ISSN 1682-296X (Print)
ISSN 1682-2978 (Online)

Bio Technology

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Biotechnology 6 (4): 567-572, 2007
ISSN 1682-296X

Pharmaceutical and Nutritional Prospects of Two Wild Macro-Fungi Found in Nigeria

Okwulehie, Ikechukwuka Cyriacus, Nwosu, C. Princewill and Okoroafor Chukwuma Johnpaul
Michael Okara University of Agriculture, Umudike, P.M.B. 7267, Umuahia, Abia State Nigeria, Nigeria

Abstract: The bioactive, proximate and vitamin composition of two wild macro fungi, found in Nigeria were investigated. The macro fungi, *Schizophyllum commune*, (split gill mushroom) and *Polyporus* sp. (bracket fungi) were obtained growing on dead logs of mango (*Mangifera indica*) and Iroko (*Chlorophora excelsa*), respectively. The fruit-bodies of the fungi were harvested fresh, dried, ground and analysed using Association of Analytical Chemists methods and other standard methods. The results of the analyses showed that the macro-fungi contained the bioactive compounds, alkaloids, flavonoids, phenols, saponins and tannins in varying quantities. The fungi are equally rich in proteins, vitamins and mineral elements. Flavonoids occurred more in *S. commune*, than in *Polyporus* sp. while there is more saponins in *Polyporus* sp. than in *S. commune* (0.40 mg/100 mg). Furthermore phenols and tannins occurred more in *S. commune* than in *Polyporus* sp. On the other hand, *Polyporus* sp. contained the highest amount of ash, fat crude protein, crude fibre, carbohydrates and moisture than *S. commune*. *S. commune* is richer in ascorbic acid and niacin than *Polyporus* sp. whereas riboflavin and thiamin of *Polyporus* sp. appeared more than those of *S. commune*. The mineral elements of *S. commune* of calcium potassium and sodium are higher than those of *Polyporus* sp. of calcium, potassium and sodium, while the magnesium, nitrogen and phosphorus of *Polyporus* sp. are higher than those of *S. commune*. The result obtained from the analyses of the two macro fungi has been discussed in relation to their prospects for medicinal purposes.

Key words: Wild macro-fungi, bioactive compounds, proximate analysis, pharmaceutical prospects, Nigeria

INTRODUCTION

In present times, mushrooms have continued to generate a lot interest. These interests are mainly in the areas of the implication of mushrooms as food (Chang, 1980), in the cure of diseases (Rambelli and Menini, 1983; Oei, 1991; Bushwell and Chang, 1993; Stamets, 1993), in bioremediation and as important item of commerce (Smith, 1972; Stamets, 1993).

The increased interest in the consumption of mushrooms as food stems from their nutritional and therapeutic values. Most mushrooms are very important nutritionally. According to Aletor (1995), Fasidi (1996) and Okwulehie and Odunze (2004a), tropical mushrooms are rich in protein, minerals and vitamins. The protein content of mushrooms has been reported to be twice that of vegetables and four times that of oranges (Bano, 1993) and significantly higher than that of wheat (Aletor, 1990). It is not surprising therefore that Okwulehie and Odunze (2004a), reported that the increased demand for mushrooms could be contingent upon the phenomenal rise in the unit costs of the conventional sources of animal proteins such as beef, pork, chicken and fish as opined by Aletor (1995).

Mushrooms contain appreciable quantities of crude fibers. Although little information exists on the Total Dietary Fibre (TDF) content of mushroom, the crude fibre contents values reported by many authors, suggest that mushrooms are potential sources of dietary fibers (Crisan and Sands, 1978; Kurasawa *et al*., 1982).

According to Oso (1977) and Okwulehie and Odunze (2004a), mushrooms generally contain low fat and oil content. Because of the low content of mushrooms, they are recommended as good food supplement for patients with cardiac problems.

The vitamins content of many mushrooms have been investigated and results of such investigations show that they are rich in vitamins C, B1, B2, B3 and vitamins D, (Bano and Rajarathnam, 1988) Okwulehie and Odunze, (2004a). Since vitamins are essential in the diet of man and

Corresponding Author: Okwulehie, Ikechukwuka Cyriacus, Michael Okara University of Agriculture, Umudike, P.M.B. 7267, Umuahia, Abia State Nigeria, Nigeria

conventional sources of vitamins are scarce (Aletor, 1995). It is pertinent therefore that attempts made to increase the list of the sources of cheap vitamins, is not misdirected.

Fasidi and Kadiri (1990), Aletor (1995) and Fasidi (1996), have also reported that tropical mushrooms are rich in minerals nutrients and carbohydrates. From the fore going, it is wise to recommend mushrooms as alternative nutrient-rich bush meat in the diet of Nigerians and to encourage researches geared towards discovering nutrient-rich species.

Mushrooms have been discovered to have therapeutic values. Bushwell and Chang (1993), reported that mushrooms have anti-tumoral, anti-cancer, anti-cholesterol and anti-hemorrhage effects. The considerable pharmacological activities of mushrooms make them of interest in pharmaceutical industries for the development of drugs. Most bioactive compounds which play essential roles in human and animal physiology have been found in many mushrooms. According to Okwulehie and Odunze (2004b), *Auricularia auricular*, *Pleurotus squarrosulus* and *Russula* sp. has been found to contain appreciable amounts of Alkaloids, phenols, Saponins and Flavonoids. According to Sofowara (1993), the plants widely used as in traditional medicine, contain in one or more of its parts potent bioactive compounds which are precursors for useful drug synthesis.

Alkaloids have powerful effects in animal physiology and are of interest in pharmaceutical industries for drug manufacture (Edeoga and Eriata, 2001). According to Rambelli and Menini (1983), alkaloids are stimulants and act by prolonging the action of several hormones.

Flavonoids have been reported to be useful in the treatment of some physiological disorders and diseases. According to Hilang and Feraro (1992), flavonones which are anti-oxidants are used to combat carcinogenesis and ageing processes, Similarly flavonoids have been reported to have anti-bacterial functions (Dokara, 1995).

Saponins which are characterized by their bitter tastes, have been implicated in the prevention of parasitic fungi diseases (Bidwell, 1979) and protection of grains from attack by weevils and related animal parasites (Riaz and Chaudhary, 1993).

Tannins also inhibit pathogenic fungi and also reduce the rate of grazing on plants by animals that feed of plants. They also affect many human physiological activities such as stimulation of phagocyte cells, host-mediated anti-tumor activities and a wide range of anti-infective actions (Haslam, 1996).

The present study is aimed at investigating if the mushrooms under investigation contain the compounds mentioned above and how much. This is in addition to the ascertaining how rich in nutrient the mushrooms are. This would enable the authors suggest how much prospects exist in the use of the mushrooms investigated, as food and as medicinal raw material in drug synthesis.

MATERIALS AND METHODS

Sample collection, identification and preparation for analysis: The two wild macro-fungi, namely, *Schizophyllum commune* (split gill mushroom) and *Polyporus* sp. (Bracket fungus), used for the investigation were collected from logs of mango (*Mangifera indica*) tree and Iroko (*Chlorophora excelsa*) tree, respectively, from different parts of Abia State. They were harvested fresh and fleshy in the month of August, 2006 and were identified by Dr. I.A. Okwujiako; a mycologist in the Department of Biological Sciences, Michael Okpara University of Agriculture, Umudike, Abia State.

The macro-fungi were prepared for analysis by drying the fruit bodies in the Selecta model oven at 104°C for four hours, following the method of Latiff *et al.* (1996). The *Polyporus* sp. was dried longer because of its thick and fleshy nature.

The dried specimens were broken into smaller pieces before grinding into fine powder using a Thomas Willey milling machine (Okwulehie and Odunze, 2004a). The dried and powdered samples were dispensed into air-tight bottles and kept in a cool dry place until required for the analysis.

Determination of percentage Bioactive compounds:

Alkaloids: For quantitative estimation of alkaloids, the method of Maxwell *et al.* (1995) was followed. The alkaloids were extracted from 20 g of each of the dried powdered mushroom samples using 100 mL of 10% acetic acid. The extracts were filtered to remove cellular debris and then concentrated to a quarter of the original volume. To this concentrate, 1% NH_4O was added drop-wise until no precipitate was formed. The alkaloids thus obtained were dried to a constant weight at 65°C in an oven. The weights were used to calculate the percentage alkaloids using the formula:

$$\text{Alkaloids}(\%) = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100$$

Determination of percentage flavonoids and saponins: The percentage flavonoids and saponins were determined following the methods of Bohn and Kloupai-Abyazani (1994) and Peng and Kobayashi (1995). The percentages were calculated as above.

Determination of phenols: To determine the percentage phenols in the test macro-fungi, the method of Harborne, (1988) was followed. Two grams of the sample was used. The absorbance of the solution was read off at 505 nm wavelength using a spectrophotometer.

Determination of tannins: To determine the tannins components of the macro-fungi the method of Okeke and Elekwa (2002) using 0.5 g of the sample, in 10 mL of 2 M HCl. This was shaken for 5 min and transferred into a volumetric flask and made up 50 mL. The mixture was filtered and 5 mL of the filtrate was introduced into a test tube. Three milliliters of 0.1 M $FeCl_3$ in 0.1 N HCl and 3 mL of 0.008 M of potassium ferrocynide (K_3Fe [CN] $_3$) were added. The absorbance was read at 720 nm within 10 min.

Proximate analysis: The percentage moisture and ash contents of the dry samples were obtained oven dehydration at 98°C for 5 h and then weighing the incinerated residue obtained at 600°C after 2 h (Leon-Guzman *et al*., 1997) ether (AOAC, 1980).

Crude fibre content was determined by Weende method (AOAC, 1980), while total nitrogen content determined using the micro-Kjeldahl method of the AOAC. The crude protein content was calculated using a conversion factor of 6.25. The total carbohydrate content was estimated as the remainder after accounting for the ash, crude fibre, protein and fat contents Miller and Tobin, 1980). Similarly the gross food energy was estimated following the method of Osborn and Voogt, (1978), using the equation

$$\text{Fe (in grams calories)} = (\%\ \text{CP}\times 4) + (\%\ \text{Fat}\times 9) + (\%\text{CHO}\times 4)$$

Where:

FE = Food Energy;
CP = Crude Protein;
CHO = Carbohydrate

Determination of vitamins: Vitamins were determined using spectrophotometric method, according to AOAC (1980). The powdered macro fungi samples were extracted by EDTA/TCA extraction method and the extracts were read off at different wave lengths.

Determination of mineral elements: The determinations of the mineral elements in the dry samples were done following the wet digestion extraction methods. The powdered samples were sieved and 0.2 g of each put into a 25 mL round bottomed flask. The samples were digested using 5 mL nitric acid (HNO_3) and 2 mL perchloric acid ($HClO_4$). The solution was filtered after adding 15 mL of distilled water into a 50 mL volumetric flask and the volumes made up to mark with more distilled water. The minerals in the digested samples were then determined by atomic absorption spectrophotometer following the development of colour with ammonium molybdate.

RESULTS AND DISCUSSION

Alkaliods, flavonoids, phenols, saponins and tannins were all detected in the two fungi (Table 1). The quantities however varied with the fungus species; for example, *S. commune* yielded more flavonoids (3.80%), phenols (0.70% and tannins (0.70%) than *Polyporus* sp. with 0.60% flavonoids, 0.081% phenols and 0.32% tannins; while *Polyporus* sp. contained higher amounts of saponins of 2.50% than *S. commune* (0.40%). *S. commune* and *Polyporus* sp. contained almost the same quantity of alkaloids of 0.015 and 0.013%, respectively (Table 1). The presence of these bioactive compounds in the two fungi suggests that they have medicinal potentials. This inference is drawn from the fact that most of the plant parts uses in the treatment of diseases have traces of alkaloids. For example, Rahila *et al*. (1994), detected alkaloids in *Euphorbia* species used as purgative. Similarly *Momordica charanta* and *Azadirachta indica* used in the cure of malaria contain alkaloids (Harborne, 1988; Haslam, 1998). Godwin and Mercer (1972), reported that saponins, in low concentrations are toxic to animals mainly because they cause haemolysis of red blood cells while reports are available that saponins derived from *Marsdenia* species caused infertility in rats. These reports further confirm the medicinal potentials of the fungi under investigation. *Polyporus* species however appear to have more of this potential since it contains more saponins than *S. commune*. According to Godwin and Mercer (1972); flavonoids are phenolic glycosides which exist *in vivo* as glycosides. Okwulehie and Odunze, (2004b) detected large quantities of flavonoids in *Pleurotus tuber-regium*. This mushroom is consumed mainly for its flavour. It is possible that the flavonoids are responsible for the flavouring properties of the sclerotium of *P. tuber-regium*. Incidentally *S. commune* which yielded more flavonoids (3.80%) than *Polyporus* sp.

Table 1: Bioactive compounds composition of *Schizophyllum commune* and *Polyprus* sp. Investigated (Percentage dry basis)

Bioactive Compound	*Schizophyllum commune*	*Polyporus* sp.
Alkaloids	0.015	0.013
Flavonoids	3.800	0.600
Phenols	0.700	0.081
Saponins	0.400	2.500
Tannins	0.700	0.320

Values are means of three replicates

Table 2: Proximate composition of *Schizophyllum commune* and *Polyporus* sp. investigated (Percentage)

Analysis	*S. commune*	*Polyporus* sp.
Ash	7.460	8.220
Fat	1.280	2.040
Crude protean	9.630	14.000
Crude fibre	0.044	0.068
Carbohydrate	81.590	85.670
Moisture	91.800	95.000
Energy value	376.400	414.360

Values are means of three replicates

Table 3: Vitamin composition of *S. commune* and *Polyporus* sp. investigated (mg/100 g dry wt basis)

Vitamins	*S. commune*	*Polyporus* sp.
Ascorbic and (Vit. C)	0.49	0.37
Niacin (Vit. B_3)	1.30	0.48
Riboflavin (Vit. B_2)	0.22	0.54
Thiamin (Vit. B_1)	0.28	0.47

Values are means of three replicates

(0.60%) is edible with good flavour, while *Polyporus* sp. is not edible. The low content of flavonoids and high content of saponins in the *Polyporus* sp. may be part of the reasons for its inedibility.

The two macro-fungi are rich in crude protein which is 14. 00% in *Polyporus* sp. and 9.63% in *S. commune*. Similarly the ash, fat, crude fibre and moisture contents of the two macro-fungi are 7.46, 1.28, 0.044 and 91.8% for *S. commune* and 8.22, 2.04, 0.068 and 95.0% for *Polyporus* sp., respectively (Table 2 and 3). Their carbohydrate contents are 81.59 and 85.67%, respectively, while their energy values are 376.40 and 414.36 cal g^{-1}, respectively.

The two fungi species also contain ascorbic acid, niacin, riboflavin and thiamin. There is not much variation in the ascorbic acid, riboflavin and thiamin contents. The values of these vitamins for *S. commune* are 0.49, 0.22 and 0.28% while the values for *Polyporus* sp. are 0.3, 0.54 and 0.47%. The niacin content of *S. commune* is 1.30% and that of *Polyporus* sp. is 0.48%

The result of the proximate and vitamin analyses of the two macro-fungi clearly shows that they are rich in nutrients and hence qualify as good food materials. Earlier studies have indicated that mushrooms are rich sources of nutrients and compare favourably with meat, egg and milk (Gruen and Wong, 1982; Zakhary *et al*., 1983; Aletor and Aladetimi, 1989; Okwulehie and Odunze, 2004). The results also show that the two fungi are rich Sources of mineral elements. *S. commune* yielded 3.63% potassium, 1.54% nitrogen, 1.50% calcium 0.73% magnesium, 0.15% phosphorus and 0.38% sodium, while *Polyporus* sp. contains 2.69% potassium, 2.24% nitrogen, 1.40% calcium, 0.795 magnesium, 0.25% phosphorus and 0.25% sodium (Table 4).

The trend of the mineral elements in the two fungi appears the same. For example potassium content is high in each case followed by nitrogen and calcium. Similarly phosphorus, sodium and magnesium are low.

Table 4: Mineral elements composition of *S. commune* and *Polyorus* sp. investigated (mg/100 g dry wt basis)

Mineral element	*S. commune*	*Polyporus* sp.
Calcium (Ca)	1.501	1.401
Magnesium (Mg)	0.730	0.790
Nitrogen (N)	1.540	2.240
Phosphorus (P)	0.145	0.288
Sodium (Na)	0.375	0.250

Values are means of three replicates

Generally the two macro-fungi are rich in nutrients including vitamins and minerals elements. Unfortunately *Polyporus* fungi which is a bracket fungus is not edible while *S. commune* is edible in Nigeria and Malaysia (Latiff *et al*., 1996), although Kuo (2003), considers it to be non-edible. According to Kuo (2003) *S. commune* is too small and leathery to be considered of culinary value, the present authors how ever present a contrary view since the mushroom is rich in nutrients, moreover there are much smaller mushrooms such as *Flammulina velutipes* that are still relished as food.

The high contents of the bioactive composition of the two macro-fungi species makes them potentially useful pharmaceutically. The pharmaceutical potentials of *S. commune* is further strengthened by the reports of Qui and Lui (2002) who reported that *S. commune* is pharmacologically important because of the presence of schizophyllan, a polysaccharide which has a considerable anti-cancer activity. From the present findings it can be conceived that the two macro-fungi investigated hold tremendous potentials as raw materials for drug manufacture in addition to potentials of *S. commune* as rich source of proteins, vitamins and mineral elements needed in the diets of Nigerians.

Further researches is however required in the characterization of the bioactive components.

REFERENCES

Aletor, V.A. and O.O. Aladetimi, 1989. Compositional evaluation of some cowpea varieties in some under-utilized edible legumes in Nigeria. Die Nuhrung, 33: 99-107.

Aletor, V.A., 1990. Anti-nutritional factors in some Nigerian feedstuffs, herbage byproducts, crop residue and browse plants. A Monograph Prepared for the Presidential Task Force on Alternative Formulation of Livestock Feed Products Development, Quality, Evaluation and Health Implications. Cabinet Office, Lagos, Nigeria.

Aletor, V.A., 1995. Compositional studies on edible tropical specials of mushroom. Food Chem., 54: 256-268.

AOAC (Association of Official Analytical Chemists), 1980. Official Methods of Analysis. 13th Edn., Washington, DC.

Bano, Z. and S. Rajarathnam, 1988. Studies on the cultivation of *Pleurotus sajor*-caju. Mushroom J., 101: 243-245.

Bano, Z., 1993. Food value of mushrooms. Gram Prandyogiki, 3: 224-225.

Bidwell, R.S.G., 1979. Plant Physiology. 2nd Edn., Macmillan, London, pp: 643.

Bohn, B.A. and R. Kloupai-Abyazan, 1994. Flavonoids and condensed tannius from leaves of Hawasain (*Vaccinium raticulatum* and *V. calycinium*). Pac. Sci., 48: 458-463.

Bushwell, Y.A. and S.T. Chang, 1993. Edible Mushroom Attributes and Applications in Genetics and of Edible Mushrooms. Chang, S.T., J.A. Bushwell and P.G. Miles (Eds.), Gordon and Branch, Philadelphia, PA., pp: 297-334

Chang, S.T., 1980. Mushroom production in South-East Asia. Mushroom Newslett. Trop., 4: 5-10.

Crisan, E.V. and A. Sands, 1978. Nutritional Value of Edible Mushrooms. In: The Biology and Cultivation of Edible Mushrooms. Chang, S.T. and W.A. Hayes (Eds.), Academic press, New York, pp: 137-167.

Dokara, F.D., 1995. Plant flavonoids: Biological molecules for useful exploitation. Aust. J. Plant Physiol., 22: 87-99.

Edeoga, H.O. and D.O. Eriata, 2001. Alkaloids, Tannins and saponins contents of some medical plants. J. Med. Aromatic Plant Sci., 23: 344-349.

Fasidi, I.O. and M. Kadiri, 1990. Changes in enzyme activities of *Termitomyces robustus* (Becli) and *Lentinus subnudus*, during sporophore development. Food Chem., 48: 255-258.

Fasidi, I.O., 1996. Studies on *Valvariella escuenta* (Mass) Singer, cultivation on agricultural waste and proximate composition of stored mushrooms. Food Chem., 55: 161-163.

Godwin, T.W. and Mercer, 1972. Introduction to Plant Biochemistry. Pergamon Press Oxford, pp: 350.

Gruen, F.H. and M.W. Wong, 1982. Distribution of cellular amino acids, proteins and total nitrogen during fruit body development in *Flammuling velutipes*. Can. J. Bot., 160: 1339-13412.

Harborne, J.B., 1988. Phytochemical Methods. Chapman and Hall Ltd., London, pp: 11-113.

Haslam, E., 1996. Plant polyphenols (vegetable tannins) as drugs, possible mode of action. J. Nat. Prod., 59: 205-215.

Haslam, E., 1998. Plant Polyphenols, Vegetable Tannins Revisited. Cambridge University Press, Cambridge, pp: 250.

Hilang, M.T. and E. Ferraro, 1992. Phenolic Compounds in Food and Cancers Prevention. In: Phenolic Compounds in Food and Their Effect on Health II, Antioxidants and Cancer Prevention. Higlan, M.T. and H.O.T. Lee (Eds.), American Chemical Society (ACS) Symposium Series 501, American Chemical Society. Washington, DC., pp: 8-12.

Kuo, M., 2003. *Schizophyllum commune*. http;//www. mushroom expert.com.

Kurasawa, S.L., J. Sugahana and J. Hayashi, 1982. Studies on dietary fibre of mushroom and edible wild plants. Nutr. Rep. Int., 26: 167-173.

Latiff, L.A., A.B.M. Daran and A.B. Mohamed, 1996. Relative distribution of minerals in the pileus and stalk of some selected edible mushrooms. Food Chem., 56: 155-121.

Leon-Guzman, M.F., I. Silva and M.G. Lopez, 1997. Proximate chemical composition, free amino acid contents and free fatty acid contents of some wild edible mushrooms from Queretaro Mexico. J. Agric. Food Chem., 45: 4329-4332.

Maxwell, A., M. Speeris, R. Pingal, D.R. Mootoo and W.F.C. Reynolds, 1995. 3B amino S spirosalane steroidal alkaloids from *Solanum triste*. J. Nat. Prod., 58: 625-628.

Miller, H.G. and G. Tobin, 1980. Nutrition and Food. Processing. Groom Helm Ltd., London, pp: 152.

Oei, P., 1991. Mushroom Cultivation with Special Emphasis on Appropriate Techniques for Developing Countries. Tool Publication III, pp: 52-60.

Okeke, C.U. and I. Elekwa, 2002. Phytochemical study of the extracts of *Gongoronema tatifolium* Benth. (Asclepiadacea). J. Health Visual Sci., 5: 47-55.

Okwulehie, I.C. and E.I. Odunze, 2004a. Evaluation of the nutritional value of some tropical edible mushrooms. J. Sustainable Agric. Environ., 6: 157-162.

Okwulehie, I.C. and E.I. Odunze, 2004b. Evaluation of the myco-chemical and mineral composition of some tropical edible mushrooms. J. Sustainable Agric. Environ., 6: 163-170.

Osborn, D.R. and P. Voogt, 1978. Calculation of Calorific Value. In: Analysis of Nutrients in Foods. Academic Press, New York, pp: 239-240.

Oso, B.A., 1977. *Pleurotus tuber-regium* from Nigeria. Mycologia, 69: 271-279.

Peng, J.P. and H. Kobayashi, 1995. Novel furastonol glycosides from *Allium macrostenum*. Planta Medica, 6: 58-61.

Qui, U. and Y. Lui, 2002. Fruit body production in Basidiomycetes. Applied Microbiol. Biotechnol., 54: 141-152.

Rahila, T., N. Rukhsndra, A.A. Zaidi and R. Shamshila, 1994. Phytochemical screening of medical plants belonging to the family Euphorbiacea l. Pak. Vert. J., 1: 160-162.

Rambelli, A. and U.G. Menini, 1983. Manual on Mushroom Cultivation. Food and Agricultural Organisation of the United Nations, Rome. Italy, pp: 68.

Riaz, M. and F.M. Chaudhary, 1993. Chemistry of Medical Plants and Traditional Medicine in Africa. Spectrum Books Ltd., Ibadan, Nigeria, pp: 289.

Smith, J., 1972. Commercial mushroom production process. Biochemistry, 7: 24-26.

Sofowara, A., 1993. Medicinal Plants and Traditional Medicine in Africa. Spectrum Books Ltd., Ibadan Nigeria, pp: 289.

Stamets, P., 1993. Growing Gourmet and Medical Mushroom. Ten Speed Press Berkely, pp: 610.

Zakhary, W.J., M.T. Abu-Baki, R.A. El-Maloy and M.A. El-Tabey, 1983. Chemical composition of world mushrooms collected from Alexandma Egypt. Food Chem., 11: 31- 41.