

ALLELOPATHIC ACTIVITY OF SOME WILD MUSHROOM IN INDONESIA

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ABSTRACT

To date, allelopathic activity of mushroom has not been reported in Indonesia. The aim of this study was to examine the allelopathic activity of wild mushroom extract through bioassay germination on *Vigna radiata* L. seed. A total of 13 wild mushrooms namely : *Amanita* sp.1, *Armillaria* sp.1, *Armillaria* sp.2, *Auricularia* sp., *Clitocybe* sp., *Crepidotus* sp., *Fomitopsis* sp., *Ganoderma* sp., *Lepiota* sp.1, *Microporus* sp., *Panaeolus* sp., *Polyporus* sp., and *Rigidoporus* sp. used for the material extraction. The extraction of 13 wild mushrooms was done using pure water. Pure extract (25%, 50%, and 75%) was applied by using sprayer directly on the seed for 7 days. The parameters observed including percentage of seeds germinating, length of radicles, and length of plumules. The highest germination rates as well as length of plumules and radicles were obtained in the negative control using distilled water, whilst *Imperata cylindrica* extract which used as positive control showed opposite result. Mushroom extract showed variation in the parameter observation. *Rigidoporus* sp., *Daedalea* sp.1, and *Microporus* sp. 2 seem to have the best activity of allelopathic effects, while *Auricularia* sp. consistently induced the highest effect of seed development. Overall, in line with few previously reports, this results can broadening the information of utilization of allelochemical properties of wild mushroom.

Keywords: Allelopathy, germination, plumule, radicle, seed, mushroom

INTRODUCTION

Weeds are plants which inhabit in a location where their occurrence are undesirable due to their adverse effects on the ecosystem or agriculture (Norris, 1992; Kim, 1994; Gadermaier et al., 2014). The weed control is one of the paramount aspects to obtain high yields on farming sectors. The herbicides application, which believe as powerful tools in agricultural activity, has gradually increased since decades which contaminates the environment with serious consequences to all life form. Moreover, many reports the concerning of weeds resistance which is a consequence in most cases of mutations or pre-existence of genes that confer resistance to the population (Agostinetto et al., 2002; Oliveira et al., 2014). Researchers also pointed that herbicidal toxic effect on non-target soil creatures which involve in degrading and decomposing organic matter (Nuret et al., 2013; Wolmarans and Swart, 2014). Therefore, the need for biological weed control such as development of bio-herbicides has risen over the decades.

In the term of fungal utilization approach, fungal pathogens in weed control is mostly used. Wood and Morris (2007) discovered that the Australian gall-forming rust fungus *Uromycladium tepperianum* assists to reduce the infestation of *Acacia saligna* at over 50 localities in South Africa. Another prime examples of using fungi in biocontrol of weed are the prosperous use of the European rust fungus *Phragmidium violaceum* to control European blackberry (*Rubus* sp.) in Chile, the use of *Puccinia chondrillina* to control *Chondrilla juncea* (rush skeleton weed) in Australia, which is considered as the most astonishing successes ever performed with biocontrol (Tansey and Kendrick, 1992). However, it is important to consider that the secondary infection of fungal pathogens which can lead to a successive distribution of disease in the field. As a result, it is necessary to develop another alternative weed control methods, which besides, again can reduce some negative environmental impacts.

Some organisms including plants and fungi release allelochemicals which can alter the organisms around them. Only few studies proved that macro fungi species have allelopathic potential (Araya, 2015; Kara, 2018; Osivand et al., 2018). Allelochemicals released by mushrooms may have specific effects on the growth and development of neighboring plants. Araya (2015) proposed that the allelochemicals releasing mechanism from mushrooms are similar to those in common plants. The allelopathic effects of mushrooms rely on hyphae biomass, the allelochemicals itself, and the tolerance of affected organisms (e.g., plants or insects) (Fuji et al., 2004). Accordingly, using wild filamentous hyphae with fruiting bodies would be ideal for assessing the allelopathic potential of mushrooms (Osivand et al., 2018). Since it is difficult to collect large amounts of filamentous hyphae for bioassay, the most feasible option is to use fruiting bodies, which collectable in aggregates (Araya, 2015). As Indonesia poses high diversity of mushroom both in forest and natural park area (Putra et al., 2017; 2018; 2019), it is needed to explore allelopathic activity from many kind of wild

mushrooms. Different mushroom species act as a promising source for the production of various compounds that can be used as potential herbicides. The objective of this study was to observe allelopathic activity of wild mushroom extract through bioassay germination on *Vigna radiata* L. seed. This research is the first report of allelopathic activity of mushroom extract in Indonesia.

MATERIAL AND METHODS

Wild Mushroom Extract Preparation

A total of 13 wild mushrooms namely : *Amanita* sp.1, *Armillaria* sp.1, *Armillaria* sp.2, *Auricularia* sp., *Clitocybe* sp., *Crepidotus* sp., *Fomitopsis* sp., *Ganoderma* sp., *Lepiota* sp.1, *Microporus* sp., *Panaeolus* sp., *Polyporus* sp., and *Rigidoporus* sp., were collected from Mekarsari Tourism Park, Indonesia in July 2017 and Gede Pangrango Mountain National Park, Indonesia in July-August 2018 as described by Putra et al. (2018; 2019). Epigeal parts of the mushrooms were cleaned, dried, and then grounded by blender into small pieces. Then 50 g was taken in to bottom flask and 500 ml distilled water was added on it (1:10)(W/V) (Wardle et al., 1992). Mixture was stirred for 10 min and then slurry was filtered through filter paper (whatman No:1) and centrifuged in 4000 rpm for 10 minutes to obtain pure extracts. Obtained solution is diluted with distilled water to prepare different concentrations (25%, 50%, and 75%).

Seed Preparation

Seeds of *Vigna radiata* L. used in this study were obtained from the local market. They were soaked in distilled water for 12 hours. The water was drained and the seedling were ready for allelopathic test (day 1).

Allelopathic bioassay test

The experiment was conducted according to Kara (2018) with three replications. The seedlings were kept moist by spraying (2 times a day) tap water, *Imperata cylindrica* extract, and the wild mushroom extract in a covered Petri dish with sterile cotton. Germinated seeds were recorded on day 7th after sowing. The parameters observed including percentage of seeds germinating, length of radicles, and length of plumules. *Imperata cylindrica* extract served as the positive control group since they have the property of allelopathic effects (Eussen, 1979; Inderjit and Dakshini, 1991; Cerdeira et al., 2012), while distilled water was the negative control group. The results were obtained under laboratory conditions.

RESULTS AND DISCUSSION

Allelopathic bioassay test using extracts derived from 13 wild mushroom showed that the aqueous extracts of wild mushroom possess allelochemicals that suppressed the germination and seedling growth of *Vigna radiata* L. (Table 1). A hundred percent of germination rate were obtained by extract of *Amanita* sp.1, *Lepiota* sp. 1, *Crepidotus* sp., and *Clitocybe* sp. Treatment as well as distilled water, while *Rigidoporus* sp. extract is the only treatment which the germination of *Vigna radiata* L. seeds never existed. *Rigidoporus* has been known as causative agent of white root disease which is the most destructive root disease in rubber plantation (Silva *et al.*, 2017). It is still unclear which bioactive properties of *Rigidoporus* play key role of allelopathic effects. Falade *et al.* (2017) reported that the bioactive compounds found in the extracts of *Rigidoporus microporus* (SW) were hexadecane, n-hexadecanoic acid, pentadecanoic acid, octadecane, hexadecanoic acid, n-octadecenoic acid, di-n-octyl phthalate (1,2- benzenedicarboxylic acid, dioctyl ester) and n-decanoic acid. However, the use of *Rigidoporus* extract in weed management has never been done before. The seeds germination with *Imperata cylindrica* treatment only occurred at 25% concentration, in contrast to *Daedalea* sp.1 which germination emerged only at 75% concentration. Members of the genus *Daedalea* are brown-rot fungi which have been used for biodegradation due to their capability of producing hydroxyl radicals in the Fenton reaction (Purnomo *et al.*, 2008; 2010; 2011). Hydroxyl radicals are highly reactive species which attack most of the organic molecules (Lester, 2008). Based on the results of this study, *Daedalea* sp. can also be good candidate for further observation on its allelopathic effects. The rest of treatment showed successful germination rate from 33.3%-100%. This study proved that different mushroom extract varying in the seeds germination effect.

Table 1 Germination rates of *Vigna Radiata* L. seeds

Groups	Germination rates (%)		
	25% Extract	50% Extract	75% Extract
<i>Polyporus</i> sp.	66.7	100	66.7
<i>Armillaria</i> sp.1	66.7	66.7	0
<i>Armillaria</i> sp.2	66.7	100	66.7
<i>Microporus</i> sp.2	33.3	33.3	33.3
<i>Fomitopsis</i> sp.	0	66.7	33.3
<i>Daedalea</i> sp.1	0	0	66.7
<i>Rigidoporus</i> sp.	0	0	0
<i>Panaeolus</i> sp.	100	66.7	100
<i>Amanita</i> sp.1	100	100	100
<i>Lepiota</i> sp.1	100	100	100
<i>Auricularia</i> sp.	100	100	66.7
<i>Crepidotus</i> sp.	100	100	100
<i>Clitocybe</i> sp.	100	100	100
<i>Imperata cylindrica</i>	66.7	0	0
Distilled water		100	

In the term of radicle development, the longest length possessed by *Auricularia* sp. extract in all concentration compare to all treatment and negative control, whilst *Rigidoporus* sp. extract was the only treatment in all concentration which the radicle was not growth. The *Rigidoporus* sp. allelopathic effect was even better compare to *Imperata cylindrica* (positive control) and *Daedalea* sp.1 (Fig 2). It is still uncertain which bioactive properties of *Auricularia* sp. act as inducer of seed germination in this study. Chang and Miles (1989) reported that nutritional content of *Auricularia* are 89.1% water, 4.2% protein, 5.3% fat, 2.8% carbohydrate, 19.8% fiber, and 351mg calories. The rest of treatment showed variation in the effect of radicle length. The shortest radicle length was 0.3 mm (*Microporus* sp. 2 treatment) while the longest was 5.7 mm (*Auricularia* sp. treatment). Osivand *et al.*, (2018) proved that *Microporus vernicipes* extract has allelopathic effects on *Lactuca sativa* var. Great Lakes 366. However, there is no record yet on bioactive properties of this mushroom. This research findings showed that *Microporus* group also can be feasible candidate for weed management by mushroom allelopathic-based effects.

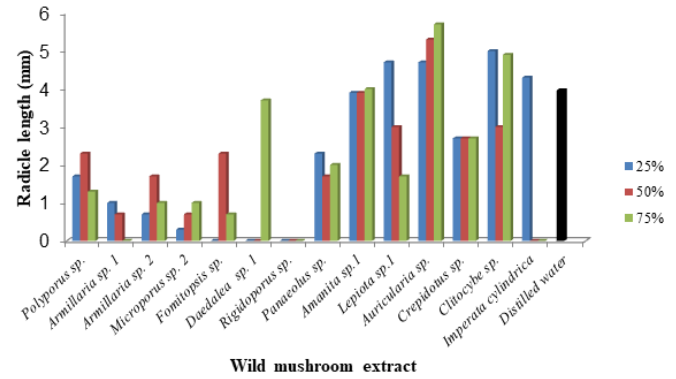


Figure 1 Effect of aqueous extract of wild mushroom on radicle length of *Vigna radiata* L. after 7 days. Extract concentrations (25%, 50%, and 75%). (-) Control :distilled water, (+) control : *Imperata cylindrica* aqueous extract.

Turning to the plumule length, all of treatment showed allelopathic effect inhibition on plumule development while *Auricularia* sp. was the only mushroom extract which induce plumule growth (Fig 3). This is also interesting since positive control only inhibit the plumule growth at 25% concentration whilst negative control showed adequate inducing effect on *Vigna radiata* L. plumule development. The longest plumule was 4.8 mm (25% of *Auricularia* sp. extract) while distilled water treatment only 4.7 mm. The plumule part of the seed is emerge after growth of radicle, which comes out from the seed during germination. This study confirmed that all of wild mushroom extract used (except *Auricularia* sp.) inhibit the plumule development of *Vigna radiata* L. even though the radicle was emerged. Further study for evaluating the allelopathic effect wild mushroom to the common weed as well as observation of its specific allelochemicals is necessary, in order to develop alternative weed control methods, which can reduce some negative environmental impacts in Indonesia .

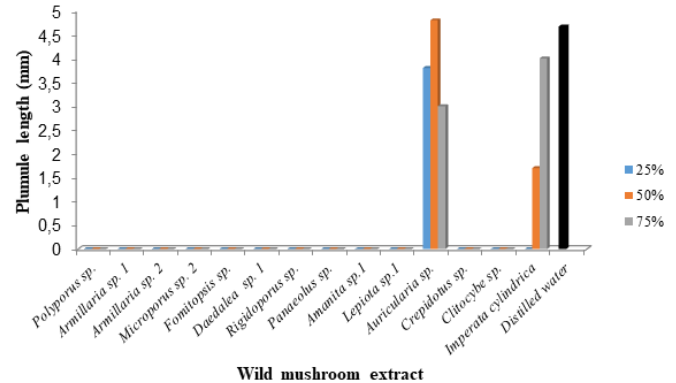


Figure 2 Effect of aqueous extract of wild mushroom on plumule length of *Vigna radiata* L. after 7 days. Extract concentrations (25%, 50%, and 75%). (-) Control :distilled water, (+) control : *Imperata cylindrica* aqueous extract.

CONCLUSION

The present study provides the evidence of allelopathic activity of wild mushroom in Indonesia. It is also recommend that mushroom allelopathic effects should be consider used as prospective bio herbicides for weeds management. Extract of *Rigidoporus* sp., *Daedalea* sp.1, and *Microporus* sp. 2 are the most potential candidates for further obsevation.

CONFLICT OF INTEREST

The author declared that present study was performed in absence of any conflict of interest.

Acknowledgement: Author thanks to Tiara Aulia Dinindaputri, M. Aldi Nasrulloh, Rahmadi Sitompul, and Nadiyah Chalisya for their assisance.

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