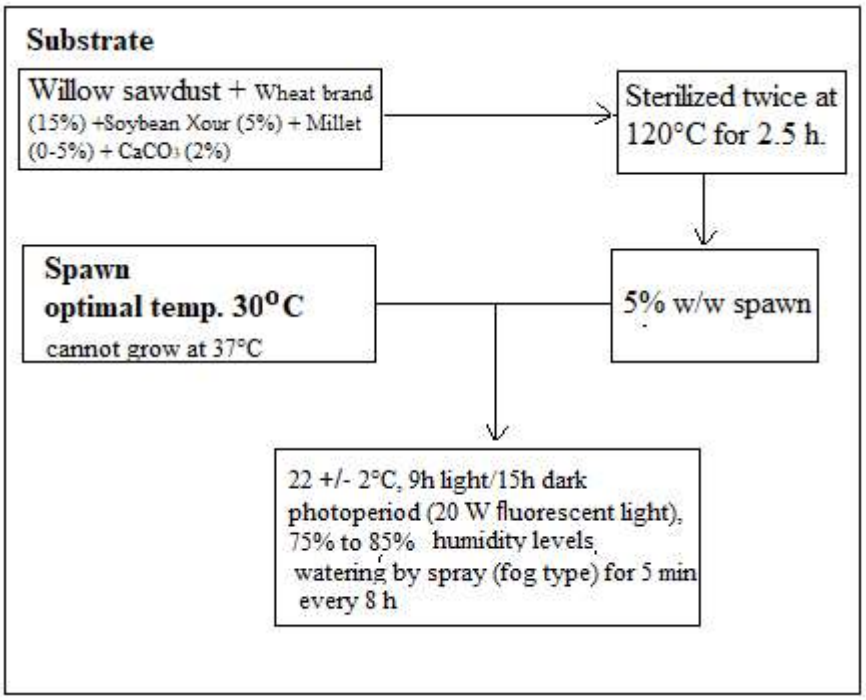
The species does not appear on the list of aphilophoroids in the Amazon (GOMES-SILVA & GIBERTONI, 2009) which seems to indicate that the identification is incorrect. Until identification, cultivation assessments will not be possible.

Favolus brasiliensis

Despite being one of the most common and productive macrofungi in Brazilian forests, it has little cultivation research (SILVA-NETO et al., 2020). In the studied ethnic groups, the species was found in fallen trunks and collected directly (PRANCE, 1984). *Polyporus tenuiculus* (considered by some authors to be synonymous with this species) has already been tested with sawdust with different compositions, presenting easy growth (OMARINI et al., 2009).

A summary of the cultivation protocol and necessary conditions is shown in Figure 2.

Figure 2 - Flow chart for *Polyporus tenuiculus* production.



According to OMARINI et al. (2009).

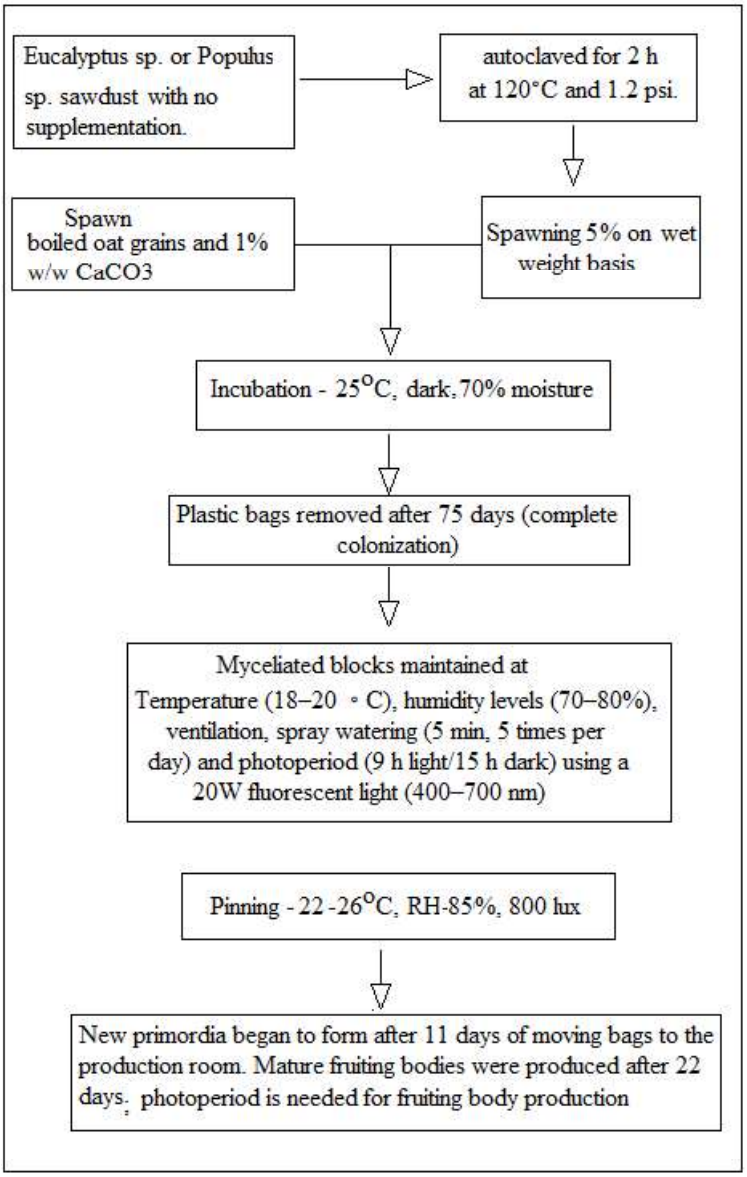
Gloeoporus thelephoroides

Cited for many Brazilian regions, the species does not have a cultivation protocol (ABRAHÃO et al., 2009; BALTAZAR & GIBERTONI 2009).

Gymnopilus spp.

This genus has species commonly found in Brazilian forests. *Gymnopilus earlei* Murr. and *G. hispidellus* Murr. are cited as consumed by the Yanomami. *Gymnopilus pampeanus*, a species that grows on *Eucalyptus* spp. planted in Brazil, was studied and its cultivation techniques developed and which are summarized in Figure 3 (COLAVOLPE & ALBERTÓ, 2014). Perhaps similar techniques could be used for other species of the genus (Figure 3).

Figure 3 - Flow chart for *Gymnopilus pampeanus* production.



Adapted from COLAVOLPE & ALBERTÓ (2014).

Hydnopolyporus fimbriatus

Due to the general aspect of its basidiome, the species is highly attractive for commercialization. However, little data exists on its cultivation. It is known that it does not grow in spawn made using pure grains, being grown only with wood chips (25% added to wheat grains). In this condition, the mycelium grows 4 mm per day, completely colonizing the substrate in 28 days (polypropylene bags with 1 kg of substrate). A fruiting test was done with wood chips (*Populus alba*) soaked for 18 hours followed by mixing with 15% wheat bran and 3% CaCO3 in 600g cellophane plastic bags. Then, the bags were sterilized at 15 psi and 121 ° C for 120 min. In this test, no fruiting was observed (SHAHTAHMASEBI et al., 2018).

Substrates with 20 g of cotton cake moistened with 30 mL of water (70% humidity) and another with 40 g of physic nut cake (*Jatropha curcas*) moistened with 55 mL of water (moisture around 60%) efficient for the mycelium cultivation of this species (SOUZA, 2019).

Lentinus and *Panus* spp.

At least 3 species of *Lentinus* (*L. crinitus, L. strigosus* and *L. velutinus*) receive the same name by the Yanomami (shiocoiniamo) according to Góes-Neto & Bandeira (2003), a number increased to 5 in SANUMA et al. (2016) that uses the expression *si-okoniamo* for *Panus neostrigosus, Panus strigellus, Panus velutinus, Lentinus bertieri, Lentinus crinitus.* This indicates that, due to the difficulty in recognizing characteristics that distinguish them, they end up collecting everything as the same species, except *L. cubensis*, called *nainaiamo*. This difficulty is also common in the current morphological taxonomy. It is important to note that the *Lentinus*/*Panus* species are considered edible by the literature, but *L. concavus* is considered the only one that needs to be well cooked, as it may cause dizziness and nausea. Thus, it is recommended to consume all species well cooked.

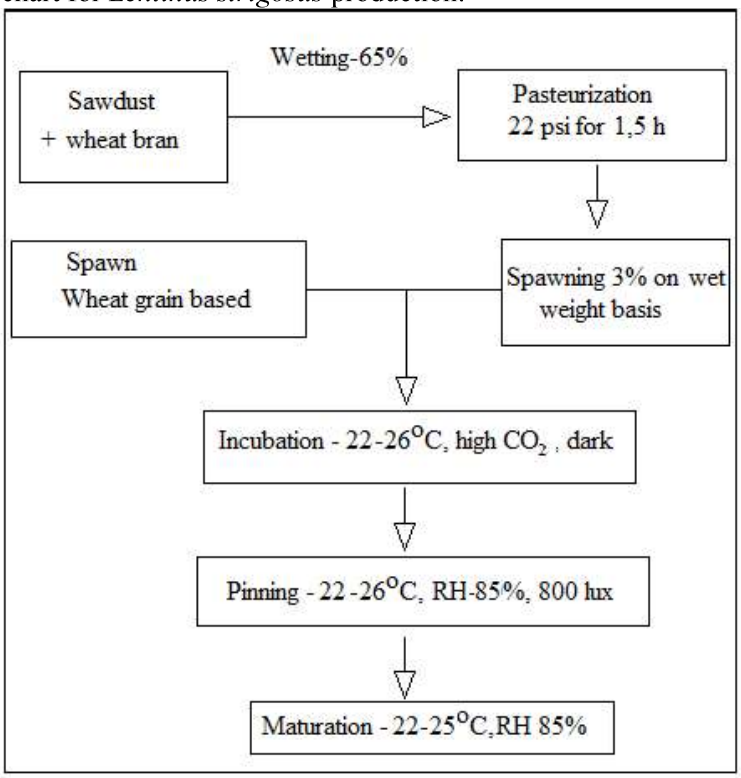
The mycelium of *Panus strigellus* grew well on sawdust from 11 forest species in the Amazon, presenting the same potential for use in the formulation of seed-inoculum and/or cultivation of this edible fungus (VARGAS-ISLA et al., 2012).

The evaluation of the mycelial growth of a *L. crinitus* strain confirmed that it can grow on agro-waste in Colombia. The treatment T6 (Orange peel and brand) was determined to be the best for the mycelial growth (0.0790 cm / h), T7 (Bran, Orange peel and rice husk) and T5 (Rice hush and orange peel) followed, with mycelial growth rates of 0.0753 cm / h and .0720 cm / h, respectively (DÁVILA et al., 2020).

Lentinus strigosus was cultivated in India using sawdust of selected trees viz. Tunni, Mango, Shisham (80 kg), wheat bran (20 kg), CaCO3 (1 kg) and CaSO4 (0.5 kg). *Lentinus (Panus) velutinus* was also cultivated in this country using sawdust of selected trees (80 kg), wheat bran (20 kg), CaCO3 (1 kg) and CaSO4 (0.5 kg) (SHARMA et al., 2020).

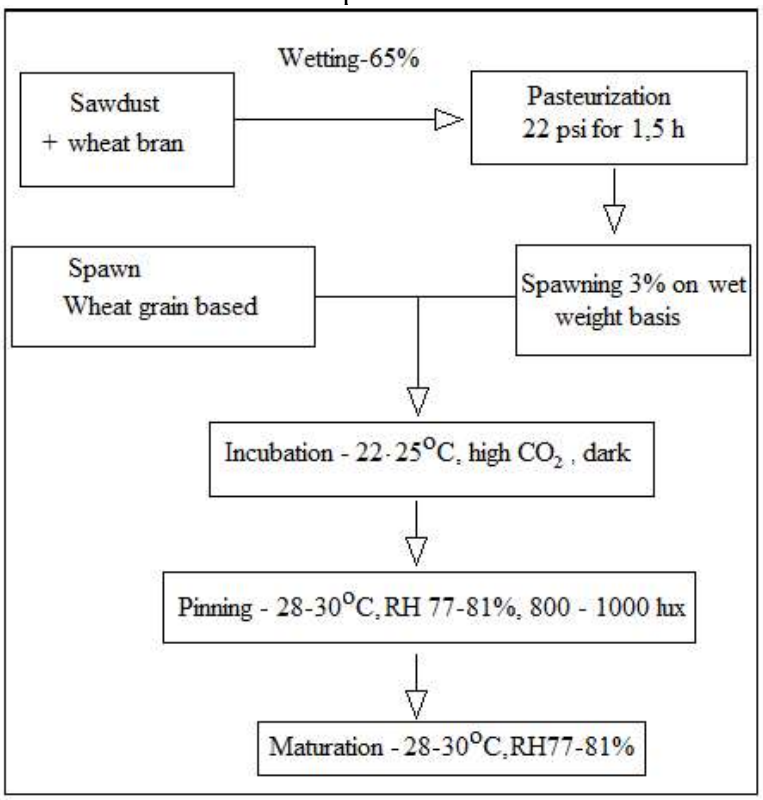
Two cultivation protocols with the necessary conditions are shown in Figures 4 and 5.

Figure 4 - Flow chart for *Lentinus strigosus* production.



Adapted from SHARMA et al., (2020).

Figure 5 - Flow chart for *Lentinus velutinus* production.



Adapted from SHARMA et al., (2020).

Leucocoprinus cepistipes

This species is cited as edible (BI et al., 1993), but slightly toxic to some people (Desjardin et al., 2014). Therefore, it is recommended to be careful. It is exported in flower substrate all over the planet, indicating its easy adaptation to several substrates including those usual in floriculture (SZCZEPKOWSKI et al., 2014). However, there are no studies for cultivation.

Pleurotus spp.

All species of *Pleurotus* are grown commercially on substrates of different origins, from logs to sawdust and compounds based on grass straw. It is worth mentioning here the use of species not or little cultivated as *Pleurotus albidus*, which even presents therapeutic potential to fight/delay diseases associated with oxidative stress and inflammation (GAMBATO et al., 2016). Ergotionein was found in the extracts of this mushroom (GAMBATO et al., 2018).

Polyporus indigenus and *P. sapurema*

"Indian bread" or "flexible stone" (ANCHIETA, 1560) can be kept in a humid place, which will continue to form basidioma that can be constantly collected. Following Rolf Singer's guidelines at the time, AGUIAR & SOUZA (1981) managed to form mushrooms from sclerotia kept in a humid chamber. Forests could be enriched with sclerotia found in excavations of road beds, foundations of houses and crops throughout Brazil and simply buried in preserved forest, instead of being used directly in food. This in order to make it possible to collect the mushrooms that will be formed. This activity is recommended as a way to supplement your diet, serving very well the purpose of growing mushrooms without much investment, with sclerotia reaching up to 60 kg t and weight.

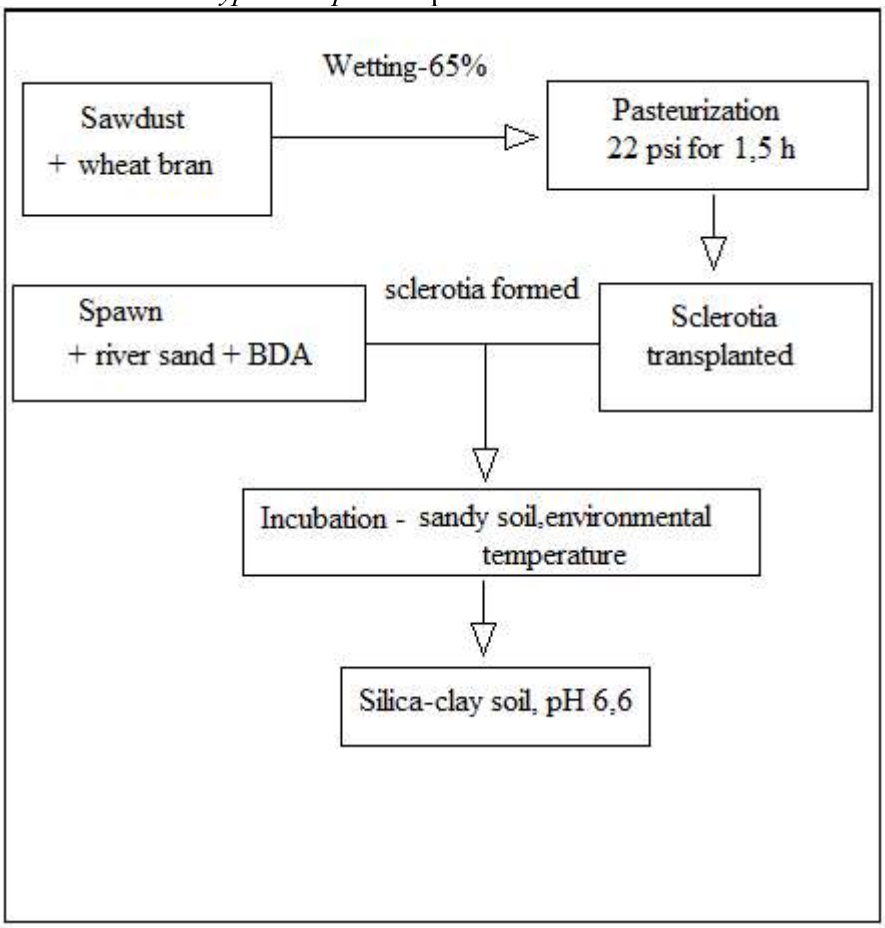
Analyzing the peel and pulp of the sclerotia of *P. indigenus*, it was found the occurrence of fats (1.1 / 1.7%), proteins (0.9 / 2.2%), carbohydrates (39 / 59.6%), indicating that 100g would supply a human's food with 50% of daily needs (AGUIAR & SOUZA, 1981).

Polyporus sapurema, which is found in southeastern and southern Brazil, could have the same use. However, one of the authors (JP), even with constant field trips since 1986, has never met this species in nature (in the southern region). The species is cited for Paraná [MEIJER (2006), as *P. cf. sapurema*], Santa Catarina (VIÉGAS, 1959; TORREND, 1926), São Paulo (RICK, 1960), Rio Grande do Sul, Espírito Santo and Bahia (VIÉGAS, 1959). *Polyporus pseudosapurema* Pickel cited to Pernambuco may correspond to this species (TAVARES, 1939).

SAMPAIO (1944) mentions that the Indians' bread (because the Brazilian Indigenous Natives are believed to eat it), or "saporema", is an edible tuberous mushroom called the Brazilian truffle (*Polyporus saporema*), whose tuber was found for sale in the São Paulo markets (BRADE, 1930). This was also cited by Eurico Santos, in an article on "Truffle", in "O Jornal", of May 18, 1941 (SANTOS, 1941). The collection and commercialization of sclerotia may have led the species to some degree of threat. Despite the name of the species supposing that it is parasitic and that it has some smell was not confirmed in studies of inoculation and in evaluations of fresh sclerotia (VIÉGAS, 1959). BOOCK (1945) evaluated the soil in the region where sclerotia were found in the plateau of São Paulo State – Brazil (Ubatuba) and referred to it as slightly acidic (pH 6.6), silica-clayey, with excellent total nitrogen content. These data can be important for the artificial

reproduction of the sclerotia in an alternative substrate or even in the field. GOMES-SILVA et al. (2012) describe both species in English language for the first time and with the revision of specimens of *P. sapurema* from Acre state (collection made in 1979), São Paulo (1968), Espírito Santo (1917), from two collections without location and collections of *P. indigenus* from Amazonas (Manaus/Itacoatiara Road, Km 12, 1977). In addition to the specimens cited in this work, the collections existing in other Brazilian herbaria were reviewed, and there is no mention of recent collections, as shown by the collection dates: - Herbarium Leopoldo Krieger (CESJ) of the Federal University of Juiz de Fora; - Herbário Lauro Pires Xavier collected in Manaus - Amazon (10/10/1978), JPB (13265) - INPA Herbarium: Amazonas, Fazenda Arauna, B.inger, VIII / 1977 (INPA 90190). In the SpeciesLink (2020 revision) in the registered Brazilian herbariua, 10 collections were found, one of them from Cuzco in Peru under this specific name, and the most recent of 1980, collected in Acre. A summary of the cultivation protocol is shown in Figure 5.

Figure 5 - Flow chart for *Polyporus sapurema* production.



Data from (VIÉGAS, 1942, 1959; BOOCK, 1945).

Polyporus spp.

There are at least 12 species of *Polyporus* in Brazil (PUTZKE & PUTZKE, 2017), being the most common genus in woods on logs, even in drier seasons, but none is commercially cultivated. No species of *Polyporus* is known to be poisonous (WRIGTH,

2008), and by the favoloid to porose hymenophore, white spore print, growth on wood, are easily recognized. There are many sources of secondary metabolites of medicinal interest, such as in *P. tricholoma* (VIEIRA et al., 2008).

Pycnoporus sanguineus

The species is used for its medicinal, antibacterial and antifungal properties (PEITER-BENNICA et al., 2008). Its use was also studied for the discoloration of effluents from the olive oil industry and the discoloration of azo and anthraquinone dyes (JAOUANI et al., 2005; LU et al., 2007). The species is also used in the Amazon as a dye for finishing pieces clay (SÓTÃO and FIGUEIREDO, 1996). It was found that the species grows well in substrates using two sawdust sizes of *Eucalyptus* sp. and three concentrations of rice bran added to sawdust, with the diameter, mass and number of basidiome not influenced by the addition of rice bran (MARTINAZZO-PORTZ, 2011). Therefore, to have a fungus like these in cultivation condition, pure *Eucalyptus* sawdust is sufficient. In field activities they are frequent in dead broom trees (*Baccharis dracunculifolia* D.C.) in areas of abandoned agricultural practices and in the initial stages of succession. Various substrates obtained, when recovering agriculture in areas such as these, may come to be used for the production of this species, since, in general, they are simply burned.

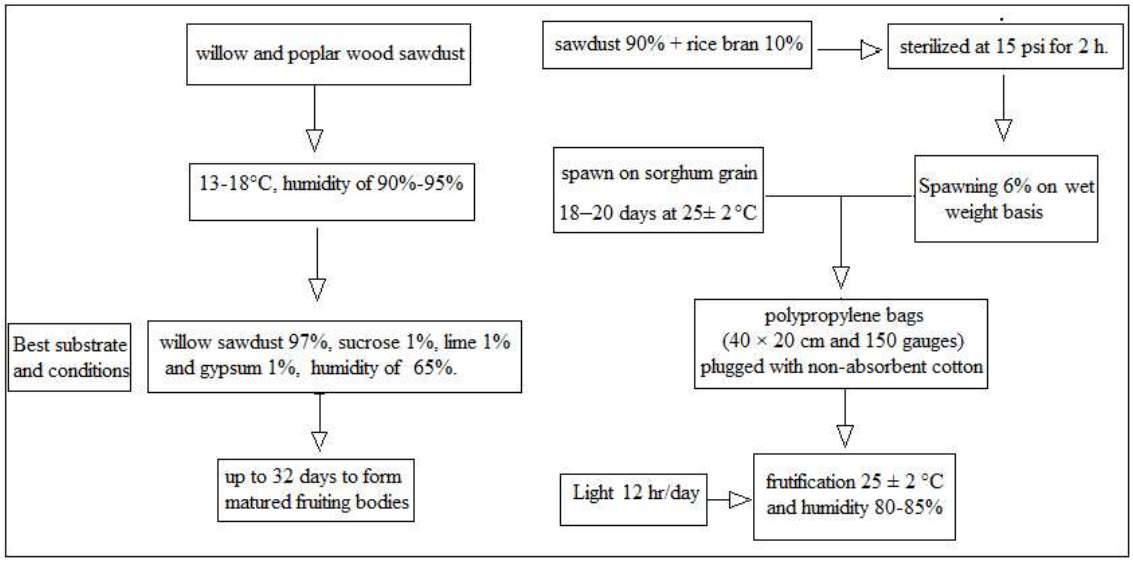
Trametes spp.

The genus *Trametes* is still beginning to be cultivated, being *T. versicolor* one of the most promising species. It is already being cultivated in countries like India and Mexico, among others (VEENA & PANDEY, 2012; GUERRERO et al., 2011). Cultivation experiments have been also conducted with other species like *Tametes suaveolens* (MA et al., 2019; GILBERTSON and RYVARDEN, 1987; ZMITROVICH et al., 2011) (Figure 6).

In Brazil *T. cubensis* and *T. ochracea* are eaten and *Trametes cupreorosea* is used as medicinal for menstrual disorders.

DAMASCENO (2016) purifies and characterizes laccase of *Trametes cubensis* in cultivation and DAMASCENO et al. (2019) uses it for biodegradation of petroleum derivatives (PAHs).

Figure 6 - Flow chart for *Trametes suaveolens* (left) and *T. versicolor* (right) production.



Data from (MA et al., 2019; VEENA & PANDEY, 2012; GUERRERO et al., 2011).

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