RESEARCH APPROACHES ON THE APPLICATION OF MEDICINAL PLANT EXTRACTION IN INHIBITION OF FUNGAL TOWARDS THE IMPROVEMENT OF INDOOR AIR QUALITY 2010-2020: A SYSTEMATIC REVIEW.

ABSTRACT

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This review provides current information on the application of medicinal plant extraction in inhibition of fungal towards the improvement of indoor air quality 2010-2020 based on analysis of published studies. A systematic literature search of ResearchGate, ScienceDirect, PubMed, Google Scholar and Wiley Online Library from 2010 to 2020 was conducted based on PRISMA Guideline without excluded other relevant articles found during the search. A systematic review search on the topic was conducted using appropriate databases to identify potentially relevant citations. The findings of this review are to listed certain type of medicinal plant extractions against various pathogenic fungi and standardize the method of extraction use in medicinal plants extraction thus evaluate certain medical plant extraction has a potential to inhibit pathogenic fungi that will improve the indoor air quality thus will avoid health issues among community.

Keywords: Fungi inhibition, medicinal plant extraction, pathogenic fungi, indoor air quality, method of extraction.

Abbreviations:

IAQ	Indoor Air Quality
SBS	Sick Building Syndrome
pH	Potential of hydrogen
CO2	Carbon Dioxide
MFC	Minimum Fungicide Concentration
MIC	Minimun inhibitory concentration
EOs	Essential Oil

1.0 INTRODUCTION

Indoor air quality (IAQ) is the air quality around buildings and structures. Poor indoor air quality has been linked to sick building syndrome that will reduced productivity of the workers and impaired learning in schools. A systematic review are conducted in other to avoid sick building syndrome. So, a natural method of medicinal plant extraction to inhibit fungi are search based on this topic to improve indoor air quality.

Air is a basic requirement of life, together with food and water which is maintaining indoor air quality in our office, house and all residential buildings is a must (M Pierpaoli, 2018). The sick building syndrome (SBS) is used to describe a condition in which the resident of a building experience acute health or comfort related effects that seem to be linked directly to the time spent in the building (Joshi, 2008; Author & Shiel, 2021; Environmental Protection Agency & Environments Division, 1991; Stolwijk, 1987).

In 2010, the Department has introduced the Industry Code of Practice on Indoor Air Quality 2010 to increase the compliance of designated workplaces (Axelrad, 2009; Quality et al, 2019). In year 1970s, many buildings are designed to reduced ventilation rate in order to maintain the indoor environment more efficiently thus the construction of buildings with energy-efficient air conditioning system has caused sick building syndrome (SBS) to prevail in Malaysia as a result of poorly maintained air conditioning system, raising the levels of indoor air pollutants (Syazwan Aizat. I et al., 2009; Joshi, 2008; Star and Safety, 2020).

The most important factors influencing mould growth are moisture, temperature, type of substrate and exposure time, whereas less important factors are

availability of mould spores, pH, light, oxygen and surface roughness (Vereecken and Roels, 2012). Specialist concerns on buildings are oriented on the mould growth on surfaces and structures (Gutarowska and Zakowska, 2002). Different solutions for the moulds development were found as the treatment of surfaces with biocidal products (Linder, 2004). A modern orientation is the use the essential oils as biocides because the plant extracts are generally assumed to be more acceptable and less hazardous than the synthetic compounds (Magan and Aldred, 2007).

A synthetic substance or synthetic compound refers to a substance that is man-made by synthesis, rather than being produced by nature. It also refers to a substance or compound formed under human control by any chemical reaction, either by chemical synthesis or by biosynthesis (JSTOR, 2012; Synthetic substance, 2020).

Synthetic chemists routinely perform deep and comprehensive spectral characterization of compounds synthesized in the laboratory, often within 24hour of synthesis (O kayser, 2003). The growing use of synthetic chemicals, including pesticides and pharmaceuticals to attack unwanted organisms, has outpaced rising atmospheric CO2 concentrations and other agents of global change in the last 45 years (Bernhardt et al., 2017). Organic compounds make up the bulk of living organisms, and also comprise an extremely large and varied group of man-made chemicals that can be released to the environment, in which they frequently are regarded as contaminants (Compounds, 2020).

Plant extracts are exceedingly complex, multicomponent mixtures and the level of difficulty in exact quantification of plant hormones is determined mainly by their low concentration in extracts (Hooykaas et al., 1999). Plant extracts are of certain interest because they are almost safe, increase the shelf life of foods, are

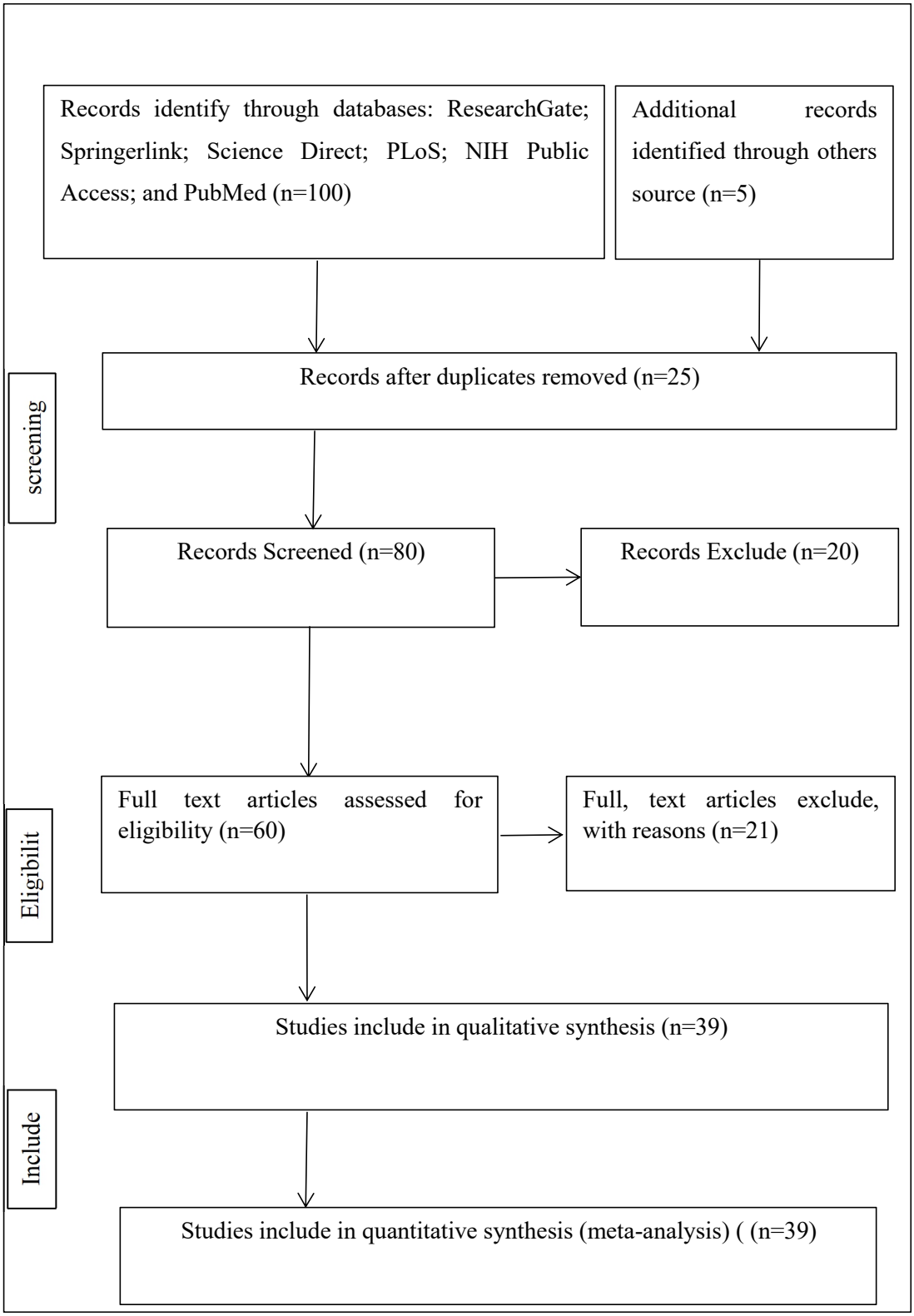
widely accepted by consumers, and have the possible to be exploited for multiple uses (Kalpna D. Rakholiya et al., 2013). Medicinal plants have been the source of treatment of abundant diseases in African traditional medicine as well as other forms of treatment from multiple cultures of the world (Metabolite et al., 2020).

They show various promising effects for several health problems, such as colds, coughs, throat irritations, stomachache, indigestion, and gastrointestinal diseases, and have also positive protecting activities such as spasmolytic, sedative, antiviral, anti-inflammatory, antiseptic, hepatoprotective, antihyperglycemic, and immunostimulating (Metabolite et al., 2020).

Justification, by using medicinal plant extract are less hazardous than synthetics compound which implement nature thus inhibition of fungi growth is to improve poor ventilation in air quality of indoor buildings area.

2.0 METHODOLOGY

Systematic reviews and meta-analyses are importants tools for summarizing evidence precisely and valid. The outlines of a systematic review of fungi inhibition shown in Figure 1 based on preferred reporting items for systematic reviews and meta-analyses (PRISMA) guideline (Moher *et al*., 2009). Searches of published literature for application of plant extracts to inhibit fungi towards the improvement of indoor air quality were conducted between January 2020 and April 2020, by using the following databases: ResearchGate; Springerlink; Science Direct; PLoS; NIH Public Access; and PubMed. Searches were run by using the keyword including "Fungi Inhibition", "Indoor Air Quality", "Medicinal Plant" and "Plant Extraction" where the original papers published in local and international journals from 2010 to 2020 were selected. A total of one hundred were retrieved through initial search using databases (n=70), and Google Scholar (n=30). From this initial search, twenty-five articles were duplicates and hence removed. After removing duplicate citations, the selected full text of published sources was retrieved electronically and final selection of relevant sources to include was performed in a second review which is to certify that the articles follow with the search inclusion and exclusion criteria. Finally, a total of thirthy-nine articles were included in this meta-analysis and critically reviewed as summarized in Figure 1 The outlines of a systematic review of fungi inhibition based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline (Moher *et al*., 2009).



The outlines of a systematic review of fungi inhibition shown in Figure 1 based on preferred reporting items for systematic reviews and meta-analyses (PRISMA) guideline (Moher *et al*., 2009).

3.0 RESULTS

AUTHOR	RESEARCH FOCUS	TYPE OF EXTRACTION	FINDINGS
Stangarlin et al., 2011.	Plant extracts are taken from tree species.	-	◆ 237 plants from the Brazilian flora are antimicrobial potential tested by Brazilian researchers.
Díaz Dellavalle et al., 2011	Extracts of 10 plant species against *Alternaria* spp.	Aqueous, saline buffer and acid extracts	◆ Extracts exhibit fungicidal properties.
Al-Askar, 2012	Antifungal activites on three types Saudi Plant.	Ethanolic Extract	◆ All tested plant extracts of seeds, roots, and rinds had different level of antifungal activity against fungi.
Mouafo & Constant, 2012	Antimicrobial activity of some Cameroonian medicinal plant	Methanol Extract	◆ Plant extracts exhibit antimicrobial activity and *N.latifolia* proved to be most effective as an antibacterial and

	extracts.		antifungal.
Amini et al., 2012	(MIC) and (MFC)	Essential Oil	◆ Growth inhibition studied for essential oils that have potential to control of some plant pathogenic fungi thus considered in developing fungicides.
Timothy et al., 2012	Cassia alata linn as medical plant	Aqueous and ethanol	◆ Cassia alata exhibit a greater antifungal activity against some human pathogenic fungi.
Rahmoun et al., 2013	Henna as traditional medicine	Water and five organic extract	◆ The results has antifungi activity related to the presence of lawsone in the leaves plant thus can exploited largely in research of new antifungal drugs.
Aala et al., 2013	Effects of garlic	Aqueous	◆ Garlic extract as an alternative to treat dermatophytes.
Kumar &	Antifungal	Acetone,	◆ Extracts exhibit amazing

Academy, 2013	activity of solvent based extracts common weeds	methanol, benzene, ethyl acetate and chloroform extracts	fungicidal properties thus used as herbal fungicides.
Stević et al., 2014	Antifungal properties determined by in vitro microdilution method	Essential Oil	◆ Combination of particular oils showed reduction of the MIC values when combined, commendatory mixtures thus the reduction of the total number of fungi, in situ, using selected essential oils was determined.
Singh et al., 2014	In vitro screening of selected plant extracts against Alternaria alternata	Methanol extracts	◆ Phytochemical analysis of leaf extracts shows presence of Alkaloids, Terpenoids, Phenols, Saponins and Tannins at various concentrations.
Pandey & Tripathi,	Overview of certain	Standardization of Extraction	◆ Extraction methods used pharmaceutically involves

2014	extractants and extraction processes with their advantages and disadvantages.		the separation of medicinally active portions of plant tissues from the inactive/inert components by using selective solvents.
Rogawansamy et al., 2015	Treatment of Fungal in Indoor Air Environments	Liquid and Vapour form	◆ Tea tree oil are effective antifungal agent tested thus industrial application for the remediation of fungal contamination in residential and occupational buildings.
Mayuri C. Rathod, 2015	Antifungal activity of two plant species.	Aqueous and acetone extracts	◆ The acetone extracts of plant are more efficient as compared to the water extract.
Moghaddam et al., 2015	Antifungal activity of essential oil from seed of *E.platyloba.*	Essential oil	◆ Great potential of antifungal activity as a mycelia growth inhibitor against the tested phytopathogenic fungi.

Nn, 2015	Comparison of extraction method.	-	◆ All stages of extractions, from the pre-extraction and extraction are equally important in the study of medicinal plants.
Aghazadeh et al., 2016	Effect of zinger	Aqueous	◆ Ginger extract has good antifungal and antibiofilm.
Onaran et al., 2016	Plant Extracts against Different Plant Pathogenic Fungi	Methanol	◆ Plant extracts of natural antifungal subtract as a biological pesticide for alternative management methods against plant diseases.
Of &Polymer, 2016.	Antifungal activity of zingiber officinale	Chloroform, ethanol, acetone, petroleum	◆ Some plant extracts tested possess antifungal activities against *fusarium oxysporum.*
Kerkeni et al., 2016	antifungal activities of various plant components and novel	-	◆ Natural products, either as pure phytocompounds or as standardized plant extracts, provide unlimited opportunities for new drug

	approaches		lads because of normally matchless chemical diversity.
Jahani et al., 2016	The antifungal effects of the extracts of the plants against *Candida albicans*	Methanol Extraction	◆ Antifungal activity Peganum harmala, Echinophora platyloba, Rosmarinus officinalis and Heracleum persicum has expressed Feb plants can be used to treat infections.
Şesan et al., 2016	Efficacy of different plant extracts against *A.alternata*,	Aqueous extraction	◆ Plant extracts with highly efficacy could be an alternative in the protection of blackcurrant as medicinal crop against Alternaria leaf spot and fruit rot especially in organic horticulture system.
Prakash et al., 2017	Effects of Banana of Aspergillus niger	Aqueous extraction	◆ The extract of dried Kadali banana peel powder and ash exhibited antifungal activity against

			Aspergillus niger
Njoki et al., 2017	The effectiveness of medicinal plant extracts in the control of aflatoxin production.	Aqueous Extraction	◆ Medicinal plant extracts can control toxigenic fungal spread.
Reza et al., 2018	Antimicrobial Activities of some Plant Extracts against Fungi	Aqueous and Alcoholic extraction	◆ All extracts of the plants tested showed varying level of antimicrobial activities against phytopathogenic fungi and clinical isolates.
Umaru, 2018	Antifungal activity of three different plant.	Methanol Extract	◆ All plants extract was found maximally affected against the activity of *Aspergillus niger, Aspergillus Flavin, Candida tropicalis* and *Fusarium oxysporium* and aggressively inhibits the growth of species in

			various plant extracts.
Rani, 2018	Plant extract against Alternaria leaf blight of pigeonpea	Aqueous Extraction	◆ Garlic clove extract at 10% was found most effective giving 84.31% inhibition against *Alternaria alternata*
Hu et al., 2019.	Antifungal Activity from seven different species by agar diffusion againts three fungi	Plant essential oil	◆ The in vivo inhibitory activity of selected EOs on naturally infected bread demonstrated that cinnamon and clove EOs thus used as natural antifungal agents.
Mogashoa et al., 2019	The Acetone leaf extract	Methanol, butanol, acetone, ethyl acetate, chloroform, dichloromethane and n-hexane.	◆ The acetone leaf extract used to control *P. janthinellum* infections
Butassi et al., 2019	Antifungal activity of *P. tetramera*	Aqueous extraction	◆ Anti-*Candida* activity of *P. tetramera* extracts led to the most suitable extract

	berry, leaf and root extracts		thus antifungal properties of the threatened species *P. tetramera.*
Meela et al., 2019	Extract of plant against eight plant fungal pathogens	Ethyl acetate, methanol, water, Chloroform, ethyl acetate, formic acid, Benzene, ethanol, ammonia hydroxide extraction.	◆ Extracts of certain invasive plant species had better activity against some fungal pathogens than some commercial fungicides
Darmadi et al., 2019	Cinnamon leaves extraction	Acetone Extract	◆ The acetone extract of cinnamon leaves has the potential as a biofungicide.
Bonifácio et al., 2019	Extracts from *Astronium* sp. Against *Candida albicans*	Aqueous Extract	◆ *A. urundeuva* leaves extract to be further investigated and developed as an antifungal

Wu et al., 2020	Medicinal plant and its potential for providing antimicrobial.	Ethanol Extract	◆ Antimicrobial activity of fungal endophytes suggests that fungal endophytes harbored inside the root tubers of S. dielsiana hold great promise as biocontrol agents against a broad spectrum of economically signifificant pathogens.
Jiang et al., 2020	52 herb extracts againts pathogenic fungi	Ethanol extract	◆ *Rosa chinensis, Neopicrorhiza scrophulariiflora,Phellodendron chinense* and *Syzygium aromaticum* displayed the strongest antifungal effects.
Rabiu & Haque, 2020	Various methods used in the preparation and screening of medicinal	-	◆ Procedures include maceration, digestion, decoction, infusion, percolation, Soxhlet extraction, supercial extraction,

	plants		ultrasound-assisted, and microwave assisted extractions.
Ibrahim & Kebede, 2020	Medicinal plant for treatment	Methanol and Aqueous extraction	◆ Plant material can be affected as the temperature of treatment is increases with respect to various times of exposures.
Khuseib et al., 2020	*Aloe dhufarensis Lavranos* is an important medicinal plant	Aqueous Extraction	◆ Endophytic fungi of A. dhufarensis with antagonistic activity against phytopathogenic fungi.
Huang et al., 2020.	Ability of endophytic fungi isolated from cucurbit plants	Isolation method	◆ The strains are commercially potential for the biocontrol of plant diseases

Table above listed the findings and type of extraction used by each of the article.

4.0 DISCUSSION

4.1 medicinal plants extraction againts certain pathogenic fungi.

According to table above there are findings has been list out sort to 39 articles. All of 39 Articles find that all type of plant listed use to inhibit fungi are succeed towards certain species of fungi according to extraction has been used.

First and foremost, plants extract are commonly taken from tree species that has been proven by researcher and government that can be taken for inhibition of fungi. There are other 237 plants from the Brazilian flora whose antimicrobial potential was tested by Brazilian researchers (Stangarlin et al., 2011).

Next, there are 34 article from the table above has been prove that their medicinal plant species succed in inhibition of fungi (Díaz Dellavalle et al., 2011; Al-Askar 2012; Mouafo & Constant, 2012; Amini et al., 2012; Timothy et al., 2012; Rahmoun et al., 2013; Aala et al., 2013; Kumar & Academy, 2013; Stević et al., 2014; Singh et al., 2014; Rogawansamy et al., 2015; Mayuri C. Rathod, 2015; Moghaddam et al., 2015; Aghazadeh et al., 2016; Onaran et al., 2016; Of &Polymer, 2016; Jahani et al., 2016; Şesan et al., 2016; Prakash et al., 2017; Njoki et al., 2017; Reza et al., 2018; Umaru, 2018; Rani, 2018; Hu et al., 2019; Mogashoa et al., 2019; Butassi et al., 2019; Meela et al., 2019; Darmadi et al., 2019; Bonifácio et al., 2019; Wu et al., 2020; Jiang et al., 2020; Ibrahim & Kebede, 2020; Khuseib et al., 2020; Huang et al., 2020).

Lastly, there four article from the table above stated an overview of certain extractants and extraction processes with the advantages and disadvantages thus a comparison of plants extraction method (Pandey & Tripathi, 2014; Nn, 2015; Kerkeni et al., 2016; Rabiu & Haque, 2020).

4.2 method of extraction used in inhibition of fungi.

First and foremost, there are 15 articles using an aqueous solution in their method of plant extraction (Díaz Dellavalle et al., 2011; Timothy et al., 2012; Rahmoun et al., 2013; Aala et al., 2013; Mayuri C. Rathod, 2015; Aghazadeh et al., 2016; Şesan et al., 2016; Prakash et al., 2017; Njoki et al., 2017; Reza et al., 2018; Rani, 2018; Butassi et al., 2019; Bonifácio et al., 2019; Ibrahim & Kebede, 2020; Khuseib et al., 2020). It is important because by using an aqueous extraction, the natural product in inhibition of fungi occurs but this type of method extraction usually not very effective as alcoholic extraction.

Besides, there are 30 of the article using alchoholic extraction either Acetone, methanol, benzene, ethyl acetate and chloroform extracts, ammonia hydroxide extraction (Al-Askar, 2012; Mouafo & Constant, 2012; Timothy et al., 2012; Kumar & Academy, 2013; Singh et al., 2014; Mayuri C. Rathod, 2015; Onaran et al., 2016; Of &Polymer, 2016; Jahani et al., 2016; Reza et al., 2018; Umaru, 2018; Mogashoa et al., 2019; Meela et al., 2019; Darmadi et al., 2019; Wu et al., 2020; Jiang et al., 2020; Ibrahim & Kebede, 2020). Most of the researcher suggest in using of alchoholic extraction as it is more effective in enhance the antifungal activity.

Lastly, there are four article prefer in using a ready essential oil of medicinal plant extraction in their method as it save time and more faster in result (Amini et al., 2012; Stević et al., 2014; Moghaddam et al., 2015; Hu et al.,2019).

5.0 CONCLUSION

This present study shown that most of the medical plant extraction has a potential to inhibit pathogenic fungi that will improve the indoor air quality thus will avoid health issues among community. The most effective plant species based on the result are Cameroonian, *Algerian Lawsonia Inermis* (henna plant), C*assia Alata Linn.,* Tea Tree oil, *P. tetramera* berry, Zinger, Ginger, Banana, Cinnamon, *Astronium* sp., Curcubit plant and *Aloe dhufarensis Lavrano* that already proven by the articles above has a potential in inhibition of pathogenic fungi that can be use in further research as it will improve the indoor air quality. Lastly, according to findings above alchoholic extraction is more effectively in enhance the antifungal activity of plants species compare to aqueous extraction. So, there are 34 articles has been prove that their type of medicinal plant extraction by using certain method of extraction are proven in inhibition of fungi thus further research in technologies by using this organic compound to improve the indoor air quality should be done.

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