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Assessment of antioxidant potentials of the wild and domesticated saprophytic edible mushrooms from Tanzania

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Abstract

Tanzania natural forests harbor several indigenous edible mushrooms that are meagerly exploited due to various reasons including unawareness on their potential values. This study establishes antioxidant potentials of seven wild edible mushroom species, and their two domesticated forms. The investigation used mushroom methanolic extract for antioxidant activities' determination. A DPPH (1, 1-diphenyl-2-picrylhydrazyl) radical was used as a substrate to determine radical scavenging abilities whereas ferrozine was employed to determine ferrous ion chelating abilities. Additionally, quantitative analyses for β-carotene, lycopene, flavonoids, and total phenolic compounds were done using spectrophotometric assay. Mushrooms analysed displayed amazing antioxidant potentials which varied between different species and between the wild and domesticated forms of the same species. The range of EC_{50} values for DPPH free radical scavenging activity (DRSA) was 0.075 − >0.3 mg/mL, with the strongest and weakest EC_{50} recorded from *P. tenuiculus* and the wild *Amylosporus sp. IJ-2014*, respectively. The range of EC_{50} values for ferrous ion chelating activity (FICA) was <0.1 − 0.455 mg/mL, with the strongest and weakest EC_{50} noted in domesticated *Amylosporus sp. IJ-2014* and *L. sajor-caju*, correspondingly. The maximum and minimum total phenolic content (TPC) recorded were 537.39 and 160.97 mg GAE/100g, from domesticated *Amylosporus sp. IJ-2014* and *Laetiporus sp. IJ-2014*, respectively. The highest and least quantities of β-carotene (BC) recorded were 48.59 and 5.56 mg/100g, from *P. tenuiculus*/wild *Amylosporus sp. IJ-2014* and *P. cystidiosus*, respectively. Lycopene contents (LC) ranged from 2.24 to 18.95 mg/100g, with *P. cystidiosus* and *P. tenuiculus* having the slightest and peak values, correspondingly. Maximum value for total flavonoid contents (TFl) recorded was 25.27 mg QE/100g from *P. tenuiculus* whereas the minimum value was 3.71 mg QE/100g from *P. cystidiosus*. Due to the antioxidant potentials of these mushrooms, people are advised to maximally exploit them for improved nutrition and health.

Keywords − 1, 1-Diphenyl-2-picrylhydazyl − Antioxidant − Ferrozine − Free radical − Saprophytic edible mushrooms

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Introduction

Antioxidants are chemical compounds that protect cells from free radical induced damages (Halliwell & Gutteridge 1990). Free radicals damage cells gradually and are involved in development of some illnesses associated with diseases of diabetes mellitus, HIV infection, malignant tumor and inflammation (Papas 1999). There are internal and external sources of free radicals. Internal sources include nutrient metabolism, ageing process and inflammation whereas external sources include drugs, tobacco smoke, ionizing radiation, air pollution, organic solvents, pesticides and extreme exercise (Blokhina et al. 2003). When free radical reactions start within cells, they tend to spread to neighboring cells with increasing effect. They alter biomolecules such as proteins, lipids, carbohydrates and nucleic acids (Laguerre et al. 2007). Though naturally occurring antioxidants tend to prevent oxidative damages of free radical reactions in all organisms, they are inadequate to completely prevent those damages (Morgan & Liu 2011, Siomek 2012). Supplementation by man-made antioxidants such as propyl gallate (PG) and tertiary butylhydroquinone (TBHQ) have been reported to have adverse, toxic effects (Kahl & Kappus 1993). Consequently, the increased attention is paid to investigations and exploitation of antioxidant rich foods (Finley et al. 2011).

Recently, mushrooms have been reported as sources of physiological agents for medicinal applications and various therapeutic activities including antioxidants (Jose et al. 2002, Wong & Chye 2009). There are several varieties of wild mushrooms whose medicinal profiles have not been described especially from developing countries (Wong & Chye 2009). It has been established that extracts from fungi that have been obtained by methanolic extraction comprise various polyphenolic compounds including flavonoids, lycopene and β-carotenes (Muruke 2014, Tibuhwa 2014). Polyphenols are familiar for their large array of biological actions that include free radical scavenging and metal chelation activities (Burgosa et al. 2013).

Tanzania is endowed with natural forests harboring varieties of wild edible mushrooms which are meagerly exploited. Mushroom eating habit is more common in rural areas and relies exclusively on collection from the natural forests, eating them fresh or sun-drying them for long preservation (Tibuhwa 2014). Many people are doubtful about mushrooms as a valuable food source. Ignorance has led them to become suspicious about whether food of fungal origin can grasp any great nutritional assurance or antioxidant value (Crisan & Sands 1978). It seems much education is needed before full advantage can be taken of this readily available, nutritionally and antioxidant rich food source (Crisan & Sands 1978, Chang & Mshigeni 2001). In Tanzania few studies have been conducted on antioxidant activities of edible mushrooms. For instance, Tibuhwa (2014) reported antioxidant activities of fresh and dry mushrooms in the genera *Cantharellus* and *Afrocantharellus*, Muruke (2014) reported antioxidant activities of *Pleurotus cystidiosus* whereas Hussein et al. (2015) reported antioxidant activities of six species of edible mushrooms. The present study complements the work by Hussein et al. (2015), it aimed at establishing the antioxidant potentials of seven species of wild saprophytic edible mushrooms and comparing between the wild and their respective domesticated forms.

Materials & Methods

Sample collection

The study was conducted within natural forests of Lutindi, Shume-Magamba and Kieti in Tanga region, Kazimzumbwi forest in Pwani region and some planted trees at University of Dar es Salaam, Mwalimu JK Nyerere Mlimani Campus, in Dar es Salaam region. Mushroom samples were collected during rainy seasons (March−May and September−December, in 2011/2012). The collected mushrooms were identified using morphological and genetic markers (ITS and LSU regions of nuclear ribosomal DNA). Comprehensive study on identification of these mushrooms will be reported elsewhere. The identified wild edible saprophytic mushrooms were subjected to domestication trials as detailed by Juma et al. (2015). Domestication process started with isolation of mushroom germplasm in which sterile tissues of wild edible mushrooms were aseptically cultured on potato dextrose agar.

Mycelia obtained were used to develop mushroom spawns using sorghum grains. Later on spawns were inoculated on prepared substrate, dry sugarcane tops, and then monitored for spawn running and fructification. The wild and successfully domesticated mushrooms were dried at 50°C to constant weight and then preserved in silica gel for nutritional and antioxidant assays. The studied mushroom samples are presented in Table 1.

Determination of mushroom antioxidant activities

Antioxidant activities of mushrooms were assayed by determining their free radical scavenging abilities and ferrous ion chelating capabilities. In connection to that the concentration of organic/phenolic compounds with antioxidant effects were evaluated.

Crude extract preparation

Methanolic extractions were carried according to Pal et al. (2010). 1 g of mushroom fruitbody from each sample was weighed and pounded using motor and pestle, then soaked in 250 mL of methanol. The soaked material was continuously stirred for 48 hours, later on filtered using filter paper (WHATMAN FILTER PAPER) and evaporated to dryness under reduced pressure, in a rotary evaporator (BUCHI R 210, SWITZERAND) with 90 rpm. The obtained concentrates were stored in dark at 4°C until further use. The percentage yield of the evaporated extracts was calculated based on dry weight according to Maisuthisakul et al. (2007) as follows:

$$\text{Yield}\ (\%) = (W_1 / W_2) * 100$$

Where: W_1 = Weight of extract after methanol evaporation

W_2 = Dry weight of the mushroom sample

DPPH free radical scavenging activity (DRSA)

The 1, 1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging activity was determined as per Cuendet et al. (1997) and Burits & Bucar (2000). 1 mL of various concentrations (0.006− 0.3 mg/mL) of the mushroom extracts in methanol was added to 4 mL of a 0.004% (w/v) methanol solution of DPPH. After a 5 min incubation period at room temperature the absorbance was read against a blank at 517 nm using a UV spectrophotometer (UV-VIS MODEL 6305 JENWAY UK). Inhibition of free radical DPPH (DPPH free radical scavenging activity) in percent was calculated in the following way:

$$\text{DPPH free radical scavenging activity}\ (\%) = (A_{control} - A_{sample}) / A_{control} * 100$$

Where: $A_{control}$ is the absorbance of the control reaction containing all reagents except mushroom extract and A_{Sample} is the absorbance of the mushroom extract.

The EC_{50} value (mg/mL), which is the concentration of the extract/standard that reduces 50% of the free-radical concentration, was calculated through linear interpolation between values above and below 50% activity.

Ferrous ion chelating activity (FICA)

In this study, the ferrous ion chelating capacity assay was used to evaluate the ability of mushroom antioxidants to disrupt the formation of the complexes or to prevent interaction between transition metal ions and lipids. The assay for ferrous ion chelating ability was conducted as per the method described by HeimLer et at. (2007) with slight amendments. 0.05 mL of extracts (0.006 − 0.3 mg dry mushroom extract/mL) was pipetted in Eppendorf tubes, and then 0.7 mL of methanol and 0.0125 mL of 2.0 mM ferrous chloride were added. Mixture was allowed to stand for 10 min at room temperature, and then 0.05 mL of 5.0 mM ferrozine was added. The mixture was shaken and after 5 min the absorbance was measured at 562 nm using a UV spectrophotometer (UV-VIS MODEL 6305 JENWAY UK). EDTA served as the positive control, and a sample with methanol instead of mushroom extract served as the negative control (blank). The percent ferrous ion chelating ability was calculated according to the equation:

$$\text{Chelating ability}\ (\%) = (A_0 - A_1) / A_0 * 100$$

Where: A_0 is the absorbance of the blank, and A_1 is the absorbance in the presence of sample (extract or standard)

The EC_{50} value (mg/mL), which is the concentration of the extract/standard that chelates 50% of the ferrous ion, was calculated through linear interpolation between values above and below 50% activity.

Total phenolic content (TPC)

Total phenolic content was determined in mushrooms' methanolic extracts by the Folin−Ciocalteu assay, modified to micro-scale by Arnous et al. (2002). Briefly, 0.01 mL of extract was mixed with 0.79 mL distilled water and 0.05 mL Folin−Ciocalteu reagent in Eppendorf tubes. Tubes were vortexed and after 1 minute, 0.15 mL of saturated sodium carbonate solution were added. Following incubation of the mixture in the dark for two hours, the absorbance was measured at 750 nm using a UV spectrophotometer (UV-VIS MODEL 6305 JENWAY UK). Gallic acid was used as calibration standard and the results were expressed as mg gallic acid equivalents (mg GAE) per 100 g of dry mushroom.

Determination of total flavonoids (TFl)

Determination of total flavonoids was done with aluminium chloride as per Jaita et al. (2010) and Pitchaon et al. (2007) using quercetin as standard. 1 mL of each mushroom extract was mixed with 4.3 mL of 80% aqueous ethanol containing 0.1 mL of 10% aluminium nitrate and 0.1 mL of 1 M aqueous potassium acetate. The mixture was left for 40 minutes at room temperature and then the absorbance was determined calorimetrically at 515 nm using a UV spectrophotometer (UV-VIS MODEL 6305 JENWAY UK). The total flavonoids concentration was calculated using quercetin standard calibration curve. Data were expressed as mg quercetin equivalent/100 g (mg QE/100 g) of mushroom extracted.

Determination of β-carotene (BC) and lycopene contents (LC)

Assays of β-carotene and lycopene contents were carried out using the method of Nagata and Yamashita (1992). 100 mg of a mushroom extract was shaken with 10 mL of Acetone-hexane mixture (92:3) for 1 minute and filtered through filter paper (WHATMAN NUMBER 4 FILTER PAPER). The absorbance of the filtrate was measured at 453, 505 and 663 nm. The β-carotene and lycopene contents were calculated from the formulae:

$$Lycopene(\mu g / mg) = 0.0458A_{663} + 0.372A_{505} - 0.0806A_{453}$$

$$\beta - carotene(\mu g / mg) = 0.216A_{663} - 0.304A_{505} + 0.452A_{453}$$

Where: A_{453}, A_{505} and A_{663} are absorbance at 453, 505 and 663 nm respectively.

Data analysis

Data on mushroom antioxidant potentials were subjected to analysis of variance (one-way ANOVA) and significance was accepted at 5% probability level using statistical package for social science IBM SPSS 21 Version (SPSS 1999). Post hoc tests were made under SNK-Dunkan/LSD Waller. The results are presented as mean of two replicates. The letter '**D**' on sample names was used to distinguish domesticated mushrooms from their respective wild species.

Results

DPPH free radical scavenging activity

A fresh prepared DPPH solution was deep purple in colour which faded away as the DPPH free radicals were quenched and converted into a colourless product (2,2-diphenyl-1-hydrazine) resulting in absorbance decrease. Thus, the more rapidly the absorbance decreased the more effective was the antioxidant activity of the extract. The results for the radical scavenging activity are presented in Figure 1 and Table 1. The highest activity was observed at the concentration of 0.3 mg/mL and it was in the

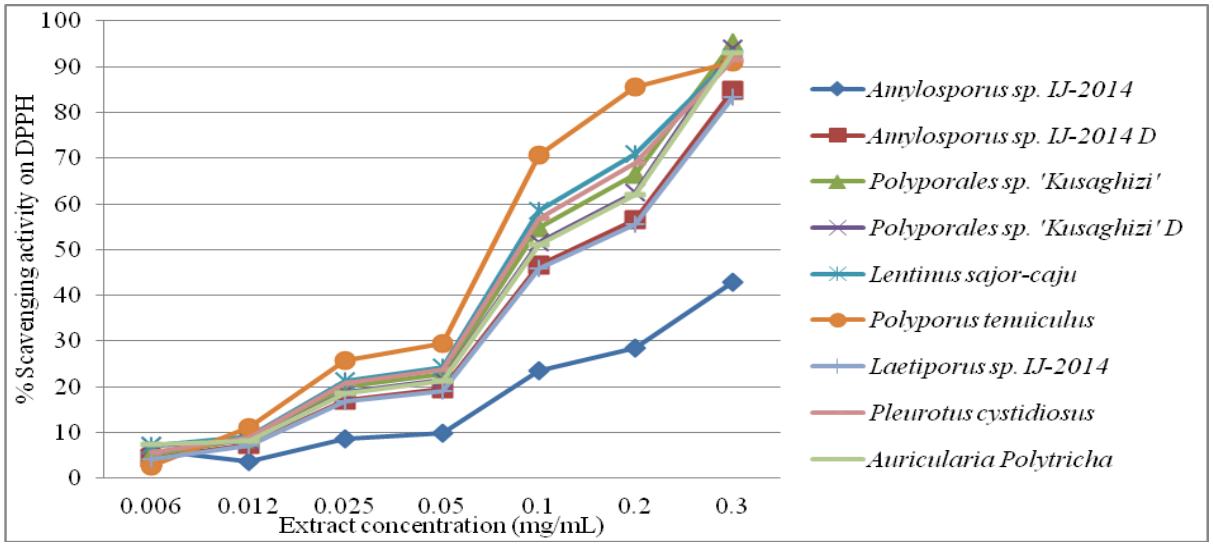

Fig. 1 – Percentage scavenging activity of mushroom extracts at different concentrations

wild form of *Polyporales sp. 'Kusaghizi'* (95.2%) whereas the least activity was noted at 0.006 mg/mL from *P. tenuiculus* (2.6%). The minimum EC_{50} value was that of *P. tenuiculus* (EC_{50} = 0.075 mg/mL), signifying the strongest scavenging ability, whereas the maximum EC_{50} value was that of wild *Amylosporus sp. IJ-2014* (EC_{50} > 0.3 mg/mL), signifying the least radical scavenging ability.

Ferrous ion chelating ability

The results of ferrous ion chelating ability of mushroom extracts are presented in Figure 2 and Table 1. The highest ferrous ion chelating activity observed was 99.45% in *A. polytricha* at 0.7 mg/mL extract concentration whereas the least activity observed was 18.61% in *L. sajor-caju* at 0.1 mg/mL extract concentration. The lowest EC_{50} value was observed in the domesticated *Amylosporus sp. IJ-2014* (EC_{50} < 0.1 mg/mL), signifying the highest ferrous ion chelating ability while the highest EC_{50} value was that of *L. sajor-caju* (EC_{50} = 0.455 mg/mL), implying the least ferrous ion chelating ability.

Table 1 Extract yield (EY), lycopene content (LC), β-carotene (BC), total flavonoids (TFl), and total phenolic contents (TPC) in edible mushrooms with EC_{50} for DPPH free radical scavenging activity (DRSA) and ferrous ion chelating activity (FICA)

Mushroom samples	**Voucher**	**EC_{50} - DRSA (mg/ mL)**	**EC_{50} - FICA (mg/ mL)**	**EY (%)**	**TPC (mg GAE/ 100g)**	**BC (mg/ 100g)**	**LC (mg/ 100g)**	**TFl (mg QE/ 100g)**
Amylosporus sp. IJ-2014	IJV29-1	>0.3	0.275	13.48	390.24	48.59	12.33	16.43
Amylosporus sp. IJ-2014 **D**	IJV29-2	0.132	<0.1	17.95	247.96	36.14	14.16	23.11
Auricularia polytricha	IJV46	0.097	0.345	10.05	186.99	12.5	5.6	9.25
Laetiporus sp. IJ-2014	IJV38	0.142	0.168	26.55	160.97	45.26	17.76	23.67
Lentinus sajor-caju	IJV50	0.086	0.455	28.91	182.73	30.28	11.84	15.78
Pleurotus cystidiosus	IJV35	0.088	0.375	4.82	237.39	5.56	2.24	3.71
Polyporales sp. 'Kusaghizi'	IJV40-1	0.092	0.1	39.67	428.46	35.16	14.09	18.78
Polyporales sp. 'Kusaghizi' **D**	IJV40-2	0.097	0.25	37.87	537.39	41.28	16.18	21.57
Polyporus tenuiculus	IJV34	0.075	0.327	29	416.26	48.59	18.95	25.27

NOTE: The letter '**D**' in mushroom samples was used to differentiate domesticated mushrooms from the wild mushrooms.

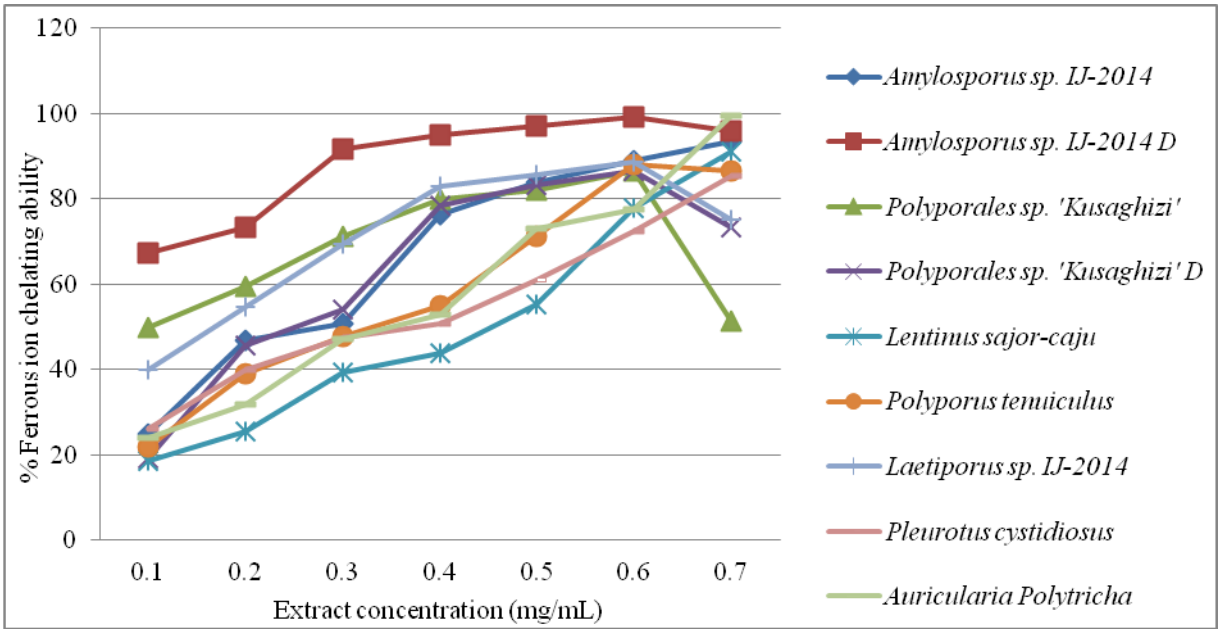

Fig. 2 − Ferrous ion chelating ability of mushroom extracts at different concentrations

Total phenolic compounds, flavonoids, lycopene and β-carotene contents

The results for total phenolic compounds, flavonoids, lycopene and β-carotene contents of the mushrooms are presented in Table 1. The extract yield ranged from 4.82 to 39.67%, with *P. cystidiosus* and *Polyporales sp. 'Kusaghizi'* possessing the least and highest values, respectively. Total phenolic content range was 160.97−537.39 mg GAE/100g, with the least and the highest values recorded from *Laetiporus sp. IJ-2014* and domesticated *Amylosporus sp. IJ-2014,* respectively. The minimum and maximum values for β-carotene were 5.56 and 48.59 mg/100g, and were recorded from *P. cystidiosus* and *P. tenuiculus*/wild *Amylosporus sp. IJ-2014*, respectively. Lycopene contents ranged from 2.24 to 18.95 mg/100g, with *P. cystidiosus* and *P. tenuiculus* having the slightest and peak values, correspondingly. Maximum value for flavonoid contents recorded was 25.27 mg QE/100g from *P. tenuiculus* whereas the minimum value was 3.71 mg QE/100g from *P. cystidiosus.*

Discussion

DPPH free radical scavenging activity

The results from this study depicted variation in mushroom radical scavenging ability not only between different species, but also between domesticated and wild forms of the same species. *A. polytricha* and domesticated *Polyporales sp. 'Kusaghizi'* possessed the same EC_{50} value of 0.097 mg/mL which was a bit higher to that of the wild *Polyporales sp. 'Kusaghizi'* with 0.092 mg/mL. The EC_{50} value of *P. cystidiosus* was 0.088 mg/mL and is within a range of 0.0359 − 0.1500 mg/mL reported by Muruke (2014) for the same species. *L. sajor-caju* and *P. tenuiculus* possessed EC_{50} values of 0.086 and 0.075 mg/mL, respectively, which are lower than the values reported by Hussein et al. (2015) for the same species, 0.23 and 0.098 mg/mL, correspondingly. In this study, the range of EC_{50} values for DPPH scavenge in all mushrooms was 0.075 − >0.3 mg/mL, which is in agreement to the range of 0.08 − >0.3 mg/mL reported by Hussein et al. (2015). With the exception of the wild *Amylosporus sp. IJ-2014* and *Laetiporus sp. IJ-2014* the range of EC_{50} values in all mushrooms investigated was 0.075 − 0.1 mg/mL unlike those from the genera *Cantharellus* and *Afrocantharellus* studied by Tibuhwa (2014) which portrayed the EC_{50} values > 0.1 mg/mL. In the same study Tibuhwa indicated that the scavenging ability is higher in the fresh mushrooms than their dry counterparts. Since all mushroom species analysed in this study were dry, it is expected that their fresh counterparts could have even higher scavenging ability.

Ferrous ion chelating ability

The ferrous ion chelating capability of mushrooms varied between different species and also between domesticated and wild forms of the same species. The wild *Polyporales sp. 'Kusaghizi'* demonstrated EC_{50} value which is more effective than that of its domesticated form by 150%. Conversely, the domesticated *Amylosporus sp. IJ-2014* demonstrated EC_{50} value which is more effective than that of its wild form by > 175%. The EC_{50} value of *P. tenuiculus,* 0.327 mg/mL, is lower than that reported by Hussein et al. (2015), 0.59 mg/mL, for the same species. The EC_{50} value of *P. cystidiosus,* 0.375 mg/mL, is higher than the range reported by Muruke (2014), 0.0911− 0.2270 mg/ml, for the same species. Likewise, the EC_{50} value of *L. sajor-caju,* 0.455 mg/mL, is higher than that reported by Hussein et al. (2015) for the same species, 0.37 mg/ml. The range of EC_{50} values for ferrous ion chelation was <0.1 − 0.455 mg/mL, which is comparable to the range of 0.12− >0.59 mg/mL reported by Hussein et al. (2015). Ferrous ions are acknowledged as the most effective pro-oxidant among various species of metal ions due to its high reactivity, which hasten lipid oxidation by breaking down hydrogen and lipid peroxidase to reactive free radicals through the Fenton type reaction. Metal chelating activity is an antioxidant mechanism, since it reduces the concentration of the catalyzing transition metal ions in lipid peroxidation (Qiao et al. 2009). The higher chelating abilities of the studied mushrooms suggest that they are a very useful food source, with powerful antioxidant abilities.

β-carotene contents

From the analysed mushroom extracts, all species owned organic compounds with antioxidant potentials in concentrations, which varied markedly between species and also between the wild and domesticated forms of the same species. β-Carotene is known to be precursor for the synthesis of vitamin A, which acts as powerful antioxidants (Ross et al. 2011). The range of β-carotene in the investigated edible mushrooms was 5.56-48.59 mg/100g which is comparable to the range of 5.35-48.15 mg/100g reported by Hussein et al. (2015) for the wild edible mushrooms. In the present study, the β-carotene content values for *L. sajor-caju* and *P. tenuiculus* were 30.28 and 48.59 mg/100g, respectively which are higher than that reported by Hussein et al. (2015), 5.35 and 37.10 mg/100g, for the same species, respectively. Muruke (2014) reported *P. cystidiosus* to have β-carotene content level of 2-45 mg/100g, which is in agreement with the value reported by this study for the same species. The β-carotene contents level was found to be higher in the wild *Amylosporus sp. IJ-2014* (48.59 mg/100g) compared to its domesticated form (36.14 mg/100g) but lower in the wild *Polyporales sp. 'Kusaghizi'* (35.16 mg/100g) compared to its domesticated form (41.28 mg/100g).

Lycopene contents

Lycopene is the most efficient singlet oxygen quencher compared with a variety of carotenoids (Chung et al. 1998) and it is three times more efficient than β-carotene in preventing lipid peroxidation in multi lamellar liposomes (Stahl et al. 1998). The lycopene content range observed in this study, 2.24-18.95 mg/100g, is in agreement with the study by Hussein et al. (2015) who reported a range of 2.16-18.32 mg/100g for the wild edible mushrooms. Besides, the lycopene content range of the present study is lower than that reported by Muruke (2014), 10-65 mg/100g, for *P. cystidiosus*. *L. sajor-caju* and *P. tenuiculus* observed to have lycopene contents of 11.84 and 18.95 mg/100g, respectively which are higher than that reported by Hussein et al. (2015) for the same wild mushroom species; 2.16 and 15.02 mg/100g for *L. sajor-caju* and *P. tenuiculus,* respectively. The lycopene contents noticed to be higher in domesticated mushrooms compared to their counterparts' wild species by 14.84% and 14.83% for *Amylosporus sp. IJ-2014* and *Polyporales sp. 'Kusaghizi',* respectively. It is very fascinating to note that the studied mushrooms had such high amounts of lycopene, which is a very good indicator of them being a good source of nutraceuticals. For comparison, the content of carotenoids (*β*-carotene and lycopene) reported by Ben-Amotz and Fishler (1998) in vegetables ranges from undetectable levels to ∼5.28 mg/100g for persimmon, ∼53.21 mg/100g for pitango, ∼103 mg/100g for carrot and ∼24.31 mg/100g for tomato. This clearly showed that the amounts of *β*-carotene and lycopene in the studied mushrooms are in abundance compared to the concentration

reported in some vegetables and other mushrooms, which implies that these mushrooms could be a good alternative source of carotenoids.

Total flavonoids contents

In this study, total flavonoids content range was 3.71-25.27 mg QE/100g, which is comparable to the range of 3.81-25.62 mg QE/100g reported by Hussein et al. (2015). Furthermore, Hussein et al. (2015) reported 2.49 and 20.86 mg QE/100g as flavonoid contents for *L. sajor-caju* and *P. tenuiculus*, respectively. These values are lower than the ones noted by this study, 15.78 and 25.27 mg QE/100g for *L. sajor-caju* and *P. tenuiculus*, respectively. Muruke (2014) reported total flavonoids content values of 5-31.64 mg QE/100g for *P. cystidiosus*, which is higher than that reported by this study for the same species. The study by Tibuhwa (2014) reported higher flavonoid amount from fresh form of *Afrocantharellus splendens* and *Cantharellus rufopunctatus* (155.16 and 134.31 mg QE/100g, respectively), which are also extremely higher than the peak value recorded by this study. The domesticated mushrooms observed to have higher flavonoid contents than their relevant wild species by 40.66% and 14.86% for *Amylosporus sp. IJ-2014* and *Polyporales sp. 'Kusaghizi',* correspondingly. High flavonoids level may help provide protection against oxidative stress induced diseases by contributing along with other antioxidant vitamins and enzyme to the total antioxidative defense system of the human body (Tripathy et al. 2014).

Total phenolic contents

Polyphenolic compounds are recognized as excellent antioxidants not only because of their ability to scavenge free radicals by single electron transfer (Mau et al. 2004) but also because of their stable radical intermediates (Shahidi & Wanasundra 1992). In the present study, the level of total phenolic contents in investigated mushrooms was 160.97-537.39 mg GAE/100g, which is higher than the level reported by Hussein et al. (2015), 136.21-431.03 mg GAE/100g. In the same study, Hussein et al. (2015) reported phenolic contents values of 162.74 mg GAE/100g for *L. sajor-caju*, which is lower than the one observed in this study for the same species (182.73 mg GAE/100g), and 431.03 mg GAE/100g for *P. tenuiculus*, which is higher than that obtained in this study for the same species (416.26 mg GAE/100g). Muruke (2014) reported phenolic contents level of up to 99.26 mg GAE/100g for *P. cystidiosus*, which is lower than the value obtained in this study for the same species (237.39 mg GAE/100g). Tibuhwa (2014) observed a positive correlation between mushroom total phenolic contents and their radical scavenging effects. In the present study, no correlation observed between mushroom phenolic contents and their antioxidant activities. This proposes that in addition to total phenolic contents, the variety of phenolic compounds and the proportion among them are equally imperative for determining the antioxidant potential as it was previously noted by Robu et al. (2012). Variation in antioxidant potentials between different mushroom species and between domesticated and wild forms of the same species was influenced by a number of factors including genetic nature of each species, age and parts (stipe or pileus) of mushrooms analysed as well as variation in composition of growth substrates and environmental factors (water, temperature and humidity).

Conclusion

Findings of this study revealed that the studied saprophytic edible mushrooms have amazing antioxidant activity with significant amounts of β-Carotene, lycopene, flavonoids and total phenolic compounds. Thus, people are advised to maximally exploit them for improved healthiness. Health individuals can become more industrious and better use their psychological and physiological potential for their personal development and that of their country, Tanzania.

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