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Antibacterial Activity and Nutritional Composition of Selected Indigenous Mushrooms of the Lake Victoria Basin

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Abstract: Indigenous mushrooms have attracted little attention form science in the East Africa region for a long time. And yet studies in other areas of the word have shown that mushrooms contain many different bioactive compounds with diverse biological activity. For long, mushrooms have been cultivated world wide for commercial purposes. In East Africa, however, little research has been done in to ascertain the nutritional and anti bacterial properties of indigenous mushrooms, much less their ecology. Proximate composition analysis (Weende) revealed the following: CP (25.9-41.9); CL (4.4-7.7); CHO (30.8-38.2); K (1.4-3.5); Ca (0.0095-0.0115). This points to the fact that the mushrooms are relatively high in protein and low in fat; making them potentially good health foods. Antibacterial activity was demonstrated in all puffball extracts, but particularly strong on *E. coli*. Both the polar (methanol) and the non-polar (pet-ether) extracts were shown to have antibacterial activity. The relatively high protein estimates obtained in this study indicate that the indigenous mushrooms are a good source of protein therefore could supplement human diet. The low lipid percentage of these mushrooms would mean that they are potential health foods. Crude extracts from indigenous puff ball mushrooms showed some antibacterial activity on both gram negative (*Escherischia coli* and Gram positive *Staphylococcus aureus*). Both methanol (polar) and petroleum ether extracts had activity on some organisms to varying degrees. Extracts from puff balls have greater antibacterial activity on gram negative bacteria than on gram positive. The non polar extracts (Petroleum ether) of puff balls had more activity on *E. coli*. From the results obtained it can be shown that indigenous puff balls could be a promising source of antibacterial agents. Since most mushrooms are saprophytic, easily growing on agriculture waste materials, it is recommended that agricultural system in this region be encouraged to domesticate these healthy foods. A type collection and taxonomical identification should be embarked on in the whole of the East Africa region so that botanical identification of all the indigenous mushrooms will be made much easier in the future.

Key words: Antibacterial activity, nutritional composition, indigenous mashrooms, Lake Victoria Basin

INTRODUCTION

Mushrooms are macro fungi with a distinctive fruiting body. They vary in size, structure and shape depending on the species and have been part of the normal human diet since time immemorial (Chang and Miles, 1992). They were mentioned in tales and scriptures thousands of years before Christ. Mushrooms are regarded as healthy foods and therefore have become an interesting subject in research (Stamets, 2002). They are poor in fat, high in carbohydrate and protein (Khanna and Garcha, 1984). Mushrooms also possess some vital bioactive natural products which are anti tumor (Ikekawa *et al*., 1969) anti viral and anti bacterial (Rosa *et al*., 2003). Mushrooms contain many different bioactive compounds with diverse biological activity depending on the way they are prepared and consumed (Kaneda and Tokuda, 1966).

Mushrooms have been cultivated world wide for commercial purposes for a long time (Chang and Miles, 1992). Little research has however been done in East Africa to establish the nutritional and anti bacterial properties of indigenous mushrooms (Opige *et al*., 2006a). Very little research has also been done to understand the ecology of indigenous mushrooms (Opige *et al*., 2006b). Here we report the results of studies designed to establish the nutritional composition and medicinal properties of

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some four priority mushrooms (*Termitomyces* sp.) and some puffballs that were collected from the Lake Victoria basin.

MATERIALS AND METHODS

Mushroom collection and extraction procedures: The mushrooms for nutritional composition analysis were collected during the rainy seasons, air dried and transported to the lab for analysis. The puff balls were collected at the spore stage then assayed. The puff balls were dried in the oven at 30°C, soaked in petroleum ether, Filtered. The solution was concentrated. This contained the non polar component of the puff balls. The above procedure was repeated for methanol extracts which represented the polar component.

Antibacterial activity of mushroom extracts: Mueller Hinton agar was used as the cultivation media. *Staphylococcus aureus*, *E.coli* and *Pseudomonas aeruginosa* were the reference test organisms. Determination of anti bacterial activity was done following standard procedures (Olila *et al*., 2001). Briefly, broth cultures of the micro organisms were uniformly distributed over the surface of the agar to obtain uniform inoculums. Wells of 4 mm diameter and 2.5 mm deep were made on the surface of the media. The extracts obtained were reconstituted in DMSO then poured into the wells. The plates were incubated at 37°C for 24 h. Zones of inhibition were measured and results tabulated.

Nutritional assays: The Wende system of analysis was used to estimate the values of the crude protein, fat, carbohydrates and minerals. Standard protocols AOC were adopted and used (AOAC, 1984). The results were subjected to a completely randomized design with two duplicates per test. Data on chemical composition and mushroom type were subjected to one way ANOVA. Treatment means were further compared using the Least Significant Difference (LSD) at 95% level of confidence (Table 1).

RESULTS AND DISCUSSION

Nutritional composition of indigenous edible mushrooms:

Antibacterial activity of puff ball extracts: Antibacterial activity was demonstrated in all puffball extracts, but particularly strong on *E.coli*. Both the polar (methanol) and the non-polar (pet-ether) extracts were shown to have antibacterial activity (Table 2).

In this study the protein value of *Termitomyces microcarpus* (Obwinsokere) was 25.8%. This is comparable to other values reported elsewhere (Khanna *et al*., 1984; Opige *et al*., 2006a). These relatively high protein values obtained can enrich human diet especially in villages where meat is rare and expensive (Fig. 1). It would appear then that gram for gram mushrooms contain more protein than either potato or cabbages (can supplement diet). The protein content of mushrooms is known to be highly variable due to strain of some species, tissue type and stage of development, substrate and method of analysis. However, in spite all these high values, mushrooms are still inferior in protein to such standard protein sources as meat, fish and eggs. It is also unlikely that in spite of the relatively high protein values, that mushroom can serve as a sole source of protein.

In addition to water and proteins, carbohydrates constitute the main component of mushrooms. Previous reports (Li and Chang, 1982) showed that the fluctuation

Table 1: Proximate composition in percentages of selected indigenous mushroom types

Mushroom type	DM	CP	CF	CL	TASH	MC	CHO	K	Ca
01	87..35	25.879^{c}	6.992	4.207	11.1810	12.650	38.1790	1.383^{c}	0.0095
02	85.93	32.991	7.013	5.486	12.9880	14.068	30.7895	3.479	0.0115
03	90.42^{a}	41.896	7.282	7.689	12.0015^{b}	9.586	35.0520	2.169	0.0110
04	86.87^{c}	33.838	9.218	4.754	11.1815	13.129^{a}	37.3166^{a}	2.169	0.0110^{b}
LSD	0.00	5.2778	1.1175	0.9197	0.3423	1.2463	0.0069	0.540	0.0054

(NB: 1). 01/GK/03/05. Sample 1: *Termitomycetes microcarpus*; 02/GK/03/05. Sample 2: *Kimula* 03/GK/04/05. Sample 3: *Mponziira;* 04/GK/04/05- Sample 4: *obwidhanamadhi;* 2). Means in the same column having different superscripts are significantly different; LSD = Least Significant Difference; I = values are the means of 2 determination pert sample

Table 2: Antibacterial activity of puff-ball extracts on standard reference organisms (Ly- Lycoperdon)

Sample identity	Methanol extract (vs *E. coli*)	Pet ether extract (vs *E. coli*)	Methanol extract (vs *S.aureus*)	Pet Ether extract (vs *S. aureus*)	Methanol extract (vs *Ps. aeroginosa*)	Pet Ether extract (vs *Ps aeroginosa*)
Ly-1	12	9	0	ND	0	ND
Ly-2	11	8	0	ND	0	ND
Ly-3	14	10	13	ND	12	ND
Ly-4	8	15	0	0	0	ND
Control	20	20	18	18	15	15

ND: Not Done

Fig. 1: *Termitomycetes microcarpus*

in carbohydrate content increases from the button- egg-elongation stage of the mushroom but drops abruptly at maturity. The values obtained in this study were therefore slightly lower than those of other authors probably because of the stage at which the mushrooms were picked. Others (Crison and Sands, 1978) have obtained values of carbohydrate which are very low (3-28%) compared to 30.7-38.17% (fresh samples were used while in this study dry ones were used). Mushrooms have little sugar and no starch at all which are both regarded as the worst two fattening agents therefore mushrooms are ideal for diabetes and weight watchers (Hughes, 1962).

The values obtained in this study were generally comparable with other reported findings by other researchers (Fitzpatrick *et al*., 1946; FAO, 1970, 1972). The values differ slightly from other researchers since the analyses may represent fresh samples or dried ones. In this study dried samples were used which were further dried at 30°C thus affecting the moisture content. The moisture content of a given specimen is affected significantly by environmental factors such as temperature, relative humidity and storage as well as the texture (Chang and Hayes, 1978).

In this study the fat content ranged from 4.2-7.6% . Other reports are also in a similar range for other mushrooms (Crisan and Sands, 1978). These fats consist of mostly un-saturated fatty acids, which are less hazardous to health than the saturated ones of animal fat thus making mushrooms health foods (Chang and Miles, 1997).

Like most vegetables mushrooms are good sources of minerals, phosphorus and potassium being the main constituents. Mushrooms contain every mineral present in their growth substrate but limitation to quantitating a given specimen lies in the sensitivity of the method used for analysis (Thomas *et al*., 1972).

With the increasing number of bacteria developing resistance to commercial antibiotics, extracts and derivatives from mushrooms hold a great promise for medicine in modern time (Stamets, 2002; Rosa *et al*., 2003).

Fig. 2: Kinula when young

Fig. 3: Indigenous puffballs

In this study the puffballs were assayed using methanol and petroleum ether solvents because there is need to employ a broad range of extractive solvents in the extraction of possible compounds from medicinal plants. *E. coli* was the most susceptible of the micro organisms used while *Staphylococcus* and *Pseudomonas* showed least susceptibility. The difference in activity of the extracts was because bioactive components of an extract will differ in their solubility depending on the extractive solvent used. The anti bacterial properties exhibited by some of the puffballs would confirm that there is a scientific basis to their use to treat sores, abrasion and wound infection, all of which are associated with *S. aureus* infections (Fig. 2 and 3).

The high protein values obtained in this study showed that the indigenous mushrooms are a great source therefore can supplement human diet. The low lipid percentage of these mushrooms shows that they are health foods. Mushrooms are a good source of dietary fibre thus efficient in intestinal regulation. Extracts from

puff balls have antibacterial activity. Both methanol and ether extracts have activity on some organisms to varying degrees. Extracts from puff balls have greater antibacterial activity on gram negative bacteria. Non polar components of puff balls have more activity on *E. coli.* From the results obtained it can be suggested that puff balls are promising antibacterial agents. Mushrooms being saprophytic plants which easily grow on agriculture wastes minerals, its recommended that agriculturists in this district be encouraged to domesticate these healthy foods. A type collection should be established by the taxonomists in Uganda so that botanical identification of the indigenous mushrooms be made possible in the future. There is need for collaborative study with other researchers so that identification of Ugandan basidiomycetes, isolation and characterization of active metabolites can be made easier.

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