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Research Article

Effects of Selenium Fortification on the mineral and fatty acid Properties of *Pleurotus ostreatus* Jacq

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Abstract

Introduction: Mineral elements are very important in physiological processes and hence affect the quantity and types of metabolites produced by plants and animals. In this study, the effect of selenium fortification on the mineral and fatty acid contents of *Pleurotus ostreatus* was investigated.

Methods: *Pleurotus ostreatus* was cultivated on substrate enriched with sodium selenite. The mineral and fatty acid content of the selenium enriched and non-selenium enriched fruitbodies were analysed using standard methods.

Results: Data revealed that fortification of *Pleurotus ostreatus* results to increase in the values of Ca, Mg, and Se while the value of Zn reduced. A total of 13 and 18 peaks were respectively observed in the chromatograms of non-selenium fortified and selenium fortified Pleurotus ostreatus. The following fatty acids; Pentadecanoicacid, 13-Hexyloxacyclotridec-10-en-2-one, Oleic Acid, n-Hexadecanoic acid, Stearic acid, Undecylenic Acid, 10-Undecenoyl chloride and Pentadecanoic acid 2-hydroxy-1- (hydroxymethyl)ethyl were common to both selenium fortified and non-fortified *Pleurotus ostreatus*.

Conclusion: In conclusion, fortification of *Pleurotus ostreatus* markedly affects the mineral and fatty acids of its fruitbodies with more fatty acids present in *Pleurotus ostreatus* fortified with selenium.

Keywords: *Pleurotus Ostreatus*; Selenium; Fortification; Effects; Mineral; Fatty Acids

Introduction

Mushrooms are important based on their nutrient content and the possession of bioactive compounds that promote human health. Health promoting properties such as antioxidant, antimicrobial, anticancer, cholesterol-lowering, immunostimulatory and many others had been associated with the consumption of mushroom [1-4]. The presence of bioactive compounds such as polysaccharides, dietary fibre, polyphenols, terpenes, proteins and peptides, and fatty acids had been reported to confer health promoting properties on mushrooms [5,6].

During cultivation, mushrooms can absorb mineral elements and bioaccumulate them as functional organic compounds. Mineral nutrients are indispensable to the maintenance of life. These elements are very important for cell functions at biological, chemical and molecular levels [7]. The nutritional requirement of man is at least 23 mineral elements [8]. These mineral elements are also important in the physiological processes of plants and non-chlorophyllus plants. The absence of the essential elements often results to deficiency diseases [9]. Some of these essential elements are selenium, iron, zinc, calcium and so on. Though these elements constitute only 0.02% of the body weight, however, the genesis of many nutritional disorders had been linked with interactions of these elements since they play significant role as active co-enzymes [7,10]. Volumes of scientific data from physiologic investigations have revealed that inadequate consumption of these micronutrients (minerals and trace elements) can affect the optimal absorption and utilization of other nutrients to work effectively in the body [8].

Pleurotus spp, a group of edible mushrooms that can be artificially cultivated is among the most popular edible mushrooms [5]. These groups of mushrooms have great potential for uptake and bioaccumulate various elements in their fruit bodies. The ability of *Pleurotus ostreatus*, *P. pulmonarius* to absorb Fe, Zn, Se and Li had been reported by [11-14].

The absorption of these mineral nutrients had been reported to affect the formation of macromolecules such as amino acids and fatty acids and the mineral distribution of cultivated mushrooms [3,13,15]. The present study was therefore designed to investigate the effects of selenium fortification on the minerals and fatty acids composition of *Pleurotus ostreatus*.

Materials and Methods

Production of Selenium fortified and Non-fortified *Pleurotus ostreatus*

The substrate for cultivation of Pleurotus ostreatus, rice bran and saw dust, were collected from Ado-Ekiti., Southwestern Nigeria while Pleurotus ostreatus spawn was obtained from the Federal Institute of Industrial Research, Oshodi (FIIRO), Lagos, Nigeria. The substrates (sawdust and rice bran) were mixed together in the ratio 3:1. (60% of saw dust plus 20% rice bran) and moistened with water to prevent dryness. About 700 g of the substrate was packed into polypropylene bag and sealed with paper with the aid of polyvinyl rings and this was sterilized in an autoclave and allowed to cool to room temperature. Thereafter, 8ml of Sodium selenite (Na_2SeO_3) at a concentration of 50mg/kg was injected to the some bag containing for selenium fortification. A control treatment with no sodium selenite was also prepared [3]. Following this, substrates in separate bags were inoculated with 30 g of spawn. The bags were kept in the dark room with relative humidity of 75% to ramify [16].

Mineral Analysis of Fruitbodies of *Pleurotus ostreatus*

The method of Oyetayo., *et al*. [13] was adopted for the determination of the mineral content of *Pleurotus ostreatus*. Briefly, ash obtained from 1g of dried *P. ostreatus* was digested with HNO_3 and $HClO_4$ (3:1, v/ v) with 2.0 ml of hydrogen peroxide and heated to 250 °C in a flask. It was filtered after digestion and filtrate obtained was made up to 10 mL with ultra-pure water (Milli-Q system, Millipore, USA). Atomic absorption spectroscopy was calibrated before use with each of the metal standard solution at 1000 µg/ml in 1% v: v HNO_3. The solution was prepared with ultra-pure water (Milli-Q system, Millipore, USA). A lame photometer (Jenway PFP 7, Stafordshire, UK) was used to determine Na content of the samples.

Determination of Fatty acid contents

The fatty acids were determined after a trans-esterification procedure as described by Stokovic., *et al*. [17]. Briefly, fifty milligram (50mg) of fat extracted from *P. ostreatus* was esterified for 5 min at 95°C with 3.4 ml of the 0.5 M KOH in dry methanol. The mixture was neutralized using 0.7M HCl. About 3 ml of boron triflouride (14%) in methanol was added. The mixture was heated for 5 min at the temperature of 90°C to achieve complete methylation process. The Fatty Acid Methyl Esters (FAMEs) were extracted from the mixture with redistilled n-hexane. Thereafter, the content was concentrated to 1ml, and 1µL was injected into the injection port of gas chromatography (GC-2010, Shimadzu, Japan) with auto injector (AOI), capillary column (BPX-70), analytical conditions of auto sampler, injection port settings, column oven settings and column information used for analysis of FAMEs. The quantification of the FAMEs was performed using standard mixture (C_4-C_{24}, Sigma-Aldrich, St. Louis, MO, USA) processed under similar conditions of samples. The concentration and area of each peak of FAMEs was computed using the GC post-run analysis software (Shimadzu, Japan).

Data analysis

Data gathered from the study were subjected to analysis of variance using SPSS 20.0 version.

Results

The results of mineral analysis of selenium fortified and non-fortified mushroom is shown in table 1. Fortification of *Pleurotus ostreatus* results to increase in the levels of the following minerals Ca, Mg, and Se. However, there was no remarkable change in the levels of Cu, Fe, Mn and Cr while a reduction was observed in the Zn content when compared with non-selenium fortified *Pleurotus ostreatus*.

Mineral	Non-Selenium fortified	Selenium fortified
Ca	10.40 ± 0.12	27.67 ± 0.23
Mg	12.52 ± 0.00	13.26 ± 0.02
Cu	0.16 ± 0.01	0.17 ± 0.00
Fe	0.56 ± 0.01	0.29 ± 0.01
Mn	0.42 ± 0.01	0.46 ± 0.03
Zn	3.61 ± 0.03	0.95 ± 0.03
Pd	0.00 ± 0.00	0.00 ± 0.00
Ni	0.00 ± 0.00	0.00 ± 0.00
Cd	0.00 ± 0.00	0.00 ± 0.00
Cr	0.03 ± 0.00	0.02 ± 0.00
Se	0.03 ± 0.01	0.17 ± 0.00

Table 1: Mineral concentration (mg/Kg) in selenium fortified and non-fortified *Pleurotus ostreatus*.

Fortification with selenium affected fatty acid distribution in *Pleurotus ostreatus* fruitbodies. Total of 13 and 18 peaks were respectively observed in non-selenium fortified and selenium fortified *Pleurotus ostreatus* (Figures 1 and 2).

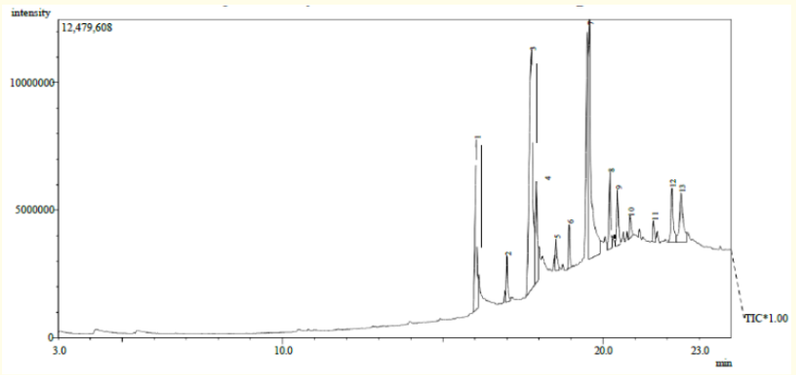

Figure 1: Chromatogram of fatty acids in Non-selenium fortified *Pleurotus ostreatus.*

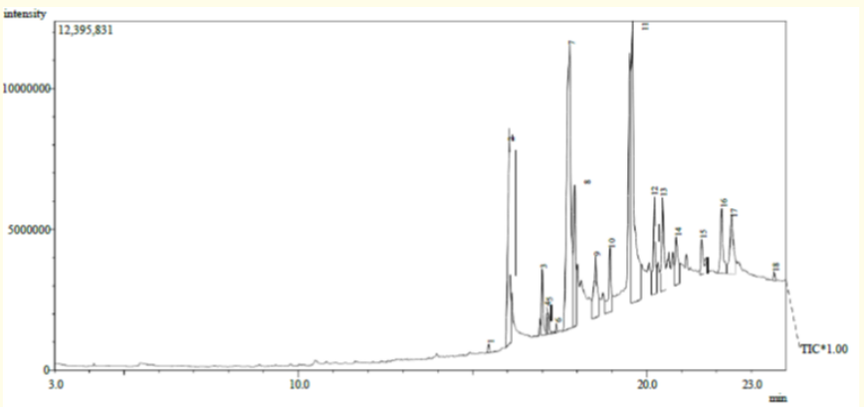

Figure 2: Chromatogram of fatty acids in Selenium fortified *Pleurotus ostreatus.*

The compounds revealed by GC MS analysis were made up of fatty acid, fatty aldehydes and tritepene (squalene) which is present only in selenium fortified *Pleurotus ostreatus* (Tables 2 and 3). The following fatty acids; Pentadecanoicacid, 13-Hexyloxacyclotridec-10-en-2-one, Oleic Acid, n-Hexadecanoic acid, Stearic acid, Undecylenic Acid, 10-Undecenoyl chloride and Pentadecanoic acid 2-hydroxy-1- (hydroxymethyl)ethyl were common to both selenium fortified and non-fortified *Pleurotus ostreatus*.

Discussion

Mineral elements are essential participants in metabolic processes [8]. Though these mineral elements constitutes very small portion of the body weight, their absence have been linked with many nutritional disorders. They play significant roles as active co-enzymes or trace bioactive substances [7,10]. Moreover, minerals are involved in the generation of the macromolecules in living organisms.

In this study, fortification of *Pleurotus ostreatus* affected the mineral elements present in mushrooms. There was increase in the level of Ca, Mg and Se. Selenium fortification may have enhanced the absorption of Ca and Mg from the substrate. Several researcher had reported the ability of *Pleurotus* species to bioaccumulate elements such as selenium, zinc, lithium, calcium and iron from the substrate on which they are cultivated [13,14,18-22]. The following have been suggested as the mechanisms that enable mushrooms to readily absorb mineral elements from their substrate: the active transportation of mineral into cell and intracellular components, biosorption methods like adsorption, ion exchange processes and covalent binding [23,24]. These elements are essential in human body metabolism. The ability of *P.* species to absorb these mineral elements could therefore be adopted as a strategy to solve the problem of mineral malnutrition in man [8,25].

Absorption se by *Pleurotus ostreatus* from the growth substrate is of importance. Such selenium enrich mushroom has been dem-

onstrated to have better antioxidant and antimicrobial properties [3,11]. Dietary selenium has been recognized as an antioxidant and the deficiency of this element has been associated with numerous chronic degenerative diseases, including multiple types of cancer, cardiomyopathy and endemic osteoarthropathy [26]. Its optimal intake could potentially prevent various types of cancer and diseases like diabetes, age-related immunosuppression and even problems related to fertility [27] in the ultimate consumer of such se enriched mushroom.

Fortification of *Pleurotus ostreatus* with selenium significantly affected its total fatty acid content. More fatty acids, fatty aldehydes, and squalene (18 compounds) were found in selenium fortified *Pleurotus ostreatus* while 13 compounds were present in non-selenium fortified *Pleurotus ostreatus* (Tables 2 and 3). Tan., *et al*. (2017) had earlier reported that metal ions such as $ZnSO_4$ and $FeCl_3$ increased biomass and lipid content in *Mortierella.* Metal ions play a significant role in influencing the lipid content of mushrooms [28]. Metal ions, especially copper, have been shown to influence lipid production in mushrooms by affecting enzyme activity and metabolic pathways, ultimately leading to changes in the lipid content of fungal cells [28]. The following fatty acids; Pentadecanoic acid 14-methyl-, n-Hexadecanoic acid, 13-Hexyloxacyclotridec-10-en-2-one, Oleic acid, Stearic acid, Undecylenic Acid, Ethanone, 1-(2,2-dimethylcyclopentyl)- and Hexadecanoic acid common to selenium and non-selenium fortified *Pleurotus ostreatus* have been reported in other mushrooms [29,30]. Saturated fatty acids (Pentadecanoic acid, Stearic acid) and unsaturated fatty acids (Oleic acid, undecylic acid) had also been reported in mushrooms species by various authors [30,31].

Conclusively, fortification of *Pleurotus ostreatus* markedly affects the mineral and fatty acids in its fruitbodies. More fatty acids were accumulated in *Pleurotus ostreatus* fortified with selenium. Moreover, the ability of *Pleurotus ostreatus* to accumulate selenium from the growth medium was revealed and this may be used as a means of delivering dietary selenium, an important antioxidant, to human.

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Conflicts of Interests

None.

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