

ASSESSMENT OF HEAVY METALS IN MUSHROOM SPECIES OBTAINED IN AKURE, NIGERIA

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Abstract: *The aim of this study was to determine the heavy metal concentrations of seven mushroom species obtained in Akure, a town in Southwest of Nigeria. The samples were pre-processed, ashed, dissolved in distilled water with drops of HCl, filtered and the resultant solution was used in the analysis. The values obtained for Manganese was the most prominent (2.66 – 4.57mg/100g) while lead was the least (0.60 – 1.68mg/100g). Cadmium was not detected in all the species. Generally, from the results obtained there were no significant differences in the accumulation of individual elements by mushrooms. Comparing the values here with the recommended dietary allowances (RDA), therefore the levels of these elements are not toxic to consumers.*

Keywords: *Heavy metals, fungal, RDA, consumers, accumulation of metals, Nigeria*

1. INTRODUCTION

The species of plants which are of the fungal lineage include mushrooms, rusts, smuts, puffballs, truffles, morels and yeasts (Blackwell et al., 2011). They belong to the family of plants called Basidiomycetes. More than 700, 000 species of these fungi have been described, although some estimates have suggested that the total number of about 1.5 million species may exist (James et al., 2006). They are used as dietary supplements and complementary medicine where they are employed as anticancer, antiviral, immunopotentiating, hypocholesterolemic and hepatoprotective agents. In fact, it has been asserted that the constant intake of either mushrooms or mushroom nutraceuticals makes people fitter and healthier. In addition, the cultivation of this class of plants also helps in the conversion of agricultural and forest wastes into useful matter thus reducing environmental pollution (Osemwegie et al., 2006). Mushrooms have been used for dyeing wood and other natural fibres (Abulude, 2013) and it has been asserted that their use for this purpose, dated back to the prehistoric time of synthetic dyes (Oghenekaro et al., 2008).

The presence of heavy metals in the environ has been a major public health concern, their removal from the environment is deemed important to the protection of environmental health. According to Quarcoo and Adotey (2013), mushrooms absorb heavy metals from a substrate via spacious mycelium. Age and the size of the fruiting body are of less importance. The proportion of the metal content originating from the atmospheric depositions seems to be also of less importance due to the short lifetime of a fruiting body, which is usually 10-14 days. Mushrooms are also known to be capable of bio-accumulating more heavy metals in their fruit bodies since some of these heavy metals are natural components of the earth's crust.

The objective of the present work was to determine the potential health risk contents of six trace elements in fruiting bodies of widely consumed mushroom species grown in Akure, Southwest, and Nigeria.

2. MATERIALS AND METHODS

2.1 Source of Materials and Sample Pre-treatment

The mushrooms; *Lentinus subnudus* Berk (M1), *Chlorophyllum molybdites* (M2), *Volvariella esculenta* (M3), *Coprinus tramentarius* (M4), *Pleurotus ostreatus* Jacq (M5), *Termitomyces microcarpus* (M6) and *Pleurotus pulmonarius* (M7) were collected from the Federal College of Agriculture campus, Akure, Ondo State, Southwest part of Nigeria. The bad or rotten samples were sorted out. The samples were oven dried at 65oC for 72 hours and were then pounded into powdered form using porcelain pestle and mortar. The milled samples were then sieved with a 2mm mesh sized sieve and stored in waterproof polyethylene bags at room temperature for further analysis.

2.2 Mineral Compositions

The minerals were analyzed from solutions obtained by first dry-ashing the samples at 5500C to constant weight and dissolving the ash in 100cm³ volumetric flasks using distilled water with a few drops of concentrated hydrochloric acid. The minerals were determined using atomic absorption spectrophotometer (AAS). All determinations were reported on dry weight basis. All determinations were made in triplicates and the results were expressed as the mean ± SD. The Pb/Zn ratio was calculated for each of the samples. Analysis of variance (ANOVA) was used to determine the significant differences in the mean concentrations of the metals between the samples. These statistical analyses were determined with the SPSS package.

3. RESULTS

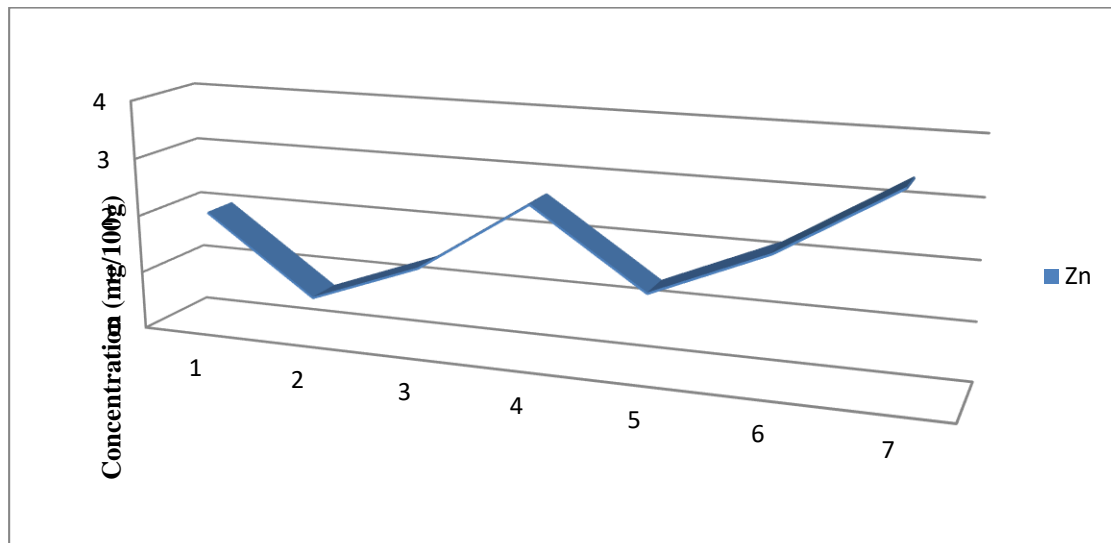


Figure 1: Zinc Content of the Seven Mushroom Samples
 *Same as footnote Table 1

Lentinus subnudus (1), *Chlorophyllum molybdites* (2), *Volvariella esculenta* (3), *Coprinus atramentarius* (4), *Pleurotus ostreatus* (5), *Termitomyces microcarpus* (6) and *Pleurotus pulmonarius* (7)

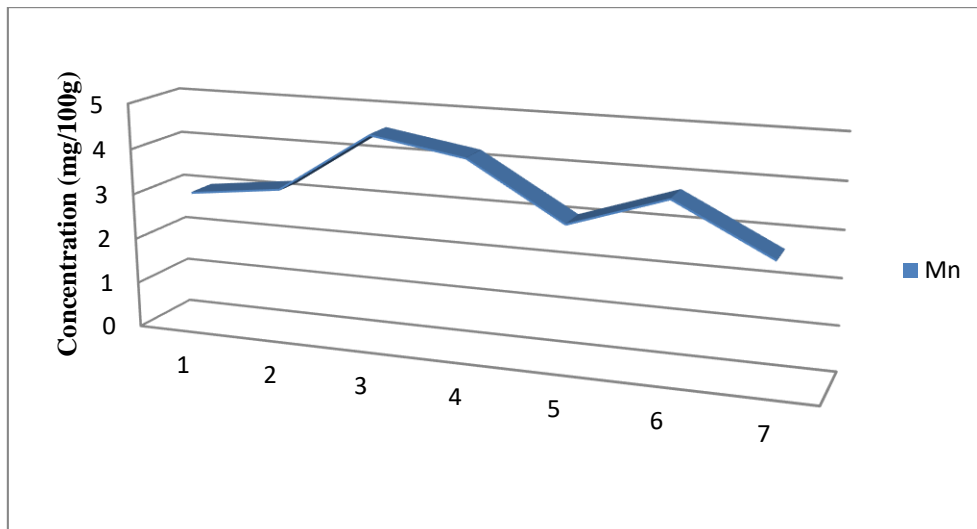


Figure 2: Manganese Content of the Seven Mushroom Samples
*Same as footnote Table 1

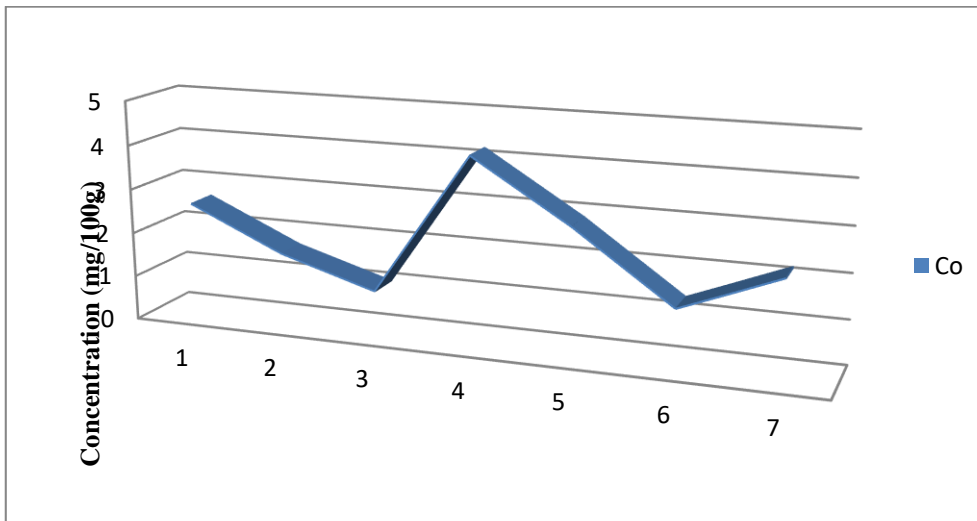


Figure 3: Cobalt Content of the Seven Mushroom Samples
*Same as footnote Table 1

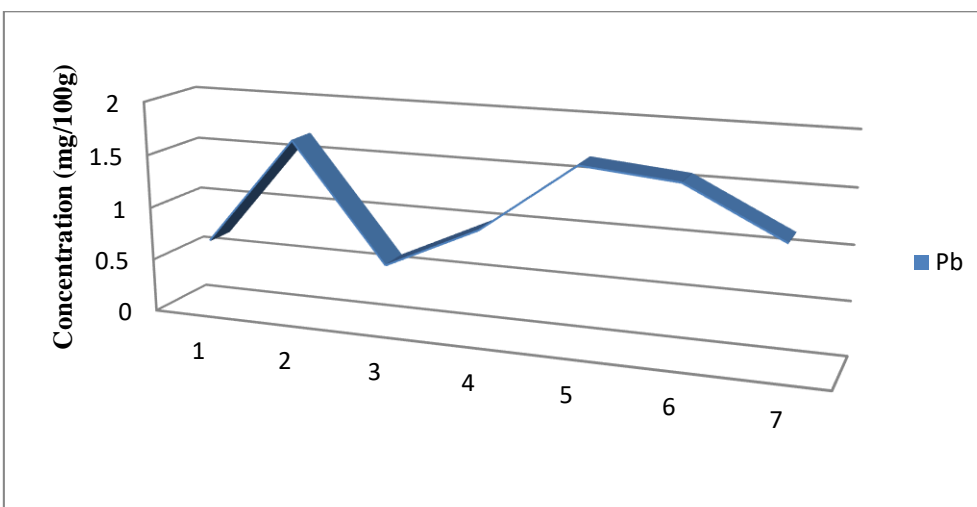


Figure 4: Lead Content of the Seven Mushroom Samples
*Same as footnote Table 1

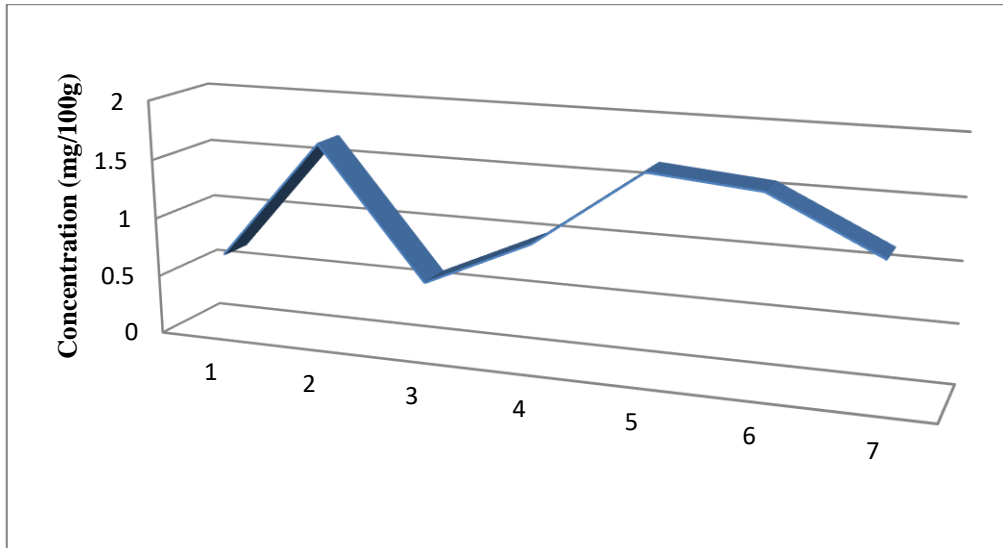


Figure 5: Copper Content of the Seven Mushroom Samples
*Same as footnote Table 1

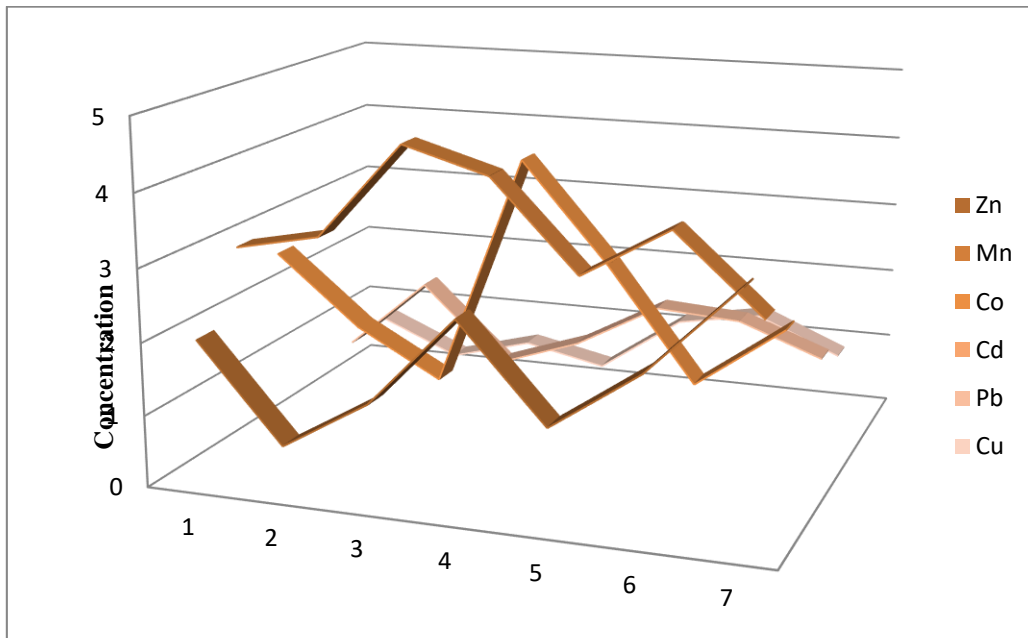


Figure 6: The Results of Heavy Metal Compositions of the Selected Species of Mushrooms (mg/100g)
*Same as footnote Table 1

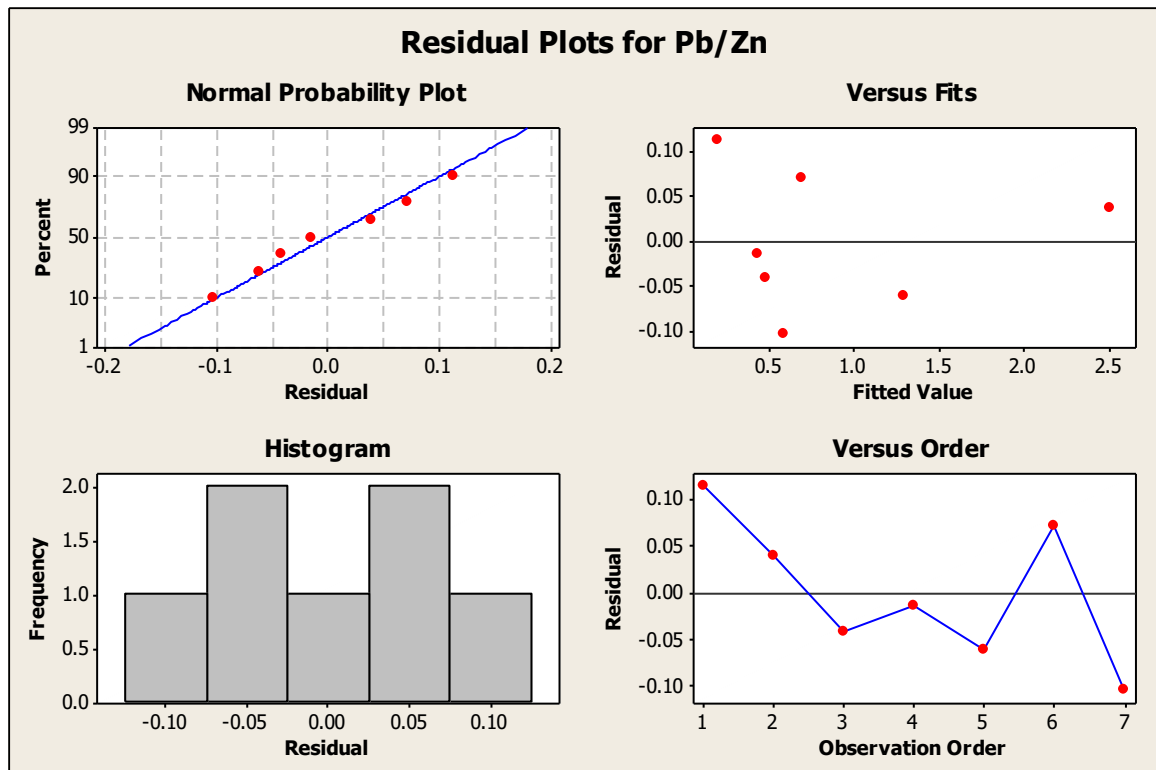


Fig 7: Residual Plots for Pb/Zn

*Same as footnote Table 1

nd – Not detectable, *Lentinus subnudus* Berk (M1), *Chlorophyllum molybdites* (M2), *Volvariella esculenta* (M3), *Coprinus tramentarius* (M4), *Pleurotus ostreatus* Jacq (M5), *Termitomyces microcarpus* (M6) and *Pleurotus pulmonarius* (M7)

All values were expressed as averages of triplicate determinations \pm the standard deviations and values bearing the same superscripts in the same row are significantly not different ($p > 0.05$).

4. DISCUSSION

The study determined the heavy metals in the mushroom samples. The data is presented as follows (mg/100g): 0.66 – 2.64 (Zn), 2.91 – 4.57 (Mn), 0.54 – 2.87 (Co), Not detected (Cd), 0.60 – 1.68 (Pb) and 0.23 – 1.14 (Cu). The mean value of each metal composition is shown in Fig 1 – 6 and Table 1. The results indicated low value for Pb while the highest was recorded for Mn. This depicted that this low concentration of Pb might be connected to the low vehicular traffic within the vicinity of collection (Abulude et al., 2007). The high value obtained for Mn confirms the effects of traffic related sources such as corrosion of metallic part, concrete materials, reentrained dust from roads and tear and wear of tyres and engine parts. When the results of Mn and Pb obtained here were compared with the results elsewhere - Lagos, Iran, India, USA and China (Kord and Kord, 2011; Abida et al., 2009; Olukanni and Adeoye, 2012).

Table 1: The Results of heavy metal Compositions of the Selected Varieties of Mushrooms (mg/100g) and Pb/Zn ratio

Parameters	Samples						
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇
Zn	2.15±0.20 ^c	0.66±0.02 ^a	1.37±0.02 ^b	2.64±0.02 ^e	1.33±0.02 ^b	2.17±0.02 ^c	2.35±0.03 ^d
Mn	2.91±0.07 ^b	3.23±0.02 ^d	4.57±0.02 ^g	4.22±0.03 ^f	3.08±0.02 ^c	3.76±0.03 ^c	2.66±0.02 ^a
Co	2.63±0.02 ^f	1.67±0.02 ^d	1.03±0.02 ^b	0.54±0.20 ^a	2.87±0.02 ^g	1.34±0.02 ^c	2.19±0.02 ^e
Cd	Nd	nd	Nd	nd	Nd	nd	Nd
Pb	0.67±0.02 ^a	1.68±0.02 ^c	0.60±0.02 ^a	1.10±0.02 ^b	1.63±0.02 ^c	1.67±0.02 ^c	1.12±0.02 ^b
Cu	0.75±0.02 ^d	0.23±0.23 ^a	0.57±0.02 ^c	0.34±0.03 ^b	1.14±0.02 ^f	1.32±0.02 ^g	0.85±0.02 ^e
Pb/Zn Ratio	0.31	2.55	0.44	0.42	1.23	0.77	0.48

nd – Not detectable, *Lentinus subnudus* Berk (M₁), *Chlorophyllum molybditis* (M₂), *Volvariella esculenta* (M₃), *Coprinus tramentarius* (M₄), *Pleurotus ostreatus* Jacq (M₅), *Termitomyces microcarpus* (M₆) and *Pleurotus pulmonarius* (M₇)

All values were expressed as averages of triplicate determinations ± the standard deviations and values bearing the same superscripts in the same row are significantly not different (p > 0.05).

It was observed that the results for these mushroom samples were far below. The average zinc contents also differed significantly ($p < 0.05$) with *Pleurotus pulmonarius* having the highest while *Chlorophyllum molybdites* had the lowest.

The average copper contents also differed significantly ($p < 0.05$) where *Termitomyces microcarpus* had the highest while *Chlorophyllum molybdites* had the lowest (Table 1). Close relationships between metals concentrations traffic and anthropogenic sources have been shown by Kord and Kord, 2011; Abida et al., 2009; Olukanni and Adeoye, 2012 on mushroom samples.

The concentrations of Zinc (Zn) observed in the species are shown in Table 1. The highest concentration of Zn was seen in *Coprinus tramentarius* (M4), ($2.64 \pm 0.02 \text{mg}/100\text{g}$) as compared to least *Chlorophyllum molybdites* which had a concentration of $0.66 \pm 0.02 \text{mg}/100\text{g}$. An independent statistical analysis performed at 95% Confidence Interval revealed no statistically significant difference between the zinc contents found in all the mushrooms at $p > 0.05$. The Zn content obtained in this work were below *Lentinula laedodes* ($9.44 \pm 0.24 \text{mg}/100\text{g}$), *Pleurotus florida* ($5.06 \pm 0.04 \text{mg}/100\text{g}$) and *Pleurotus djamor* ($9.21 \pm 0.03 \text{mg}/100\text{g}$) recorded by Mallikarjuna et al., (2013)

Below detection limits was recorded for Cadmium in all the samples. Our results are in good agreement with Mallikarjuna et al., (2013) for *Lentinula laedodes*, *Lentinula cladopus*, *Pleurotus florida*, and *Pleurotus djamor*. The occurrence and distribution of different toxic components in certain mushrooms is not only a theoretical mycological problem but also has practical environmental and toxicological aspects. According to the FAO/WHO (1990) tolerable weekly intake of cadmium and lead are 0.007 and 0.025 mg/kg body weight, respectively. The lead and cadmium levels in all studied species are below detection limits and thus, these mushroom species are safe for consumption.

The Pb/Zn ratio of the samples was calculated. The ratio ranged from 0.35 – 2.55. It is far above the results (0.06 – 0.18) obtained by Sendaet al., (2014) in precipitation at Tsu City and within 0.081 – 3.17 in goats' urine obtained in Nigeria by Abulude et al., 2006. According to the authors, their reference data showed that the pollution in their sample was not caused by the pollutant transport from the continent, but the local pollutants, this maybe the same reason in our case. The Residual Plots for Pb/Zn are shown in Fig 7. The plots revealed that at residual levels of 0.05 the histogram frequency was 2, also 2 was found in the observable order. It could be deduced that the samples were low in the residue of the Pb and Zn that may be caused by the low vehicular traffic within the environment of sampling.

5. CONCLUSION

The results indicated low value for Pb while the highest was recorded for Mn. It is gratifying to note that cadmium was below detection limit. However, it is recommended that the vicinity monitoring should be emphasized. The measured Pb/Zn ratio was identical, it can be deduced that the high values may have been caused by local pollutants.

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