Proximate and Antinutrients Compositions, and Health Risk Assessment of Toxic Metals in Some Edible Vegetables

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ABSTRACT

The proximate, antinutrients and heavy metals composition of five edible vegetables – Telfaria occidentalis (fluted pumpkin), Brassica oleracea (cabbage), Pterocarpus mildbraedii (mkpa), Ceratotheca sesame ides (bungu), and Gongronema latifolium (utazi) were determined using standard procedures. Health risk model was used to estimate the non-carcinogenic risk of heavy metals consumption. Proximate analysis reveals moisture content in the range 56.45 – 90.80%, ash 6.10-32.60%, crude protein 12.60-26.25%, crude fat 4.20-13.15%, crude fibre 0.10-0.60%, carbohydrate 41.00-73.50% and caloric value 290.00-434.35 kcal. The highest levels of antinutrients are found in Gongronema latifolium (soluble oxalate), Telfaria occidentalis (total oxalate and phytate) and Pterocarpus mildbraedii (HCN and tannins). Cd, Cr, Ni, Pb, Cu and Zn and Fe (in Pterocarpus mildbraedii) are below FAO/WHO toxic limits. Estimated daily intake is well below the recommended oral reference doses. The Hazard quotient of individual heavy metal for each vegetable is less than one, implying no health risk. However, the hazard index of the combined elements indicates significant health risk in the consumption of Brassica oleracea (cabbage) for men, and Brassica oleracea (cabbage) and Ceratotheca sesamoides (bungu) for women. The vegetables used in the study are safe sources of beneficial nutrient to people in the area.

Keywords: Edible Vegetables, Nutritional and Antinutritional Composition, Metals, Health Risk.

INTRODUCTION

Vegetables are consumed in diets all over the world, and are a rich source of nutrients essential for human health and well-being. The green leafy vegetables synthesise and accumulate amino acids from the natural environment. Thus, they provide the cheapest and richest source of proteins. Some vegetables are also used as herbal and medicinal remedies in various traditional and cultural settings[1,2]. It is pertinent to note that while vegetables are veritable sources of nutrients, they also contain chemical compounds that are toxic and fatal to human. In essence, vegetables contain chemical

compounds that present both nutritional factors (vitamins, proteins, essential fatty acids, etc.) and anti-nutritional factors (oxalates, tannins and others) [3, 4].

The nutritional factors are responsible for the health-promoting effects[5]. Slavin and Lloyd[6] demonstrated that high consumption of vegetables reduced the incidence of non-communicable diseases e.g. cancers, arthritis and cardiovascular and neuro-degenerative diseases. Anti-nutritional factors are natural compounds that interfere with metabolic processes and can result in human and animal death[7]. The ingestion of oxalate-containing foods predisposes to increase in urinary oxalate, and a potential threat to persons at risk of developing kidney stones[8].

The growing demand for vegetables draws many actors into the production line. In the tropics and subtropics, the women produce vegetables for food, and to supplement household income[1]; but this may not be without risk. Vegetables cultivated in heavy metal contaminated environment, bioaccumulate and biomagnify in humans, leading to ailments and death[9, 10]. Complex biological and geochemical processes, anthropogenic factors such as agricultural practices, waste treatment, industrial activities and vehicular traffic, and natural sources including wild fires and dust are associated with soil trace metals[11, 12, 13].

A good edible vegetable contains substantial amount of the beneficial nutrients, and much less of anti-nutrients and heavy metals. Rouphael *et al*.[14] reported genetic and environmental factors amongst others, to influence the biosynthesis, composition and concentration of the health-promoting nutritional factors[15]. The aim of the project therefore, was to determine the proximate, antinutrients and metals contents of five edible vegetables – *Gongronema latifolium* (utazi), *Telfaria occidentalis* (fluted pumpkin), *Brassica oleracea* (cabbage), *Pterocarpus mildbraedii* (mkpa) and *Ceratotheca sesamoides* (bungu) purchased from Itu Local Government Area of Akwa Ibom State; estimate the daily intake of these metals (Cu, Cd, Zn, Ni, Pb, Cr, and Fe) for men, women and children through ingestion of the vegetable; and assess the non-carcinogenic health risk using the hazard quotient and hazard index.

MATERIALS AND METHODS

Sample Collection and Preparation

Fresh samples of *Gongronema latifolium* (utazi), *Telfaria occidentalis* (fluted pumpkin), *Brassica oleracea* (cabbage), *Pterocarpus mildbraedii* (mkpa) were purchased at Itam main market while *Ceratotheca sesamoides* (bungu) was purchased at the Itu bridge head, all in Itu Local Government Area of Akwa

Ibom State. The leaves were separated from the stalk, washed with tap water, followed by deionized water. Each sample was cut into small pieces using stainless steel knife and air-dried. The dried samples were then ground to fine powder with plastic mortar and pestle, sieved through 0.5 mm mesh size (British Standard, London) and stored in airtight Ziploc bags for analysis[16].

Proximate, Antinutrient and Metal Analyses

The vegetables were analysed for proximate composition – moisture, ash, crude protein, crude fat, crude fibre, carbohydrate and caloric value (AOAC 1990) as described by Udousoro and Ekanem[17]. Antinutrients – hydrogen cyanide, tannins, soluble oxalate, total oxalate and phytate were determined as described[16]. One gramme of each vegetable sample was ashed at 550 ^{o}C and the ash dissolved in 50% HCl (20 ml) following the procedure by Wilson *et al*.[18]. Mineral elements (Cu, Fe and Zn) and toxic elements (Cd, Cr, Pb and Ni) were determined using an atomic absorption spectrometer (UNICAM 939/959 ASS).

Non-Carcinogenic Health Risk Assessment of Metals from Ingestion of Vegetables

The estimated daily intake (EDI, mg/kg bw/day) of mineral elements (Cu, Fe and Zn) and heavy metals (Cd, Cr, Pb and Ni) was computed using equation 1[19, 20] to assess the long-term exposure of men, women and children to metals from ingestion of vegetables [*Gongronema latifolium* (utazi), *Telfaria occidentalis* (fluted pumpkin), *Brassica oleracea* (cabbage), *Pterocarpus mildbraedii* (mkpa) and *Ceratotheca sesamoides* (bungu)].

$$EDI = \frac{C_i \times IR \times CF \times EF \times ED}{BW \times AT} \quad \text{-eqn1}$$

where Ci is the concentration of the metal (mg/kg), IR is the ingestion rate (g/day, 0.55 for adults-male and female, 0.2 for children), CF is the correction factor (no unit, 0.085), EF is the exposure frequency (days/year), ED is the exposure duration (years; 70), BW is the body weight (kg, 70, 65 and 30 for male, female and children, respectively), and AT is the average time (years, EF x ED = 25550).

The hazard quotient (HQ) for single metals from ingestion of edible vegetables was calculated using equation 2 for men, women and children populations

$$HQ = \frac{EDI}{RfD} \quad \text{- -} \quad \text{eqn 2}$$

where EDI is the estimated daily intake (mg/kg/day), and RfD (mg/kg/day) is the oral reference dose and has the value 0.04 (Cu), 0.001(Cd), 0.3 (Zn), 0.02 (Ni), 0.004 (Pb), 0.003 (Cr), and 0.7 (Fe)[21, 22]. HQ>1 indicates potential adverse health risks on humans. The hazard index (HI) was calculated using the equation 3; it is used to estimate the potential

non-carcinogenic human risk when more than one metal is consumed. Hazard index H1>1poses adverse non-carcinogenic health risk on humans[22, 23].

$$HI = \sum HQ \quad - \qquad \text{eqn 3}$$

Quality Control

All reagents were of analytical grade (BDH, UK). Sample containers and glassware were thoroughly cleaned and soaked in 10% HNO_3 before use. Samples were analysed in duplicate. Standard solutions of elements for calibration were prepared from 1000 ppm stock solutions. Metals were analysed in the wavelengths (nm)- 324.8, 232, 217, 357.9, 228.8, 248.3, and 213.9, for Cu, Ni, Pb, Cr, Cd, Fe, and Zn, respectively. Spiked recoveries were used to validate analytical procedures[24] and recoveries (percentages) were obtained from equation 4.

$$\%Recovery = \frac{C_{spiked} - C_{unspiked}}{C_{standard}} \times 100 \quad \text{- - eqn 4}$$

where C_{spiked}, $C_{standard}$, and $C_{standard}$ are the concentrations in the spiked sample, unspiked sample and concentration in standard, respectively. The mean recoveries (%) from four replicates were 95±0.97, 102±1.34, 82±0.52, 76±1.04, 101±0.67, 88±0.73 and 91±0.09 for Cu, Ni, Pb, Cr, Cd, Fe, and Zn, respectively.

Statistical analyses of data were processed using IBM SPSS Statistics 20 and Microsoft Excel.

RESULTS AND DISCUSSION

Proximate Composition

Proximate compositions of *Gongronema latifolium* (utazi), *Telfaria occidentalis* (fluted pumpkin), *Brassica oleracea* (cabbage), *Pterocarpus mildbraedii* (mkpa) and *Ceratotheca sesamoides* (bungu) are presented on Table 1. The moisture content ranges from 56.45% in *Pterocarpus mildbraedii* to 90.8% in *Brassica oleracea*. Moisture content determines the life span of the vegetables; vegetables with high moisture content are prone to spoilage[25]. Ash content measures the mineral content of the vegetables; it ranges from 6.1% in *Brassica olvevacea* to 32.6% in *Ceratotheca sesamoides*. The ash content is higher than values reported in Uyo (5.5-16.1%)[17] and Delta State (1.52-2.00%)[7]; this indicates the vegetables are good sources of dietary minerals.

Crude protein content decreases in the order 26.3% (*Telfaria occidentalis*) > 23.1% (*Pterocarpus mildbraedii*) > 22.1% (*Ceratotheca sesamoides*) > 15.4% (*Brassica oleracea*) > 12.6% (*Gongronema latifolium*). The values are higher than reported in Delta State, Nigeria[7]. The difference in content may result from varying farming practices and prevailing environmental conditions[26]. The RDA of protein is 56, 46 and 34 g/day for men, women and children, respectively[27]. The vegetables are therefore good sources of

protein. Crude fat is a good source of energy, and protects internal tissues in the body[24]; it ranges from 4.20% in *Ceratotheca sesamoides* to 13.15% in *Telfaria occidentalis*. It is higher than what is reported in selected vegetables in Northern Côte D'ivoire (1.17-4.90) and Nigeria[28, 29]

Table 1: Nutritional composition of the five edible vegetables (%)

Vegetable	Moisture	Ash	Crude Protein	Crude Fat	Crude Fibre	Carbohydrate	Caloric Value (kcal)
Gongronema latifolium (utazi)	74.0±0.02	18.0±0.35	12.6±0.24	11.5±0.02	0.45±0.00	65.0±1.12	414±0.64
Telfaria occidentalis (fluted pumpkin)	75.4±0 05	7.70±1.01	26.3±0.57	13.2±0.05	0.15±0.08	52.8±0.50	434±0.83
Brassica oleracea (cabbage)	90.8±0.01	6.10±0.45	15.4±0.93	4.40±0.01	0.60±0.02	73.5±0.84	395±0.96
Pterocarpus mildbraedii (mkpa)	56.5±0.03	6.90±0.56	23.1±1.02	4.25±0.08	0.10±0.01	65.7±0.57	393±0.58
Ceratotheca sesamoides (bungu)	76.9±0.01	32.6±0.22	22.1±0.78	4.20±0.06	0.15±0.02	41.0±0.89	290±0.51

n=2

Green leafy vegetables are good sources of dietary fiber. Consumption of high levels of vegetable fiber has been known to reduce the risks of cardiovascular diseases, some cancers (colon cancer), and is used to prevent and treat constipation, obesity and diabetes[30, 31]. Crude fiber is between 0.10% in *Pterocarpus mildbraedii* and 0.60% in *Gongronema latifolium*. This is lower than values reported in vegetables from Bangladesh (9.26 – 17.70)[32]. The RDA of protein is 38 and 25 g/day for men and women, respectively[27]. Literature reveals Indian green leafy vegetables like *Brassica oleracea (*cabbage*), Coriandrum sativum (*coriander*)* and *Spinacia oleracea (*spinach*)* as good sources of dietary fibre[30]. Carbohydrate provides energy to the body. *Ceratotheca sesamoides* has the lowest carbohydrate content (41%) and *Brassica oleracea* the highest (73.5%). Emmanuel *et al.*[33] reported lower carbohydrate content than those in this study. The RDA of carbohydrate is 130 g/day for male and

female[27], hence the vegetables are good sources of dietary carbohydrate. The results obtained from caloric value in this study reveal lowest level in *Ceratotheca sesamoides* (290.00 kcal) and highest in *Telfaria occidentalis* (434.35 kcal). This is comparable to some edible vegetables in Bangladesh (327-372 kcal) [33] but higher than others from Côte D'ivoire (135-313 kcal)[28].

Antinutrient Composition

Antinutrients are substances that reduce the bioavailability of one or more nutrients when present in food with attendant reduction in the nutritional value of food plants, and adverse effects on health. Common antinutrients - hydrocyanic acid, tannins, oxalate and phytate, are investigated in *Gongronema latifolium* (utazi), *Telfaria occidentalis* (fluted pumpkin), *Brassica oleracea* (cabbage), *Pterocarpus mildbraedii* (mkpa) and *Ceratotheca sesamoides* (bungu) in the study. The mean values are presented on Table 2.

TABLE 2: Antinutritional composition of five edible vegetables (mg/100g)

Vegetable	HCN	Tannin	Soluble Oxalate	Total Oxalate	Phytate
Gongronema latifolium (utazi)	7.52	26.71	71.28	88.88	0.28
Telfaria occidentalis (fluted pumpkin)	10.36	40.53	58.08	95.04	0.90
Brassica oleracea (cabbage)	9.35	31.84	14.96	27.28	0.18
Pterocarpus mildbraedii (mkpa)	23.98	98.55	18.48	29.04	0.19
Ceratotheca sesamoides (bungu)	5.69	BDL	35.2	54.56	0.17

BDL – Below Detected Limit

Hydrocyanic acid (HCN) Cyanogenic glycosides have received much attention due to the toxic nature of hydrogen cyanide (HCN) [34, 35]. HCN ranges from 5.61 mg/100g in *Ceratotheca sesamoides* to 23.98 mg/100g in *Pterocarpus mildbraedii*. The values are higher than found in *Lasianthera Africana* (editan) from Abak, Nigeria[36]. Tannins range from 26.71 mg/100g in *Gongronema latifolium* to 98.55 mg/100g in *Pterocarpus mildbraedii*. It is not detected in *Ceratotheca sesamoides*. This is lower than reported from Ikot Abasi[4] for *Gongronema latifolium* (utazi), *Vernonia amygdalina* (Etidot), *Ocimum canum sims* (Iko), *Heinsia crinata* (Atama) and *Talinum triangulare* (Mmong-mmong

ikong). Consumption of large amounts may inhibit the functions of digestive enzymes, precipitate proteins, affect the utilisation of minerals and vitamins in the body[28, 37]. The toxic effects however, could be reduced by soaking and boiling. Toxicity of oxalates for humans is set as 2-5 g/day. High oxalate content in vegetables can be toxic to human health; it may result to kidney disease[28]. Soluble oxalate ranges from 14.96 mg/100g in *Brassica oleracea* to 71.28 mg/100g in *Gongronema latifolium*, while the total oxalate ranges from 27.28 mg/100g in *Brassica oleracea* to 95.04 mg/100g in *Telfaria occidentalis.* They are lower than found in other studies[4, 28]. The lowest value of phytate is found in *Ceratotheca sesamoides* (0.17 mg/100g), and the highest in *Brassica oleracea* (0.90 mg/100g). Phytate (phytic acid) content in vegetables decreases Ca, Fe, Mg, Zn absorption by humans from meals[38, 39]. The effect of phytate in vegetables can be reduced by fermentation, soaking in acid medium and sprouting[40].

Concentration of Metals in Edible Vegetables

The mean values (mg/kg) of mineral (Cu, Fe, Zn) and toxic (Cd, Cr, Ni, Pb) elements are presented on Table 3.

Mineral elements in edible vegetable range from 3.75 in *Pterocarpus mildbraedii* to 18.5 in *Brassica oleracea* (Cu), 309 in *Pterocarpus mildbraedii* to 612 in *Telfaria occidentalis* (Fe), and 20.85 in *Telfaria occidentalis* to 54.15 in *Brassica oleracea* (Zn). Copper is a component of several enzymes necessary for the synthesis of haemoglobin; Fe prevents anemia, while Zn is essential for growth, healthy function of the heart, reproduction, and mental ability[33].

High levels of Cu in the vegetables can lead to jaundice, also known as Wilson's disease; Zn may cause vascular shock and pancreatitis, and excess Fe, gastrointestinal side effects[41, 42]. The levels of Cu and Zn in all vegetable samples are below the toxic levels[43]. Fe exceeds[44] the toxic limit in all vegetables except in *Pterocarpus mildbraedii* (mkpa). Levels of toxic elements Cr, Ni and Pb (mg/kg) range from 0.05 in *Pterocarpus mildbraedii* to 0.8 in *Brassica oleracea*, BDL (in four vegetables) to 0.05 in *Brassica oleracea*, and BDL (in three vegetables) to 0.1 in *Ceratotheca sesamoides* (bungu), respectively (Table 3). Cadmium is not detected in any sample. All toxic elements are below[43,44] permissible limits, and pose no immediate threat to humans but bioaccumulation may pose high health risks to humans[45, 44].

TABLE 3: Mean values and standards of metal in five edible vegetables (mg/kg)

Vegetable	Cu	Cd	Zn	Ni	Pb	Cr	Fe
Gongronema latifolium (utazi)	4.05	BDL	46.95	BDL	BDL	0.05	511
Telfaria occidentalis (fluted pumpkin)	11.3	BDL	20.85	BDL	BDL	0.15	612
Brassica oleracea (cabbage)	18.5	BDL	54.15	0.05	0.05	0.8	493
Pterocarpus mildbraedii (mkpa)	3.75	BDL	40.85	BDL	BDL	0.55	309
Ceratotheca sesamoides (bungu)	17.85	BDL	27.8	BDL	0.1	0.1	570
FAO/WHO, 2002	40.0	0.20	60.0	1.00	0.30	2.30	450*

*FAO/WHO (1984) BDL – Below Detected Limit

Non-carcinogenic Health Risk Assessment

The estimated daily intake of metals through ingestion for men, women and children are given on Table 4. The highest metal contribution to EDI is Fe, followed by Zn. The EDIs of the metals from all vegetables are well below the recommended oral reference dose (RfD). The oral reference dose is an estimate of the daily exposure to which the human population may be continually exposed over a lifetime without an appreciable risk of deleterious effects[47]. The HQ values for single elements and HI values for combined elements are given on Table 5 for men, women and children. There is no HQ value greater than one through ingestion of any of the edible vegetables, implying that there would be no significant non-carcinogenic risk from single elements in any of the vegetables. The HI of combined elements through consumption of *Brassica oleracea* (cabbage) (HI=1.09 for men, 1.17 for women) and *Ceratotheca sesamoides* (bungu) (HI=1.01 for women) is greater than one, implying the men and women would have significant health risk through consumption of these vegetables.

TABLE 4: Estimated daily intake (EDI) of metals through ingestion edible vegetables by men, women and children (mg/kg bw/day)

VEGETABLES	Cu	Cd	Zn	Ni	Pb	Cr	Fe
MEN							
Gongronema latifolium (utazi)	0.0027	0	0.0313	0	0	0.00003	0.3412
Telfaria occidentalis (fluted pumpkin)	0.0075	0	0.0139	0	0	0.0001	0.4083
Brassica oleracea (cabbage)	0.0123	0	0.0362	0.00003	0.00003	0.0005	0.3288
Pterocarpus mildbraedii (mkpa)	0.0025	0	0.0273	0	0	0.0004	0.2065
Ceratotheca sesamoides (bungu)	0.0119	0	0.0186	0	0.00007	0.00007	0.3802

WOMEN							
Gongronema latifolium (utazi)	0.0029	0	0.0338	0	0	0.00003	0.3674
Telfaria occidentalis (fluted pumpkin)	0.0081	0	0.0149	0	0	0.00011	0.4397
Brassica oleracea (cabbage)	0.0133	0	0.0389	0.00003	0.00003	0.00058	0.3541
Pterocarpus mildbraedii (mkpa)	0.0027	0	0.0294	0	0	0.00039	0.2224
Ceratotheca sesamoides (bungu)	0.0128	0	0.0199	0	0.00007	0.00007	0.4095
CHILDREN							
Gongronema latifolium (utazi)	0.0023	0	0.0266	0	0	0.00002	0.2895
Telfaria occidentalis (fluted pumpkin)	0.0064	0	0.0118	0	0	0.00009	0.3464
Brassica oleracea (cabbage)	0.0105	0	0.0307	0.00002	0.00002	0.00045	0.2789
Pterocarpus mildbraedii (mkpa)	0.0021	0	0.0231	0	0	0.00031	0.1752
Ceratotheca sesamoides (bungu)	0.0101	0	0.0157	0	0.00006	0.00006	0.3226

TABLE 5: Target hazard quotient (HQ) and hazard index (HI) for the vegetables

VEGETABLES	Cu	Cd	Zn	Ni	Pb	Cr	Fe	HI
MEN								
Gongronema latifolium (utazi)	0.0676	0	0.1045	0	0	0.0111	0.4874	0.67
Telfaria occidentalis (fluted pumpkin)	0.1886	0	0.0464	0	0	0.0334	0.5832	0.85
Brassica oleracea (cabbage)	0.3078	0	0.1205	0.0017	0.0083	0.1780	0.4697	**1.09**
Pterocarpus mildbraedii (mkpa)	0.0626	0	0.0909	0	0	0.1224	0.2949	0.57
Ceratotheca sesamoides (bungu)	0.2979	0	0.0619	0	0.0167	0.0223	0.5432	0.94
WOMEN								
Gongronema latifolium (utazi)	0.0728	0	0.1125	0	0	0.0119	0.5249	0.72
Telfaria occidentalis (fluted pumpkin)	0.2031	0	0.0499	0	0	0.0359	0.6281	0.83
Brassica oleracea (cabbage)	0.3325	0	0.1298	0.0018	0.0089	0.1917	0.5058	**1.17**
Pterocarpus mildbraedii (mkpa)	0.0674	0	0.0979	0	0	0.1318	0.3177	0.62
Ceratotheca sesamoides (bungu)	0.3208	0	0.0666	0	0.0179	0.0239	0.5849	**1.01**
CHILDREN								
Gongronema latifolium (utazi)	0.0573	0	0.0887	0	0	0.0094	0.4135	0.57
Telfaria occidentalis (fluted pumpkin)	0.1600	0	0.0394	0	0	0.0283	0.4949	0.72
Brassica oleracea (cabbage)	0.2619	0	0.1023	0.0014	0.0071	0.1511	0.3985	0.92
Pterocarpus mildbraedii (mkpa)	0.0531	0	0.0771	0	0	0.1039	0.2503	0.48
Ceratotheca sesamoides (bungu)	0.2528	0	0.0525	0	0.0142	0.0189	0.4609	0.80

CONCLUSION

The investigated vegetables contain nutrients, antinutrients, and heavy metals. *Brassica oleracea* (cabbage) contains the highest moisture, crude fibre and carbohydrate; *Telfaria occidentalis* (fluted pumpkin) the highest crude protein, crude fat and caloric value; and *Ceratotheca sesamoides* (bungu) the highest ash content; hence rich in mineral ions. Antinutrients contents range from 5.691-23.948 mg/100g for hydrocyanic acid, 26.710-98.552 mg/100g for tannins, 14.960-71.280 mg/100g for soluble oxalate, 27.280-95.040 mg/100g for total oxalate and 0.170-0.900 mg/100g for phytate. Lowest level of total and soluble oxalate is found in *Brassica oleracea* (cabbage); and HCN, tannin and phytate in *Ceratotheca sesamoides* (bungu). Element in vegetables range from 3.75-18.50 mg/kg (copper), 20.85-54.15 mg/kg (zinc), BDL-0.5 mg/kg (nickel), BDL-0.1 mg/kg (lead), 0.05-0.80 mg/kg (chromium), 309.30-611.50 mg/kg (iron); and below detection limit for cadmium. Mineral elements, Cu and Zn and Fe (in *Pterocarpus mildbraedii*) are below FAO/WHO toxic limit but Fe in *Gongronema latifolium* (utazi), *Telfaria occidentalis* (fluted pumpkin), *Brassica oleracea* (cabbage), and *Ceratotheca sesamoides* (bungu) exceeds the recommended level. Daily intake of metals from ingestion of all vegetables is well below the oral reference dose. Hazard quotients (HQ) of individual element is less than one for all metals in the entire sample, hence no significant health risk is expected. The hazard index of the combined elements indicates significant health risk for men through consumption of *Brassica oleracea* (cabbage); and women through consumption *Brassica oleracea* (cabbage) and *Ceratotheca sesamoides* (bungu).

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