

DETERMINATION OF MINERAL ELEMENTS, HEAVY METALS INCLUDING MINERAL AND MOLAR RATIOS IN FRESH AND CANNED *CALOCYBE INDICA* (MILKY MUSHROOM).

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Abstract

This study was conducted to evaluate the mineral composition of canned oyster mushroom stored for different storage period. The mushroom was purchased, processed and canned using the method. The mineral composition of the *Calocybe indica* mushroom was determined using the standard methods. The result of the mineral composition of the canned *Calocybe indica* showed that the zinc, sodium, potassium and calcium varied from 0.09 to 0.40, 0.01 to 11.60, 2.17 to 8.68, 0.04 to 0.40 and 0.02 to 1.40 respectively. Heavy metals of lead, nickel, copper and chromium varied from 0.00 to 0.01, 0.00, 0.00 to 0.03 and 0.02 to 0.03 respectively while mineral/anti-nutrient

Introduction

Canning is a classical and widely accepted approach for long-term preservation (Cruz *et al.*, 2022). It is a method of preserving in which the food contents are processed and sealed in an air tight container (jars like Mason jars, and steel and tin cans) and it provides a long shelf life of foods in an edible state from one to many years (Karaaslan and Havuz, 2014). The extensive heat treatment through the steps of cooking and sterilization should

molar ratio of phy/ca, phy/zn,, phy/fe and phyxca/zn varied from 0.0005 to 0.2667, 0.2131 to 0.5500, 0.1830 to 2.6667 and 0.0003to 4.9678 respectively. Results from this study have showed that each of the canned *C. indica* mushroom samples investigated were rich in mineral content excluding zinc. However, all the mineral content was observed to significantly increase after canning and during the storage period. The mineral molar ratio also revealed no clear progression.

Key words: *Calocybe indica*, chromium, heavy metals, mineral element and molar ratio.

Inactivate enzymes, microorganisms and their spores, creating a different product and extending food shelf life. Preservation of food by canning has turn out to be considerably more specialized in recent years (Karaaslan and Havuz, 2014).

According to Yuwa-Amornpitak *et al.*, (2020) mushrooms are sources of beneficial bioactive substances, such as β -glucan, flavonoids, glycoproteins, sesquiterpenes, carotene, and phenolic compounds. These secondary metabolites are effective antioxidants that enhance human health. Mushrooms constitute a source of nine essential amino acids (histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine) that humans cannot synthesize.

Materials

The raw oyster mushroom (*C. indica*) was grown under controlled environment. The mushroom was selected with absolute care to ensure wholesomeness.

Methodology

Preparation of Mushroom

The freshly harvested fruit bodies were collected. After harvesting, the fruit bodies were washed under tap water and cut into vertical slice.

Canning of Milky Mushroom (*Calocybe indica*)

The mushrooms with a stem length of 2cm are preferred and are canned whole, sliced and stems and pieces as per demand. Well graded fresh mushrooms white in colour, without dark marks on either caps or stems are preferred for canning. Canning and sterilization was by the process prescribed by Bernas *et al*, 2006 (figure 1).

Determination of Mineral Elements of Canned Mulky Mushroom for Different Storage Period

The mineral composition of each sample was determined by wet ashing method followed by spectrophotometric reading of the level of mineral. Triplicate samples (1 g) of each sample were ashed in muffle furnace at 450°C for 5-6 hours. The ashed samples and silica dishes were removed and transferred into the desiccators to cool after which the samples were dissolved with 1 ml of 0.5% HNO₃ little distilled water was added and filtered into a clean small plastic bottle using number 43 Whattman filter. Distilled water was later used to dilute the solution up to 50 ml. Atomic absorption spectrophotometer (Buck 201, VGP) was used in determining the mineral content.

The mineral content was calculated using the formula below:

$$\text{Mineral (mg/100 g)} = (\text{RxVxD/Wt})$$

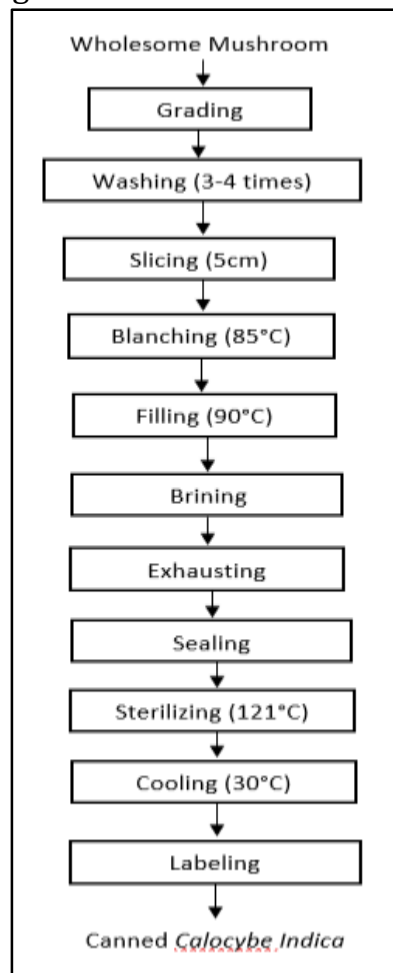
When R = Solution concentration,

V = Volume of sample digested,

D = Dilution factor, and

Wt = Weight of sample. AOAC, 2021

Fig 1 Canning of *Calocybe indica*



Source: Bernas *et al*, (2010)

Results and Discussion

The mineral composition of the fresh and canned milky mushroom (*Calocybe indica*) are presented in Table 1. The zinc, iron, potassium and calcium decrease by 58%, 66% 99% and 25%, respectively after canning. There were significant differences ($p < 0.05$) between sample TWK, FWC, TWK, sample FFC and STC, The sodium content ranged from 0.01-14.00 mg/100g. The highest value was observed in sample TWK while the lowest value was recorded in sample FRM. There were significant differences ($p < 0.05$) among the samples. and also FWC and FFC among other samples. The phytate content varied from 0.19-0.88 mg/100g. The highest value was observed in sample FRM while the lowest value was observed in sample STC. Significant difference ($p > 0.05$) exists among the samples. Thou phytate is not part of mineral elements but it is important to known the proportion in relation to them and effect.

The mineral/ anti-nutrient molar ratio composition of the fresh and canned milky mushroom (*Calocybe indica*) are presented in Table 4.16. The phy/ca, Phy/zn and Phy/fe content of fresh and canned mushroom ranged from 0.0005-3.8000, 0.1450-0.3519 and 0.1519-3.5000 respectively. The values did not show a pathern of change but they are below the critical limits recommended. The Phy x ca/zn content ranged from 0.0003-4.9678. The highest value was observed in sample FRM while the lowest value was recorded in sample FFC and STC.

The heavy metals of the fresh and canned milky mushroom (*Calocybe indica*) are presented in Table 2. The lead, nickel, copper, chromium and caldium contents were determined. The results show very low or not detected of these elements in both fresh and canned *Calocybe indica* sample.

Mineral elements analysed in this work (Na, K, Fe, Ca and Zn) all the results are expressed in mg/100g (Table 1). The values of lead, nickel, copper, chromium and calcium were below the control limits. Since the mushrooms were grown under control environment the values for heavy metals were equally low guarantee the safety of the mushrooms.

Heavy metals present in canned foods (Table 2) may be via plants, uptake in contaminated soil, heavy metal polluted water and from applied agrochemicals (Ojezele *et al.* 2021). In canning toxicology, fruits harvested for processing may become contaminated during canning processes or through leaching from metal containers into the canned product during storage (Ojezele *et al.* 2021). The values of lead, nickel, copper, chromium and cadmium which belong to heavy metal group. The values obtained are either very low or not detected in all the cases and equally below control limits. Since the mushrooms were grown under control environment the safety of the mushrooms are guarantee.

Table 1: Mineral Composition of Fresh and Canned *Calocybe indica* for 6 weeks Storage Period

Sample	Zinc (mg/100g)	Sodium (mg/100g)	Potassium (mg/100g)	Iron (mg/100g)	Calcium (mg/100g)	Phytate (mg/100g)
FRM	0.40±0.01 ^a	0.01±0.00 ^f	8.68±0.47 ^a	0.40±0.10 ^a	1.40±0.05 ^a	0.88±0.02 ^a
FWK	0.17±0.02 ^b	5.40±0.38 ^e	2.99±0.02 ^b	0.30±0.02 ^b	0.02±0.01 ^d	0.54±0.02 ^b
SWC	0.16±0.01 ^b	7.40±0.27 ^d	2.07±0.65 ^c	0.01±0.00 ^c	0.08±0.01 ^b	0.46±0.00 ^c
TWK	0.14±0.01 ^b	8.00±1.52 ^c	2.02±0.01 ^c	0.01±0.00 ^c	0.07±0.01 ^b	0.32±0.01 ^c
FWC	0.02±0.01 ^c	8.35±0.32 ^c	2.14±0.11 ^c	0.02±0.01 ^c	0.04±0.01 ^c	0.25±0.01 ^d
FFC	0.07±0.01 ^c	9.10±0.16 ^b	2.67±0.06 ^b	0.03±0.01 ^c	0.03±0.00 ^c	0.23±0.01 ^d
STC	0.09±0.01 ^c	11.60±0.20 ^a	2.17±0.08 ^d	0.04±0.01 ^c	0.02±0.01 ^d	0.19±0.01 ^e

*Mean with same superscripts in the same column are not significantly different at $p > 0.05$.

Legend:

FMR – Fresh Mushroom

FWK – First Week

SWC – Second Week

TWK – Third Week

FWC – Fourth Week

FFC – Fifth Week

STC – Sixth Week.

Table 2: Heavy Metals of Fresh and Canned Mushroom for Different Storage Period (mg/100g)

Sample	Lead	Nickel	Copper	Chromium	Calcium
FRM	0.01±0.10 ^b	ND	0.03±0.10 ^a	0.02±0.10 ^{ab}	ND
BLM	0.01±0.10 ^b	ND	0.01±0.10 ^b	0.03±0.10 ^b	ND
FWK	ND	ND	ND	0.03±0.10 ^b	ND
SWC	0.01±0.10 ^b	ND	0.01±0.10 ^b	0.03±0.10 ^b	ND
TWK	0.01±0.00 ^{bc}	ND	0.01±0.10 ^b	0.03±0.10 ^b	0.01±0.10 ^a
FWC	ND	ND	0.01±0.10 ^b	0.02±0.10 ^{ab}	ND
FFC	0.01±0.20 ^b	ND	0.01±0.10 ^b	0.03±0.10 ^b	0.02±0.10 ^a
STC	0.02±0.20 ^a	ND	0.01±0.10 ^b	0.03±0.10 ^b	0.01±0.10 ^a
Control Limit/	0.2mg/kg	0.4mg/kg	2mg/kg	0.05mg/kg	0.2mg/kg
WHO/ FAO Standards	0.21mg/kg	1.4 mg/kg		0.2mg/kg	0.06mg/kg

Phytate/mineral of all mushroom samples analyzed are summarized and shown in Table 3. Phy:Zn The importance of a foodstuff as a source of dietary zinc depends on both the total zinc content and the level of other constituents in the diet that affect zinc bioavailability as reviewed by Woldegiorgis *et al.* (2015). Phytate may reduce the bioavailability of dietary zinc by forming insoluble mineral chelates at a physiological pH (Woldegiorgis *et al.* 2015).

Table 3: Mineral/ Anti-nutrient molar ratio of canned mushroom

Sample	Phy/ca	Phy/zn	Phy/fe	Phy x ca/zn
FRM	0.0371	0.2131	0.1830	4.9678
BLM	0.6000	0.5500	2.2000	0.7800
FWK	0.1882	0.3154	0.1519	0.1038
SWC	0.0007	0.2800	3.5000	0.3833
TWK	0.2667	0.2182	2.6667	0.2618
FWC	3.8000	0.1450	1.0556	0.0962
FFC	0.4667	0.3519	0.7037	0.0003

STC	0.0005	0.2071	0.4085	0.0003
Critical Values/ Control limit	<0.24	<15	<1	<0.5

The formation of the chelates depends on the relative levels of both zinc and phytic acid. Hence, the phytate: Zn molar ratio is considered a better indicator of zinc bioavailability than total dietary phytate levels. Phytic acids markedly decrease Ca bioavailability and the Phytate: Ca molar ratio has been proposed as an indicator of Ca bioavailability. The critical molar ratio of Phytate: Ca is reported to be 0.24 (Woldegiorgis *et al.* 2015). The molar ratios of Phytate: Ca obtained for fresh and third week to sixth week are below critical while first and second week are above critical value which pose an adverse effect on absorption of calcium by phytate in these mushrooms at first and second week of canning.

Conclusion

Results from this study have shown that each of the canned milky mushroom samples investigated were rich in mineral nutrients excluding zinc. However, all the mineral content were observed to significantly increase after canning and during the storage period. The sample were above WHO/FAO daily minimum daily intake. The mineral/ anti-nutrient molar ratio of canned mushroom were below the critical levels so minerals will be available to perform their functions in human body.

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