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Study on the Control of Fungi Isolated from Sweet Potato (*Ipomoea batatas*) With Extract of Ginger (*Zingiber officinale*)

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Abstract

Sweet Potato is susceptible to spoilage by microorganisms. The effect of ethanol, methanol and aqueous extracts of Zingiberofficinale on the growth of Aspergillusfumigatus, Aspergillusflavusand Aspergillusniger isolated from spoilt sweet potato was investigated. The fungi used was susceptible to the extracts with minimum inhibitory concentration (MIC) range of 10mg/ml to 40mg/ml. Ethanol extract has more inhibitory effect than methanol and aqueous extracts. Assay of the antifungal properties of the extracts against the test fungi shows that Aspergillusfumigatus was the most resistant among the test fungi while Aspergillusniger was the most susceptible. Investigation on the antifungal effect of Zingiberofficinale on the growth of the fungi isolated from spoilt sweet potato shows that Zingiberofficinale is effective as antifungal agent against Aspergillusfumigatus, Aspergillusflavus and Aspergillusniger. Phytochemical analysis of ethanol extract of Zingiberofficinale shows that the extract contains flavonoids Tannins and Saponins. The results suggest that extracts of Zingiberofficinale may be an important preservative for sweet potato.

INTRODUCTION

Sweet potato is among the world most important versatile, and under exploited food crops with more than 133million tons in annual production. Sweet potatoes rank sixth in the world in terms of value of roots and tubers based on fresh (Udemezue and Eluagu, 2021). Sweet potato is an outstanding source of nutrients, among which are vitamins, potassium, iron, calcium, and minerals. Derive from sweet potato is a natural source health-promoting compounds due to the presence ofβ-carotene and anthocyanins in it (Senthilkumar *et al*., 2020). Its large starchy,sweet tasting,tuberous roots are a root vegetable. The desirable nutritional value of sweet potato is gaining recognition, as the understanding between diet and health increases. Various parts of the crop have been reported to contain both organic and mineral nutrients including vitamin A and C, Zinc, Potassium (K), Sodium (Na), Manganese, Calcium (Ca), Magnesium (Mg) and Iron (Fe) (Barbara *et al*., 2021; Senthilkumar *et al*., 2020).

Sweet potato (*Ipomoea batatas Lam*) is the third most important root and tuber crop after cassava (*Manihotesculenta*) and yam (*Dioscorearotundata*) within the sub-Saharan Africa. Sweet potato

is a common root crop in Nigeria with enormous potential to be an efficient and economic source of food energy (Ewell and Matuura, 2019). Compared with other roots and tubers, it contains the highest sugar and is near the top for other vitamins (Alvavez, 2021). The tubers and leaves can be consumed after boiling, mashing, roasting, baking or frying. The sweet potato tuber is rich in carbohydrate, lipid and low fibre content (Eka, 2021).

Sweet potato is an important staple food crop, particularly in Northern Nigeria where most of it is produced. It is one of the six important root and tuber crops grow in Nigeria. The other root crops are cassava, Yam, Irish potato, Cocoyam and Ginger. Within Sub-Sahara Africa, sweet potato is the third most important root tuber crop after cassava (*Manihotesculenta*) and Yam *Discorea spp*. (Ewell and Matura, 2019). Nigeria produces about 0.2% of the world's sweet potato (Agbo and Ene, 2019). The production of sweet potato in Nigeria can be improved by increasing productivity and avoiding crop failures caused by storage rots (Echerenwa and Umechuruba, 2019). Tuberous plants are plants that store nutrients in specialized underground structures called tubers. These tubers serve as a food reserve for the plant, allowing it to survive adverse conditions, such as drought or winter. The following are the most common tuberous plants in Nigeria: Potato(*Solanumtuberosum*), Yam (*Dioscorea species*), Cassava (*Manihotesculenta*), Taro (*Colocasiaesculenta*), Water Yam (*Dioscoreaalata*), Cocoyam (*Xanthosorna species*), Irish Potato (*Solanumtuberosum*) etc. (Thomas, 2021).

Potato (*Solcmurntuberosum L.*), is the most commonly cultivated tuber crop and fourth most important food crop in the world, after wheat, rice and maize (Haan and Rodriguez, 2019). Potato belongs to family *solanaceae* and genus *Solanum*. Potato is not only a widely used vegetable but also used for making processed foods. Potatoes are also used in industries for manufacturing starch, alcoholic beverages. Development of varieties with agronomically important traits, and good keeping quality is one of the challenges for potato breeders (Semagn *et al*., 2019). The nomenclature "Yam" applies to members of the Dioscorea genus of the *Dioscoreaceae* family within the order *Dioscoreales* (Alexander, and Coursey, 2023). The yam crop was initially referred to as Inhame by New Guinea users who predominantly used them as a starchy food source (Karnick, 2019). Yarn is a tropical tuber crop that is cultivated in Africa, Asia, South America, the Caribbean, as well as the South Pacific islands. After cassava, yam is the second most important tuber crop in Africa. Even though more than 644 species belong to the genus Dioscorea, only a handful of them are cultivated (Asiedu and Sartie, 2020).

Cassava (*Manihotesculenta Crentz*), a major staple food crop of the people in most parts of Africa, plays an important role in terms of food security, employment and income generation for farm families in parts of the humid tropics. It derives its importance from the fact that it produces more calories/unit area from its starchy tuberous root which is a valuable source of cheap calories especially in developing countries (Som, 2021).

Taro (*Colocasia esculent Linn.*) is a vegetative propagated tropical root having its origin from South-east Asia. It occupies 9th position among world food crops with its cultivation across Africa. Taro tubers are important sources of carbohydrates as an energy source and are used as staple foods in tropical and subtropical countries (Tewodros *et al*., 2023).

Water yam (*Dioscoreaalata L.*), the most widely distributed of all yam species (*Dioscoreaspp*), is found in various ecological zones, from tropical to temperate and low to high altitudes (Coursey, 2021). It is the common name given for species of the family Dioscoreaceae and the genus dioscorea. It is an elite staple crop in West Africa which has over the years contributed significantly to the overall nutrient intake of the populace (Carsky *et al*., 2010).

Cocoyam is a herbaceous, monocotyledonous crop. The main stem is a starch rich underground structure called corm from which offshoots, termed cormels, develop (Purseglove, 2017). Cocoyam (*Xanthosoma spp.*) is one of the six most important root and tuber crops world-wide (Onwueme and Charles, 2021). The corm, cormels, and leaves of cocoyam are an important source of carbohydrates for human nutrition, animal feed (Ndoumou et al., 2022) and of cash income for farmers (Tambong, 2021).

Ginger scientifically known as *Zingiber officinale Roscoe*, belonging to family Zingiberaceae is one of the most important plant with several medicinal, nutritional and ethnomedical values therefore, used extensively worldwide as a spice, flavouring agent and herbal remedy. Traditionally, *Z. officinale* is used in Ayurveda, Siddha, Chinese, Arabian, Africans, Caribbean and many other medicinal systems to cure a variety of diseases viz, nausea, vomiting, asthma, cough, palpitaion, inflammation, dyspepsia, loss of appetite, constipation, indigestion and pain (Grzanna *et al*., 2018).

Ginger (*Zingiber officinale Rosc*.) is an economically important horticultural crop that is consumed as a spice and highly valued for its medicinal properties. It has a long history of medicinal us dating back 2500 years in China and India for conditions such as headaches, nausea, rheumatism, and colds (Grant and Lutz, 2020). Ginger contains various therapeutic compounds with antiemetic, antiulcer, anti-inflammatory, antioxidant, antiplatelet, and anticancer activities (Bhandari*et al*., 2018).

Ginger is believed to have originated in Southeast Asia. However, its true centre of origin remains uncertain as it is not found growing in the wild (Gaur *et al*., 2019). The long history of ginger cultivation, especially in China and India, has resulted in many cultivars and land races (Kizhakkayil and Sasikumar, 2019). The cultivars grown for commercial production are essentially infertile. Seed set is rarely observed (Nair, 2023). Ginger is, therefore, clonally propagated like banana, and the lack of viable seeds makes it challenging to produce hybrid progeny in breeding programs. In turn, this makes breeding for disease resistance and environmental adaptability as difficult as it is urgent. Low genetic variability in ginger crops is of particular concern in the Australian context (D'Hont*et al*., 2022).

Horseradish (*Armoraciarusticana* P. Gaertner, B. Meyer &Scherbius; *Brassicaceae*) has been cultivated for more than 3000 years for its white, thickened, and pungent roots that are generally grated and used as a condiment. This hardy, perennial herb is a large-leaved plant that forms a rosette of large, entire margined leaves having long flowering stalks with small white flowers thatare borne in a terminal panicle (Shehata, *et al*., 2019). As a member of the Brassicaceae family,

this plant species is related to cabbage, mustard, and other cruciferous vegetables (Sampliner and Miller, 2019).

Black pepper is a popular spice crop all over the world. It's a basal angiosperm blooming vine that's generally dried and used as a spice fruit. The spice belonging to the Piperaceaefamily. The climbing shoot, also known as the "main shoot," has internodes; the laterals, which develop off the main shoot, have shorter internodes and bear the spike. Spice is one of the most precious commodities, and it dominates the global trading market (Mathew *et al*., 2021). Black pepper has known as the "King of Spices" (Srinivasan, 2021) and it is called "Golmarich" in Bangladesh. Its grew in Kerela at Southwestern India, Malaysia, Indonesia, West Indies, and South America (Hajeski, 2019).

Chili (*Capsicum annuum L.*) is a spice, a fruit vegetable widely cultivated in the world and which importance in human food is capital (Dias *et al*, 2023). Originated from South and Central America, chili, of the genus Capsicum, has more than 25 species of which only five (*C. annuumL., C. chinenseJacq., C. frutescensL, C. baccatum L.* and *C. pubescens*) are domesticated and cultivated (Bosland and Botava, 2020). Due to the existence of many difficult to identify intermediary forms resulting from natural interspecific crosses, the former three species (*C. annuunz L., C. chinenseacq., C. frutescens L.*) are now treated as one species (*C. annuum L.*) withfour cultivars groups that are: Chineasegroup (West Indies chili), frutescens group (bird chili), annuum group (hot chili) and sweet pepper group (Nsabiyera et al., 2023).

Fungal and bacterial disease affecting the storage roots are important because they affect the yield, aesthetic quality, storage life and nutritional value of the storage roots, these pathogens create local discolouration and disruption of surrounding tissues of infected tubers, resulting in changes in appearances deterioration of texture and possibly flavour or taste. The activities of these pathogenresult in post-harvest losses, reduction in the market value and misfortune to farmers. They also cause significant economic losses in the commercialization phase and are rendered unfit for human consumption (Clemente *et al*., 2018).

Postharvest rots of sweet potato have been substantially reported (Oyewale, 2022). These rots are attributed to physical, physiological and microbiological factors. Mechanical damage during harvesting, storage or transportation has been implicated in tuber predisposition to storage rots or deterioration (Ogundana *et al*., 2019). Pathogenic contamination through natural openings or wounds is considered the most critical factor in tuber decay (Udo *et al*., 2020). The degree of pathogenicity varies and is largely dependent on storage conditions. Despite the present trend to discourage the use of chemical fungicides to control Post harvest diseases of produce, they are still extensively used in many developing countries (Champ *et al*., 2018).

The fungi reported to be associated with rottening of sweet potato include *Monilochaetesinfuscans, Fusarium oxysporum, Ceratocysts fimbriata, Rhizopus stolonifer, Macrophominaphaseolina, Fusarium solani* and *Botryodiplodiatheobromae* (Clark and Moyer, 2019). Onuegbu(2022) implicated *Penicillium sp., Certocystis Jimbriata, Diaporthebatatalis, Aspergillusniger*and*Aspergillusfiavus*, as fungi responsible for decay of Sweet potato tubers.

Oyewale (2019) reported fungi associated with post-harvest fungal rots to include *Mortierellar amanniana, Rhizopus stolonifer, Mucorpusillus, Botrytis cinerea, Erysiphepolygoni* and *A. flavus*. These fungi create local discolouration and disruption of surrounding tissues of infected tubers, resulting in changes in appearance, deterioration of texture and possibly flavour or taste. Rot fungi causes post- harvest losses, reduction in the market value and misfortune to farmers. Fungicides such as Dichloronitroanline are used to protect tubers against Rhizopus soft rot (Clark and Moyer, 2019). However, the use of synthetic fungicides apart from their potential danger to both the farmer and environment (Obagwu *et al*., 2017), are unaffordable by most farmers. Recent studies on the use of plant extracts have opened a new avenue for the control of plant diseases. These plants extracts have been reported to be safe, non-phytototic to man, but effective against plant pathogens (Shivpuri *et al*., 2020).

Recent studies on the use of plant extracts have opened a new avenue for the control of plant diseases. These plant extracts have been reported to be safe, non-phytotoxic to man but effective against plant pathogens including in safeguarding food security (Shivpuri *et al*., 2020).

All plants produce chemical compounds as part of their normal metabolic activities. These chemical compounds are called phytochemicals and they primarily metabolites such as sugars and fats, which are found all plants, serving a more specific function and secondary metabolite include phenol, saponin, flavonoids etc. many of these phytochemicals can be used effectively as antifungal agents (Kim *et al*., 2021). It has been pointed out that such products from higher plants are relatively broad spectrum. They arc bio-efficacies, economical and environmentally safe and can be ideal for use gas agro-chemicals (Jayaprkasha *et al*., 2021). According to Okigbo and Ogbonaya (2019), the active principles in plants are influenced by many factors, which include the age of the plant, extracting solvent, method of extraction and time of harvesting plant materials.

Many secondary metabolites which are produced and stored up in the plant had been reported to be effective in the control of plant diseases (Jayaprkasha *et al*., 2021). The high cost of synthetic chemicals is very predominant for the control of disease, apart from this it also has hazardous effect on the environment and are also toxigenic to man and animal The negatives effects of this chemical lead to the search for an alternative means which is easily feasible, degradable and safe to man and the environment. The aim of the study is to investigate the control of fungi isolated from sweet potatoes with extract of ginger (*Zingiber officinale*) in Bida, Niger state.

MATERIALS AND METHODS

Plant Materials

Ginger (*Zingiber officinale*) and spoilt sweet potatoes were used in this study. They were purchased from modern market. Bida, Niger state.

Test Microorganisms

The microorganisms used in this study were *Aspergillus flavus, Aspergillus niger* and *Aspergillus fumigatus*. The organisms were isolated from sweet potato. They were identified after staining with lactophenol cotton-blue. The organisms were maintained on potato dextrose agar slant and stored in the refrigerator until required.

Preparation of Plant Extracts

Fifty gramš (50g) of the dried powder of Ginger (*Zingiber officinale*) was weighed separately into 400ml of the extracting solvent (methanol, ethanol and water) in different conical flasks. The samples were labeled accordingly.

The extracts were filtered into different conical flasks after which the filtrate was evaporated to dryness using a water bath (Barrington) at 80^{o}C. The extracts obtained were assayed immediately after preparation (Banso*et al*., 2020).

Determination of Antifungal Properties of Extracts

The antifungal properties of the extract were determined using agar dilution method (Banso and Mann, 2019). Different volumes of the extract were introduced into MacCartney bottles containing appropriate volume of sterile potato dextrose agar (PDA). The mixture was poured into different Petri-dishes and allowed to solidify. The plates were inoculated with 5mm diameter of the fungal culture. Control experiment was performed without the extracts at 28 ± 2°C for 48hrs. The antifungal properties were expressed in of diameter of growth (mm) (Banso and Mann, 2019).

Determination of Minimum Inhibitory Concentration (MIC)

Various concentrations (10mg/ml, 20mg/ml, 30mg/ml, and 40mg/ml) of the extract were prepared. Each of these were added to 1 8ml of potato dextrose broth in test tubes and inoculated with 0.lml of spore suspension of *Aspergillus flavus, Aspergillus niger* and *Aspergillus fumigatus* diluted to give a final spore suspension of 10% spores/mi. The mixtures were then incubated for 48hrs at 28 ± 2°C. The least concentration of the plant extracts that does not permit the growth of the inoculated test organism was regarded as the minimum inhibitory concentration. Control plates experiments were performed without the extracts (Banso *et al*., 2020).

Determination of Minimum Fungicidal Concentration

The content of the tubes that showed no visible fungal growth in the minimum inhibitory concentration (MIC) experiments were cultured into freshly prepared potato dextrose agar plates to assay for the fungicidal effect of the extracts. The plates containing the test fungi were inoculated at 28 ± 2°C for 72hrs. The lowest concentration of the extract that does not yield any visible fungal growth on the solid medium was regarded as the minimum fungicidal concentration(Banso*et al*., 2020).

Phytochemical Screening of the Extracts

Methanol extracts of Ginger (*Zingiberofficinale*) used in this study were screened for active ingredients as described by Banso *et al*., (2020).

Test for Sterols

Two milliliters of distilled water were added to 0.3g of the extract to form a solution. To 1ml of the solution, a few drops of 10% ferric chloride was added and observed. The absence of green precipitate indicates the presence of sterols.

Test for Flavonoids

Five milliliters of distilled water was added to 0.3g of the extract and 10% lead acetate solution was also added. A precipitate indicates the presence of flavonoids.

Test for Tannins

Two milliliters of distilled water was added to 0.3ml of the extract to form a solution. To lml of the solution, a few drops of 10% ferric chloride was added and observed for the formations of green precipitate. Green precipitate indicates the presence of tannins.

Test for Phenols

Three milliliters of distilled water was added to 0.3g of the extract. One milliliters of ferric chloride and 1ml of 1% potassium ferric cyanide were added and observed for the presence of phenols. Formation of green coloured precipitate indicates the presence of phenols.

Test for Anthroquinones

Three milliliters of distilled water was added to 0.3g of the extract. To 1 ml of the solution, 0.2rn1 dilute sulphuric acid and 9ml of benzene were added. Upon separation of benzene layer into another test tube, three drops of dilute ammonium solution was added. Presence of pink colouredprecipitation in the ammonium solution indicates a negative result.

Test for Saponins

Two milliliters of distilled water was added to 0.3g of the extract and homogenized. Formation of frothing that persisted on warming indicates the presence of saponins.

RESULTS AND DISCUSSION

Results

Antifungal Properties of Extracts of *Zingiber officinale*.

The results of the antifungal properties of extracts of *Zingiber officinale* are shown in Table 4:1. The mean diameter of growth of *Aspergillus fuimigatus* when assayed with ethanol extract of *Zingiber officinale* was 13.0±0.1mm. The value recorded against methanol extract was 14.0±0.2mm. While a value of 15.0±0.1mm was recorded against aqueous extract. A value of 15.0±0.1mm was recorded against *Aspergillus flavus* when ethanol extract of *Zingiber officinale* was assayed against the test fungi. The value recorded against methanol extract was 13.0±0.1mm while a value of 14.0±0. 1mm was recorded against aqueous extract. A value of 13.0±0.1mm was recorded against *Aspergillus niger* when aqueous extract of *Zingiber officinale* was assayed against the fungal. The value recorded against methanol extract was 12.0±0.1mm, while a value of' 14.0±0.2mm was recorded against ethanol extract.

Table 4.1 Antifungal properties of extracts of *Zingiber officinale*

	Mean diameter of growth (mm) ± SD			
Organism	**Control**	**Ethanol Extract n= 3**	**Methanol Extract n= 3**	**Aqueous Extract N= 3**
Aspergillusfumigatus	15.0±0.1	13.0±0.1	14.0±0.2	15.0±0.1
Aspergillusflavus	15.0±0.1	12.0±0.1	13.0±0.1	14.0±0.1
Aspergillusniger	14.0±0.2	11.0±0.1	12.0±0.1	13.0±0.1

SD = Standard deviation

n = Number of sample

Minimum Inhibitory Concentration of Extracts of Zingiber officinale against the test organisms

The result of the minimum inhibitory concentration of extracts of *Zingiber officinale* against *Aspergillus fumigatus*, *Aspergillus flavus* and *Aspergillus niger* are shown in Table 4.2. The minimum inhibitory concentration values recorded against *Aspergillus fumigatus*, *Aspergillus flavus* and *Aspergillus niger* when ethanol extract of *Zingiber officinale* was assayed against the fungi were 20mg/ml, 10mg/ml and 40mg/ml respectively. Minimum inhibitory concentration values of 10mg/ml, 20mg/mil and 30mg/ml were recorded against *Aspergillus fumigatus*. *Aspergillus flavus* and *Aspergillus niger* respectively when methanol extract of *Zingiber officinale* was assayed against the fungi. Minimum inhibitory values recorded against *Aspergillus fumigatus*,

Aspergillus flavus and *Aspergillus niger* when aqueous extracts of *Zingiber officinale* was assayed against the fungi were 10mg/ml, 10mg/ml and 20mg/ml respectively.

Table 4.2. Minimum inhibitory concentration of extracts of *Zingiber officinale*

	Minimum Inhibitory concentration (mg/ml)		
Test Organism	**Ethanol Extract**	**Methanol Extract**	**Aqueous Extract**
Aspergillusfumigatus	20	30	40
Aspergillusflavus	10	20	30
Aspergillusniger	10	10	20

Minimum Fungicidal Concentration of Extracts of *Zingiber officinale* Against the Test Organisms

The result (Table 4.3) shows that the minimum fungicidal concentration of *Zingiber officinale* against *Aspergillus fumigatus*, *Aspergillus flavus* and *Aspergillus niger* ranged between 20mg/ml and 50mg/ml. A minimum fungicidal concentration values of 30mg/ml was recorded against when ethanol extracts of *Zingiber officinale* was assayed against the fungi. Values of 50mg/ml. 40rng/ml and 40mg/ml were recorded against *Aspergillus*. *fumigatus*, *Aspergillusflavus* and *Aspergillusniger* respectively when aqueous extract of *Zingiberofficinale*was assayed against the test organism.

Table 4.3 Minimum fungicidal concentration of extracts of Zingiber officinale

	Minimum Inhibitory concentration (mg/ml)		
Test Organism	**Ethanol Extract**	**Methanol Extract**	**Aqueous Extract**
Aspergillusfumigatus	30	40	30
Aspergillusflavus	20	30	40
Aspergillusniger	20	20	30

Phytochemical constituents of *Zingiber officinale*

The results of phytochemical screening of ethanol extract of *Zingiber officinale* are shown in table 4.4. Ethanol extract of *Zingiber officinale* contains flavonoids, tannins and saponins. Phenols and sterol were absent in the extract.

Table 4.4 Phytochemical constituents of ethanol extract of *Zingiber officinale*

Constituent	Extract of *Zingiber officinale*
Sterols	-
Flavonoids	+
Tannins	+
Saponins	+
Phenols	-

- = Absent

+ = Present

DISCUSSION

This study shows that ethanol, methanol and aqueous extract of *Zingiber officinale* exhibited antifungal activities against *Aspergillus flavus*, *Aspergillus niger* and *Aspergillus fumigatus* (Table 4.1). This may be due to the presence of active principles in the plant material. Plants generally contain many secondary metabolites which constitute an important source of microbicide, pesticide and pharmaceutical drugs (Banso and Mann, 2019). Spices contain phenolic essential oils which are inhibitory to microorganisms. Theeffect on microorganisms may depend on the type as well as the medium (Adekunle, 2022). The results of this study justify the traditional use of *Zingiber officinale* as a food preservative Earlier, some work have shown that *Zingiber officinale* has antimicrobial activity against some microorganisms (Banso *et al*., 2020). It was observed that an increase in the concentration of extracts brought more activity as shown by the diameter of growth (table 4.1). This agrees with the report of Banso and Mann, (2019), Adekunle, (2022) and Banso *et al*.., (2020) that higher concentration of antifungal substances showed appreciable growth inhibition. The fact that organisms may need higher concentration of the extracts to inhibit or kill them may be due to their cell component Potency of the extracts also depends on the method used to obtain the extracts (Yu-Yan and Liu, 2021). In this study both aqueous and alcoholic extracts were used with varying antifungal effects.

The effect of methanol ethanol and aqueous extracts of *Zingiber officinale* (Table 4.2) on the minimum inhibitory concentration for *Aspergillus fumigatus*, *Aspergillus flavus*,and *Aspergillusniger* correlate with the report that microorganisms varied widely in the degree of their susceptibility to antifungal agents (Kuleon*et al*., 2023). Antifungal agents with low activity against a fungi have high minimum inhibitory Concentration while a highly antifungal agent gives a low minimum inhibitory concentration. The minimum inhibitory concentration of ethanol extractwas relatively lower than those for either methanol or aqueous extract (Table 4.2). This suggests that ethanol is more effective than water or methanol as extracting solvent for the *Zingiber officinale* used in this study. *Zingiber officinale* contains flavonoids, tannins and saponins which are

inhibitory to microorganisms. Banso *et al*., (2020) reported the antifungal effect of tannins and saponins.

CONCLUSION AND RECOMMENDATION

Conclusion

Zingiber officinale extracts used in this study exhibited inhibitory effect against *Aspergillus fumigatus*, *Aspergillus flavus* and *Aspergillus niger* isolated from spoilt sweet potatoes. Extracts of *Zingiber officinale* may be an important source of preservative for sweet potatoes.

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