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Comparative Appraisal of the Total Phenolic Content, Flavonoids, Free Radical Scavenging Activity and Nutritional Qualities of *Pleurotus ostreatus* (EM-1) and *Pleurotus eous* (P-31) Cultivated on Rice (*Oryzae sativa*) Straw in Ghana

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Authors' contributions

This work was carried out in collaboration between both authors. Author NKK designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors MWK and NKK managed the analyses of the study. Author MWK managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: The nutritional and anti- nutritional qualities of *Pleurotus ostreatus* (EM-1) and *Pleurotus eous* (P-31) cultivated on rice straw were compared.
Methodology: *In vitro* antioxidant analysis, proximate analysis, refractometry, atomic absorption and Atwaters procedure.
Results: Nutritional results recorded for the two *Pleurotus* spp. ranged 80.51±0.63- 86.81±0.63, 6.11±0.14 - 9.84±0.10, 17.75±0.17- 15.91±0.17, 15.22±0.17- 24.10±0.39, 2.01±0.24- 4.73±0.28, 55.41±2.70- 45.59±2.40, 15.00±0.18- 15.00±0.18 (Brix^{o}) and 300.61- 321.62 Kcal/100g for moisture content, ash, fibre, protein, lipid, carbohydrates, total soluble solids and metabolizable energy respectively. Mineral elements studied recorded results of 14.10±0.7- 6.00±0.15, 31.9±0.5-

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12.15±0.35, 1.77±0.18- 0.76±0.01, 0.02±0.001- 0.01±0.001, 0.03±0.001- 0.19±0.004, 0.37±0.1- 0.23±0.01, 0.04±0.001- 0.02±0.01, 6.41±0.35- 7.60±0.45, 11.02±0.3- 0.37±0.03, 0.02±0.001- 0.10±0.001 and 3.61±0.02- 3.60±0.25 for Na, K, Mg, Cu, Zn, Fe, Mn, P, Ca, Pb and N respectively. All the nutritional parameters investigated showed significant difference ($P<0.05$). Anti-nutritional results recorded ranged 3.57- 5.66 mgGAE/g, 226- 622.6 mgQE/g, 9.0- 13.0 mgGAE/g and 0.25- 1.35 mg ml^{-1}. Total phenolic content, flavonoid content, free radical scavenging ability and IC_{50} values respectively.

Conclusion: There was significant difference ($P<0.05$) between anti-nutritional parameters. The results obtained generally showed that *P. eous* was better than *P. ostreatus*.

Keywords: Pleurotus spp.; antioxidants; proximate; metabolizable energy; mineral composition.

1. INTRODUCTION

Pleurotus ostreatus and *Pleurotus eous* both belong to the division basidiomycetes, class hymenomycetes, in the order Agaricales whose fleshy fruit bodies and hymenia are borne on gills [1-3]. Their nutritive and medicinal attributes dates back to ancient times as early as 1500 BC culled from ancient literatures. They are considered as functional foods because they elicit their positive effect on humans owing to their high and qualitatively good protein content, low fat and cholesterol content, minerals and vitamins [4-6]. Functional foods are comprised of products of microbial, animal and plant origin containing physiologically active compounds and reducing chronic diseases risk. Also inclusive are neutraceutical, medicinal foods, vita foods, pharma foods, mycochemicals and dietary supplements etc. [7]. Moreover, mushrooms are low in nucleic acid contents which make them an ideal food for patients suffering from diabetes, obesity and hypertension [8].

Extensive work on medicinal attributes of *Pleurotus* spp. was done by Wang, Li and their colleagues in the first decade of the new millennium [9-11] which emphasized on fruiting bodies as well as bioactive mycelia possessing a myriad of therapeutic properties like antiinflamatory, immunomodulatory, anticancer activity, ribonuclease activity, antimicrobial, hypotensive, hyperglycemic, antiviral and have the potential to act as an anti-Human Immuno-deficiency Virus (HIV).

Fruiting bodies of *Pleurotus* spp. possessed high concentrations of antioxidants than other commercial mushrooms [12-14]. Antioxidants have been shown to prevent the destruction of β-cells [15] and to prevent or inhibit oxidation processes in human body and food products [16]. According to Li et al. [11], under normal conditions, the balance between the generation and diminution of free radicals mainly RNS (reactive nitrogen species) and ROS (reactive oxygen species) are controlled by the antioxidant defense system, but under certain pathological conditions, when RNS and ROS are not effectively eliminated by the antioxidant defense system, the dynamic balance between the generation and diminution of ROS is broken due to bimolecular oxidation [17] and so may result in significant damage to cell structure, contributing to various diseases, such as cancer, stroke, diabetes and degenerative processes associated with ageing [17].

Published studies by several researchers [18,19] show how polyphenol compounds in our diets help improve endothelial function, which is a critical factor in preventing atherosclerosis. They have also been shown to inhibit the abnormal blood platelet aggregation that cause most sudden heart attacks and strokes, while fighting inflammation and supporting healthy blood lipids. They have the potential to reduce allergic conditions [20] by blocking the release of histamine (an irritating substance causing inflammation and itching) from the mast cells that mediate allergic reactions. Letenneur et al. [21] reported that polyphenols from different natural sources may work synergistically when consumed together, with benefits from the combination resulting in more than the sum of the parts.

This study was conducted to evaluate the nutritional qualities and antioxidant properties of *Pleurotus ostreatus* (EM-1) and *Pleurotus eous* (P-31) mushrooms cultivated on rice straw.

2. MATERIALS AND METHODS

2.1 Chemicals

Analytical ethanol, methanol and sodium hydrogen carbonate $NAHCO_3$ were purchased from Sigma-Aldrich, USA. Standards of phenolic acids (gallic acid [3,4,5-Trihydroxybenzoic acid])

and of flavonoids, Potasium acetate, Quercetin [3,3',4',5,7-Pentahydroxyflavone], and 2,2-dyphenyl-1-picrylhydrazyl(DPPH) were obtained from Sigma Chemicals Co., St Louis, MO, USA. The Folin-Ciocalteu's phenol reagent and Aluminium chloride ($AlCl_3$) were from Fluka Chemie AG, Buchs, Switzerland. All other solvents and chemicals were of analytical grade.

2.2 Mushroom Material

Pleurotus ostreatus and Pleurotus eous originally from Mauritius, were cultivated on rice straw composted for 28 days, supplemented with 1% $CaCO_3$ and 10% wheat bran as described by Kortei and Wiafe- Kwagyan, [22], at the Mycology Unit of Food Research Institute, Council for Scientific and Industrial Research, Accra, Ghana. Growth and harvesting was from the period of September to December, 2013. The collected mushroom materials were solar-dried at temperature range of (50-60°C) to a moisture content of about 12%.

2.3 Chemical and Proximate Analysis

The samples were analyzed for chemical composition using the [23] procedures. Moisture was analyzed after drying in 105°C until reaching the final mass (AOAC No. 930.04). The crude protein (N × 4.38; N, nitrogen) was estimated by the Kjeldahl method (AOAC No. 978.04), the crude fat was determined by extracting a sample with diethyl ether in a Soxhlet apparatus (AOAC No. 920.39) and the ash content was determined by incineration at 460°C (AOAC No. 920.05). Total carbohydrates were calculated by difference [24].

Estimation of minerals was done by digesting mushroom sample (1 g) in a digestion mixture consisting of 18 M sulfuric acid, 12M Perchloric acid and 16M nitric acid (0.5:1.0:0.5 by volume). After proper dilution, content of Zn, Cu, Fe, Ca, Mg, Mn, Na and K were determined by measuring atomic absorption spectrophotometry [25]. An appropriate dilution was done with 0.4% lanthanum (w/w) to overcome ionic interference during the estimation of Ca and Mg. Estimation of phosphorus was done colorimetrically using the method of Fiske and Subbaraw [26].

2.4 Determination of Metabolizable Energy Content

Fat, protein or carbohydrates can supply energy. Metabolizable energy is calculated according to Atwater's procedure [27] as the following formula:

ME (Kcal /100g) = [(3.5 X CP) + (8.5 X CF) + (3.5 X NFE)]
Where, ME = Metabolic Energy; CP = % Crude Protein; CF = % Crude Fat; NFE = % Nitrogen Free Extract (carbohydrate)

2.5 Total Soluble Solids

Estimation was done by dissolving 1g of fresh mushroom sample in 10 cm^3 distilled water and sample detected by a hand held optical refractometer (RF30, Extech instruments, U.S.A).

2.6 Preparation of Mushroom Extracts

Mushroom extracts were prepared according to method as described by Stankovic, [28] with modifications. 10 g of prepared mushroom material was transferred to dark-coloured flasks and mixed with 200 ml of solvents with different polarities (de-ionised water, methanol, ethanol) respectively and stored at room temperature. After 24 h, infusions were filtered through Whatman No. 1 filter paper and residue was re-extracted with equal volume of solvents. After 48 h, the process was repeated. Combined supernatants were evaporated to dryness under vacuum at 40°C using rotary evaporator. The obtained extracts were kept in sterile sample tubes and stored in a refrigerator at 4°C.

2.7 Determination of Total Phenolic Contents in the Mushroom Extracts

The concentration of phenolics in mushroom extracts was determined using spectrophotometric method [29]. Methanolic solution of the extract in the concentration of 1 mg/ml was used in the analysis. The reaction mixture was prepared by mixing 50 ml of methanolic solution of extract; 2.5 ml of 10% Folin-Ciocalteu's reagent (v/v) dissolved in water and 2.5 ml 7.5% $NaHCO_3$. Blank was concomitantly prepared**,** containing 50 ml methanol, 2.5 ml 10% Folin-Ciocalteu's reagent dissolved in water and 2.5 ml of 7.5% of $NaHCO_3$. The samples were thereafter incubated in a thermostat at 45°C for 45 min. The

absorbance was determined using spectrophotometer at λmax = 760 nm. The samples were prepared in triplicate for each analysis and the mean value of absorbance was obtained. The same procedure was repeated for the standard solution of gallic acid and the calibration line was construed. Based on the measured absorbance, the concentration of phenolics was read (mg/ml) from the calibration line; then the content of phenolics in extracts was expressed in terms of gallic acid equivalent (mg of GA/g of extract).

$$\text{Concentration (mg/GAE)} = \frac{\text{Concentration (X)} \times \text{Volume}}{\text{Weight of sample}} \quad (1)$$

2.8 Determination of Flavonoid Concentrations in the Mushroom Extracts

The content of flavonoids in the examined mushroom extracts was determined using spectrophotometric method [30]. The sample contained 500 ml of ethanol solution of the extract in the concentration of 1 mg/ml and 100 ml of 10% $AlCl_3$ solution dissolved in 1500 ml ethanol. The samples were incubated for an hour at room temperature. The absorbance was determined using spectrophotometer at λmax = 415 nm. The samples were prepared in triplicate for each analysis and the mean value of absorbance was obtained. The same procedure was repeated for the standard solution of 500 ml of Quercetin, 100 ml of Potassium acetate (10%) and the calibration line was construed. Based on the measured absorbance, the concentration of flavonoids was read (mg/ml) on the calibration line; then, the content of flavonoids in extracts was expressed in terms of Quercetin equivalent (mg of QE/g of extract).

2.9 Evaluation of Antioxidant Activity

The ability of the mushroom extract to scavenge DPPH free radicals was assessed by the standard method [31], adopted with suitable modifications [32]. The stock solution of extracts were prepared in methanol to achieve the concentration of 1 mg/ml. Dilutions were made to obtain concentrations of 0.01, 0.05, 0.1, 0.15 and 0.2 mg/ml. Diluted solutions of sample (200 ml each) were mixed with 3800 ml of methanolic solution of DPPH. After 30 mins of incubation in darkness at room temperature (23°C), the absorbance was recorded at 517 nm. Control sample contained all the reagents except the extract. Percentage inhibition was calculated using equation 3. The data were presented as mean values±standard deviation (n = 3).

$$\% \text{ inhibition} = \frac{\text{A of control} - \text{A of sample}}{\text{A of control}} \times 100 \quad (2)$$

$$\text{Scavenging Activity} = 100 - \frac{As}{Ac} \times 100 \quad \text{or} \quad 1 - As/Ac \quad (3)$$

2.10 IC_{50} Values

Inhibitory concentration of 50% (IC_{50}) was calculated by plotting a graph of concentration and % inhibition. A linear regression was estimated to plot x-y and fit data with a straight line. From linear equation y=mx + c. Where y=50 and x calculated.

2.11 Statistical Analysis

All experimental measurements were carried out in triplicate and are expressed as average of three analyses±standard deviation. The magnitude of correlation between variables was done using a SPSS (Chicago, IL) statistical software package (SPSS for Windows, version. XVI, 2004).

3. RESULTS AND DISCUSSION

3.1 Total Phenolic Content

By manipulating the regression equation of gallic acid calibration curve (the standard curve: y= 1.227x – 0.003, r^2 = 0.988), the total phenolic content of each extract was calculated and expressed as gallic acid equivalent (GAE) to facilitate the comparison [33]. Total phenolic contents (TPC) of *P. ostreatus* (EM-1) ranged between 3.57- 4.95 mgGAE/g while *P. eous* ranged between 3.82- 5.66 mgGAE/g (Table 1). Methanolic and aqueous extracts showed no significant difference (P>0.05). However, ethanolic extracts showed significant difference (P<0.05). The results obtained were in the range of results reported by [34] who investigated the TPC of *Coprinus* spp., *Volvariella esculenta* and *Termitomyces robusta.* However results obtained were lower than values of 27.44- 49.75 mgGAE/g of plant extract of the species *Marrubium pergrinum* L. (Lamiaceae) reported by [28]. Phenolic compounds have been reported to be the major antioxidant components found in

mushrooms, whereas other potential antioxidants such as ascorbic acid, β-carotene, lycopene, and γ- tocopherol have only been found in very small amounts [35,24,36].

Table 1. Total Phenolic Contents of *P. ostreatus* (EM-1) and *P. eous* (P-31)

Species	Methanol mgGAE/g	Aqueous mgGAE/g	Ethanol mgGAE/g
Pleurotus ostreatus (EM-1)	3.57[a]	3.82[bc]	4.95[c]
Pleurotus eous (P-31)	3.96[a]	3.82[bc]	5.66[d]

Means with same letters in a column are not significantly different (P>0.05)

3.2 Flavoniod Content

Flavonoid content was obtained by manipulating the quercetin calibration curve (the standard curve equation: y= 0.005x + 0.00, r^2= 0.986)) the content of each extract was calculated and expressed in terms of quercetin equivalent (QE). The flavonoid content of *P.ostreatus* and *P.eous* ranged 226.4- 622.6 mgQE/g and 311.3- 367.9 mgQE/g respectively (Table 2). Results obtained for the samples showed significant difference (P<0.05). The flavonoid concentrations of *P. ostreatus* were found to be lower than works of some authors [17,37,38]. Nonetheless, the values recorded were higher than and was contrary to works of Iwalokun et al. [39] and Mattila et al. [40] who found no flavonoids in *Pleurotus* spp. as they investigated the comparative phytochemical, antimicrobial and antioxidant properties as well as vitamins content, mineral elements and some phenolic compounds in cultivated mushrooms respectively. The observed differences in results could be due to different composition of a given species as affected by many variables. The use of different techniques and some adopted modifications for analysing nutrients also limits the comparison of results from different studies. These factors make comparison of results obtained by different investigators impossible to a large extent. However, data generated by other investigators can be used to generate estimates of probable nutritive value of given mushrooms [41].

3.3 Free Radical Scavenging Activity (DPPH)

The antioxidant activity of three different extracts from the *Pleurotus* species is expressed in terms of percentage of inhibition (%) and IC_{50} values (mg/ml) (Fig. 1). Parallel to examination of the antioxidant activity of plant extracts, the values for two standard compounds were obtained and compared to the values of the antioxidant activity. The standard substance was quercetin.

The free radical scavenging activities of *P. ostreatus* (EM-1) and *P. eous* (P-31) ranged 9.0-13 mgGAE/g and 10-13 mgGAE/g respectively (Table 3). No significant difference (P>0.05) was observed in the results for both species. Among the three extracts and standard tested for the in vitro antioxidant activity using the DPPH method, the methanolic extracts for both *P. ostreatus* and *P. eous* recorded the highest values of 0.25 and 0.46 mg/ml respectively (Fig.1). The extracts of ethanol were 1.35 and 1.35 mg/ml while aqueous 1.25 and 1.35 mg/ml showed IC_{50} values for *P. ostreatus* and *P. eous* respectively (Fig. 1). There was however no significant difference (P>0.05) among all the extracts for IC_{50} values for both species. The results obtained were in the same range as results reported by [42] and [43]. However, this was higher than results reported by [44]. The antioxidant activity with IC_{50}< 10 mg/ml value is the smallest (good antioxidant) are the ethanol extract and included in the category of extremely powerful antioxidants [45,38] .

3.4 Proximate Analysis

Chemical analysis of the two fresh *Pleurotus* spp. revealed corresponding values of 80.51±0.63 and 86.81±0.63, 6.11±0.14 and 9.84±0.10, 17.75±0.17 and 15.91±0.17, 15.22±0.17 and 24.10±0.39, 2.01±0.24 and 4.73±0.28, 55.41±2.70 and 45.59±2.40 then 15.00±0.18 and 15.00±0.18 for moisture, ash, fibre, protein, lipid, carbohydrates and total soluble solids respectively (Table 2). All the parameters investigated showed significant differences (P<0.05) with the exception of total soluble solids. The nutrient content of mushroom varies according to the substrate composition [46]. Results obtained (Table 4) indicated accordance with previous works [47-50]. However some results were not in agreement with results obtained by other researchers [51-54]. Metabolizable energies calculated for *P. ostreatus* and *P. eous* were 300.61±1.50 Kcal and 321.33±1.50 Kcal respectively (Fig. 2). The energies differed significantly (P<0.05). Results were in the same range as results of previous researchers [55-58]. However, Pogon et al. [59] reported results of significantly (P<0.05) lower

values of the range 38-119 Kcal as they investigated the culinary and storage conditions on the quality of *Lactarious deliciosus* mushrooms.

Table 2. Total Flavonoids Contents of *P. ostreaus* (EM-1) and *P. eous* (P-31)

Species	Methanol mgQE/g	Aqueous mgQE/g	Ethanol mgQE/g
Pleurotus ostreatus (EM-1)	622.6^{ed}	226.4^{fw}	226.4^{gc}
Pleurotus eous (P-31)	311.3^{f}	339.6^{ft}	367.9^{bf}

Means with same letters in a column are not significantly different (P>0.05)

3.5 Mineral Contents

Mineral composition of mushrooms reveals the growth conditions. Minerals in the diet are essential for metabolic reactions, healthy bone formation, transmission of nerve impulses, regulation of water and salt balance [60]. On the contrary, Vetter [61] reported that the occurrence and distribution of different toxic components in certain mushrooms does not only represent a theoretical mycological problem but also has practical environmental and toxicological aspects. In this study the mineral content of the two *Pleurotus* spp. varied significantly ($P<0.05$) according to their elemental bio-accumulative potentials in their growth environment. The results of elemental composition of *P. ostreatus* and *P. eous* are showed in Table 5.

Table 3. Free radical scavenging capacity DPPH (% inhibition) of *P. ostreaus* (EM-1) and *P. eous* (P-31)

Species	Methanol mgQE/g	Aqueous mgQE/g	Ethanol mgQE/g
Pleurotus ostreatus (EM-1)	13^{hv}	10^{c}	9.0^{eb}
Pleurotus eous (P-31)	12^{hv}	10^{c}	10^{eb}

Means with same letters in a column are not significantly different (P>0.05)

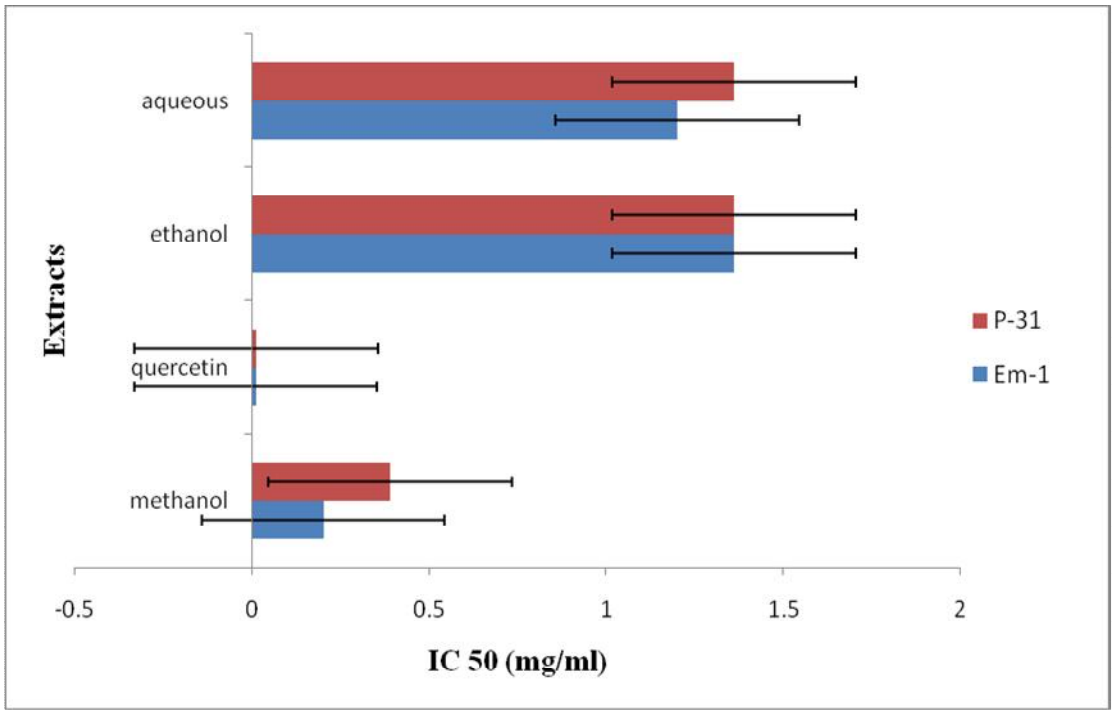

Fig. 1. Comparative half maximal inhibitory concentration (IC_{50}) of *P.ostreatus* (EM-1) and *P.eous* (P-31) for free radical scavenging activity by DPPH radical. 1- Methanol 2- Quercetin (standard) 3- Ethanol 4- Aqueous

Table 4. Comparative chemical composition of *P. ostreatus* and *P. eous* (g/100g)

Parameter	Mushroom Species	
	***P. ostreatus* (EM-1)**	***P. eous* (P-31)**
Moisture	80.51±0.63[a]	86.81±0.63[b]
Ash	6.11±0.14[de]	9.84±0.10[b]
Fibre	17.75±0.17[ab]	15.91±0.17[ab]
Protein	15.22±0.17[ef]	24.10±0.39[e]
Lipid	2.01±0.24[bc]	4.73±0.28[a]
Carbohydrate	55.41±2.70[hw]	45.59±2.40[bc]
Total soluble solids (Brix^o)	15.00±0.18[b]	15.00±0.18[b]

Means with same letters in a row are not significantly different (P>0.05)

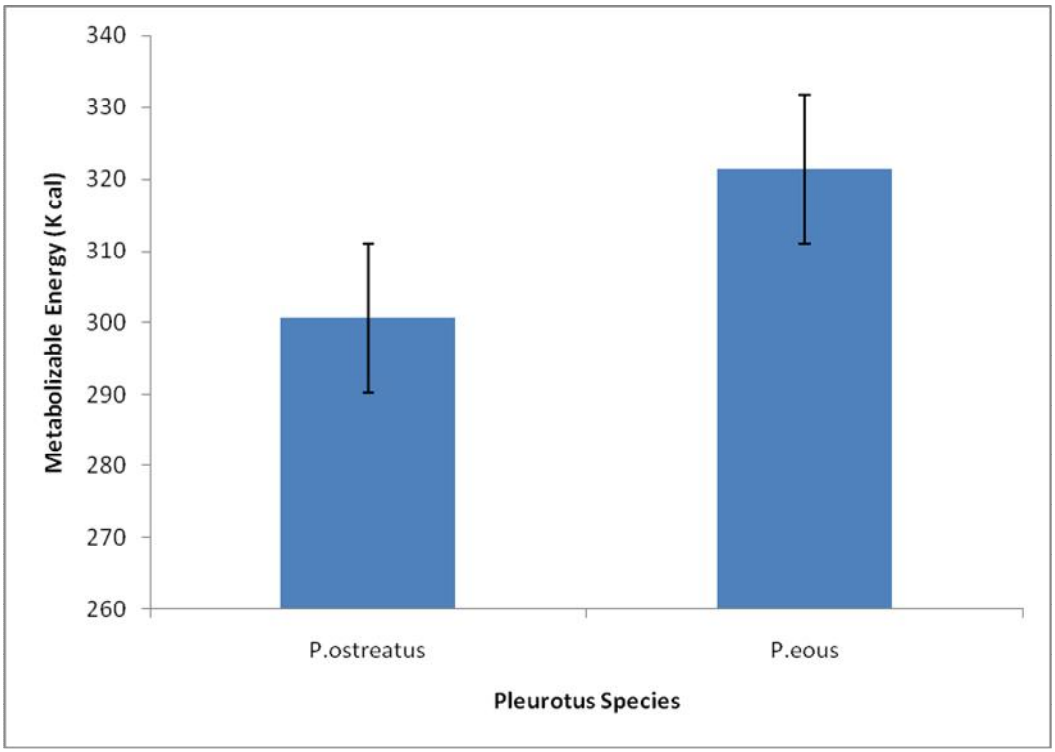

Fig. 2. Comparative metabolizable energies (Kcal/100g) of *P. ostreatus* and *P. eous*

Sodium contents for the two *Pleurotus* spp. were 14.10±0.7 and 6.00±0.15 mg/100g for both species respectively. There was a significant difference (P<0.05) and these results were in agreement with results of [62]. However, results were lower than results reported by [55]. Sodium is good for patients with hypertension [63] however relatively less amounts are needed.

Potassium content was found to be 31.9±0.5 and 12.15±0.35 mg/100g for both species respectively. *P. ostreatus* was significantly higher (P<0.05) than *P. eous*. Results tally with [62]. Although potassium is an important mineral, many people do not get enough of it from the food intake. It aids in the maintenance of normal fluid and mineral balance, which helps control blood pressure. It also plays a role in making sure nerves and muscles, including the heart, function properly [63]. USDA [64] reported that mushrooms have 98-376 mg of potassium per 84 gram serving, which is 3-11 percent of the Daily Value.

Magnesium content was found to be 1.77±0.18 and 0.76±0.01 mg/100g for both species respectively. There was no significant difference (P>0.05) observed. The results obtained agreed

with results reported by [65]. However these results were lower than results reported by [66].

Copper content was found to be 0.02±0.001-0.01±0.001 mg/100g for both species respectively. There was no significant difference (P>0.05) observed and were lower than results reported by [67]. Copper helps in the production of red blood cells, which carry oxygen throughout the body and also helps keep bones and nerves healthy [63].

Zinc content was found to be 0.03±0.001-0.19±0.004 mg/100g for both species respectively. There was significant difference (P<0.05) observed and agreed with results reported by [55] and [66]. Results obtained were within the Recommended Daily Intake (RDI) of trace elements reported by ICMR [68].

Iron content was found to be 0.37±0.1 - 0.23±0.01 mg/100g. There was no significant difference (P>0.05) observed and agreed with results reported by [55].

Manganese content was found to be 0.04±0.001-0.02±0.01 mg/100g for both species respectively. There was no significant difference (P>0.05) observed and results agreed with [67]. Results obtained were within the Recommended Daily Intake (RDI) of trace elements reported by ICMR [68].

Phosphorus content was found to be 6.41±0.35-7.60±0.45 mg/100g for both species respectively. There was no significant difference (P>0.05) observed. Since recommended daily intake (RDI) of P is 0.7g, *P. ostreatus* and *P. eous* are both high in P content, therefore can contribute to human nutrition as good source of Phosphorus [69]. Results were in disagreement with [45].

Calcium content was found to be 11.02±0.3-0.37±0.03 mg/100g for both species respectively. There was statistical difference (P<0.05) observed and agreed with results reported by [66]. Calcium aids in formation of strong bones and teeth [64].

Lead content was found to be 0.02±0.001-0.10±0.001 mg/100g for both species respectively. There was no statistical difference (P>0.05). Results obtained fell within the same range as results reported by researchers [55]. According to [70] tolerable weekly intake of lead is 0.025 mg/kg body weight. The lead levels in all studied species are very low and thus, these mushroom species are safe for consumption.

Nitrogen content was found to be 3.61±0.02 - 3.60±0.25 mg/100g for both species respectively. There was no statistical difference (P>0.05) observed. Results were in accordance with results reported by [67]. The body utilizes nitrogen for promoting protein synthesis, the creation of compounds and amino acids that influence growth, hormones, brain functions and the immune system. About 0.83 gram of protein per kilogram per day is considered sufficient to cover nitrogen requirements, according to I.D.F. [71]. For healthy people, a recent study by [72] suggested a maximum intake of 2 to 2.5 g/kg of body weight per day.

Table 5. Comparative mineral composition of *P. ostreatus* and *P. eous*

Element (mg/100g)	*P. ostreatus* (EM-1)	*P. eous* (P-31)
Sodium	14.10 ± 0.7^{ab}	6.00 ± 0.15^{c}
Potassium	31.9 ± 0.5^{cd}	12.15 ± 0.35^{e}
Magnesium	1.77 ± 0.18^{e}	0.76 ± 0.01^{fg}
Copper	0.02 ± 0.001^{a}	0.01 ± 0.001^{a}
Zinc	0.03 ± 0.001^{bf}	0.19 ± 0.004^{dc}
Iron	0.37 ± 0.1^{ab}	0.23 ± 0.01^{ab}
Manganese	0.04 ± 0.001^{bc}	0.02 ± 0.01^{bc}
Phosphorus	6.41 ± 0.35^{e}	7.60 ± 0.45^{e}
Calcium	11.02 ± 0.3^{hd}	0.37 ± 0.03^{a}
Lead	0.02 ± 0.001^{b}	0.10 ± 0.001^{b}
Nitrogen	3.61 ± 0.02^{a}	3.60 ± 0.25^{a}

Means with same letters in a row are not significantly different (P>0.05)

4. CONCLUSION

Based on the data obtained in this study, we can conclude that the analyzed *Pleurotus spp*. are highly nutritious and so could be adapted locally and nationally by integrated into nutritional projects of countries to curtail protein malnutrition. Additionally, their medicinal attributes are not to be over emphasized. However, *P. eous* was the overall best based on our findings. Further research needs to done on other species inter or intra related to ascertain their nutritional, medicinal, chemical etc. attributes to avoid speculations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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