# Relative Proximate Composition and Mineral Analysis of Three Garlic Varieties Available in Bangladesh

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Authors DI, DCR made an idea or hypothesis for research and/or manuscript and planned methodology to reach the conclusion. Authors NNL, CL, SA, ZA and DCR took the responsibility in execution of the experiments, data management and reporting. Authors DI, CL, LCM,EPL, MH and DCR took the accountability in logical interpretation and presentation of the results. Authors NNL, RKR and DCR wrote of the whole or body of the manuscript. Authors DI, RKR and DCR reviewed the article before submission not only for spelling and grammar but also for its intellectual content. All authors have read and approved the manuscript.*

| *Original ResearchArticle* |
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## ABSTRACT

Garlic is one of the most common spices in south-east Asian cuisine. Since ancient times, it has been used as traditional medicine, herbal remedies and flavoring ingredients. Large varieties of garlic are available across the world. The majority of Bangladeshi markets are availed with three of its varieties. These are Imported Large Multi-clove garlic from India or China, Bangladeshi Indigenous Multi-clove and Single-clove garlic. This study was aimed to investigate proximatecomposition, mineral concentration and energy value of Imported Large Multi-clove

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variety, Bangladeshi Indigenous Multi-clove and Single clove garlic. Imported Large Multi-clove variety was found to contain 6.53±0.08% moisture, 70.25±0.27% carbohydrate, 18.92±0.04% protein, 0.57±0.16% fat and 3.72±0.03% ash, whereas Indigenous Single-clove and Multi-clove contain 7.80±0.04% & 6.51±0.04% moisture, 71.41±0.09%&72.73±0.06%carbohydrate, 17.37± 0.06% and 17.40±0.04% protein, 0.19±0.01% and 0.21±0.02% fat, 3.22±0.01% and 3.14±0.02% ash respectively. Few Significant Distinction Were observed in nutrient and calorie contents. No single variety could be adjudged nutritionally superior or inferior to others.

## 1. INTRODUCTION

The most economically significant species of the Allium genus is garlic (*Allium sativum* L.). It is a bulbous perennial food plant of the Alliaceae family [1]. It can legitimately be called one of nature's wonderful plants with medicinal properties.Garlic helps to maintain good health by boosting immune system [2]. Garlic has some sulfur-containing compounds that stimulate the production of certain beneficial enzymes and thus protect the human body [3]. Because of its antibiotic properties, it has been used as a home remedy to help speed healing from a sore throat or other mild to moderate maladies [4]. To treat aches and pains, leprosy, deafness, diarrhea, constipation, parasitic infection and fever and to alleviate stomach ache, garlic has historically been used since a long time ago [5]. Approximately above 600 varied species of *Allium* genus are widely found across Europe, Asia, North America and North Africa [6]. Garlic varieties can be differentiated from each other by their sizes, colors, shapes, tastes and number of cloves per bulb of garlic. They broadly classified as either hard-neck and soft-neck [7]. Primarilybased on origin and number of cloves of garlics, in Bangladesh three varieties of garlic are available. They are Imported Large Multi-clove garlic, Indigenous Single-clove and Indigenous Multi-clove garlic. These garlics are an integral part of daily cuisine of million Bangladeshis and reportedly contribute many nutritional and medicinal values to their valuable health [8]. Therefore, besides adding benefits to better understanding of food phytochemistry, assessment of relative nutrient and mineral composition of these three cultivars may be crucial on account of consumers' health and nutrition. Nutritional importance based on the content of protein, carbohydrates, fats and mineralsis conventionally assessed by proximate compositional analysis [9]. However, hardly any research has been undertaken in response to the above purpose. So, the current research was carried out to perform a comparative analysis on protein, carbohydrate fat, minerals and energy in targeted garlic varieties and to decide out the better one to recommend in the context of nutritional value.

## 2. STUDY DESIGN

### 2.1 Sample Preparation

For preparing samples, each studied variety was collected from the New Market, Dhaka. The garlics were then peeled, washed and cleaned, and cloves were chopped with knife on chopping board. The chopped samples were dried in an oven at 50ºC for 8-10 hours [10]and ground by a blender. The powder of each garlic variety was then stored in separate airtight containers.

### 2.2 Determination of Proximate Composition of Garlic Samples

#### 2.2.1 Determination of moisture content

The method of Association of Official Analytical Chemists was used to determine the moisture of garlic powder on dry basis [11]. 5 g powder was weighed into a pre-weighed petri dish and dried in an oven at a temperature of 105 ± 5°C until a constant weight of dry matter was obtained. The moisture content in the sample was determined by using the following formula:

Moisture (%) = [{(Wt. of original sample – Wt. of dried sample) / Wt. of original sample} × 100]

#### 2.2.2 Determination of crude protein

The crude protein content of the samples was estimated using the Kjeldahl method [12]. The method involved protein digestion, distillation and titration.

Protein digestion: 0.2 g sample and 0.5 g digestion mixture were put in Kjeldahl flask and mixed with 20 ml of 98% concentration of $H_2SO_4$. Then the mixture was subjected to heating at 350°C in a speed digester until transparent residue contents were obtained.

**Protein distillation:** Digested sample was then entered into a distillation chamber.

**Titration:** The sample was then titrated with 0.5 N $H_2SO_4$.

### 2.2.3 Determination of crude fat

The crude fat of the powdered sample was determined using Soxhlet extraction. 3 gm of each sample was folded in filter paper and placed within labelled thimbles. Thimbles were attached to extraction columns of the fat analyser (SoxtecTM 2043). The dried boiling flasks (250 ml) were weighed and filled with about 150 ml of petroleum ether and placed under extraction columns according to their corresponding thimbles. SoxtecTM 2043 worked in 3 phases:

**Boiling phase:** Thimbles were lowered into the solvent and boiled for 2 hours at 90°C.

**Rinsing phase:** The thimbles were then raised above the solvent. This phase required 30 minutes.

**Sample extraction:** This phase required 20 minutes.

Then the thimbles were removed carefully and petroleum ether was collected from the top container and drained into another container for reuse. Then, by using a hot air oven the boiling flask was heated to make it totally free from petroleum ether. It was then cooled in a desiccator and weighed [13].

The % fat in the sample was calculated using the formula:

Fat (%) = (Wt. of fat / Wt. of original sample) × 100.

### 2.2.4 Determination of ash content

Ash content was determined by the AOAC method. About 2 gm of finely ground dried sample was weighed into porcelain crucibles and heated over a Bunsen burner until the samples burned fully. The crucibles were then heated up to 550°C for five hours in a muffle furnace. The crucibles were transferred in a desiccator for cooling down [9].

The % ash content in the garlic sample was calculated by the following formula:

Ash (%) = (Wt. of ash / Wt. of sample taken) × 100
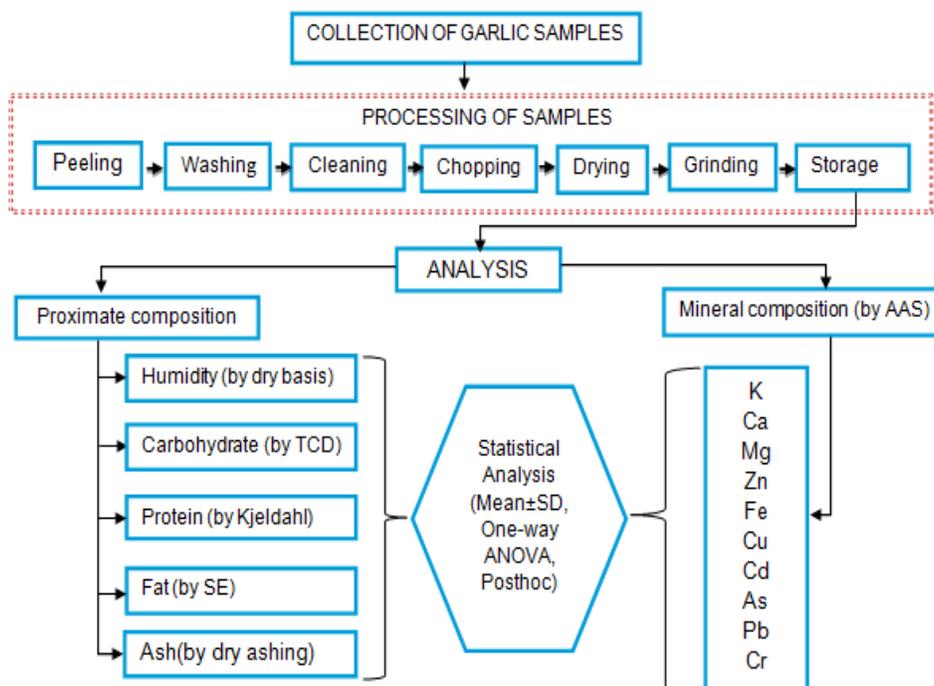


**Fig. 1. A diagrammatic view of study design[AAS (Atomic absorption spectrophotometry), TCD (Total Carbohydrate by Difference), SE(Soxhlet Extraction)]**
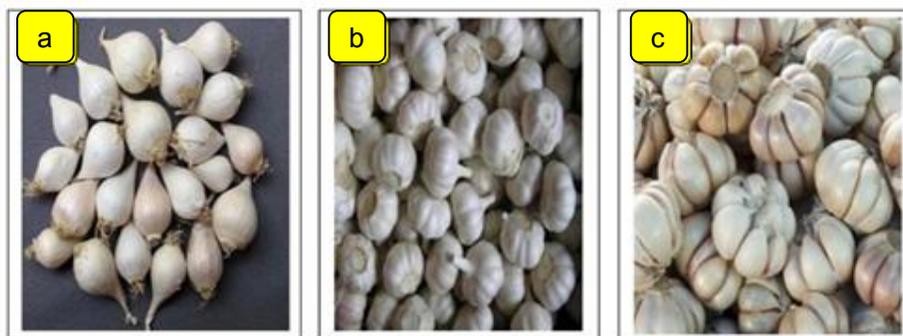
**Fig. 2. Photos of studied garlic varieties (a). Indigenous Single-clove (b). Indigenous Multi-clove (c). Imported Large Multi-clove garlic (China or India)**

### 2.2.5 Determination of carbohydrate content

For many years, the total carbohydrate content of foods has been calculated by difference, rather than being analyzed directly. The constituents of food i.e. protein, fat, moisture and ash were determined individually except carbohydrate and summed, then the sum was subtracted from the total weight of the food. This is referred to as total carbohydrate by difference.

Total carbohydrate= 100 – (Weight in grams [protein + fat + water + ash] in 100 g of sample).

### 2.2.6 Determination of energy value

The energy value of the samples was determined by multiplying the protein content by 4, carbohydrate content by 4 and fat content by 9 [9].

Energy Value = (Crude protein × 4) + (Total carbohydrate × 4) + (Crude fat × 9)

### 2.2.7 Determination of mineral content

Mineral and heavy metal content were estimated by using Atomic Absorption Spectrophoto-meter [14]. 0.5 g sample was taken into a volumetric flask. It was digested with 7 ml Nitric acid and 2ml Hydrogen Peroxide two times for 15 minutes at 180°C in 1200-watt radiation. Sonication was done by the ultra sound system for mixing and to remove bubbles from the digested sample and then it was filtered with filter paper. The sample was then placed into the flame mode of Atomic absorption spectrophoto-meter at about 2300°C to 2600°C temperature.

The flame mode includes dissolving, vaporization, Atomization and ionization. This Technique typically used for determinations of minerals and heavy metals in mg/L. The concentrations of minerals were determined by their calibration curves.

Amount per 100 g

$$= {concentration}/{weight\,taken} \times 100 \times Dilution\,times$$

### 2.3 Statistical Analysis

All the statistical analyses for this study were done by SPSS 22.0 version. One-way ANOVA with suitable Post hoc analysis was done to figure out the significant difference of nutrients at the 5% level of significance.

## 3. RESULTS AND DISCUSSION

Results of the proximate composition in studied sample materials are given in Table 1. It reveals that Imported Large Multi-clove variety contained 6.53±0.08% moisture, 70.25±0.27% carbohydrate, 18.92±0.04% protein, 0.57±0.16% fat, 3.72±0.03% ash, whereas Indigenous Single-clove and Indigenous Multi-clove contained 7.80±0.04% & 6.51±0.04% moisture, 71.41± 0.09% & 72.73±0.06% carbohydrate, 17.37± 0.06% and 17.40±0.04% protein, 0.19±0.01% and 0.21±0.02% fat, 3.22±0.01% and 3.14± 0.02% ash respectively. These findings are in parallel to the earlier findings of Nwinuka, Ibeh & Ekeke, [15]. They found 4.88±0.13% moisture, 17.35±0.00% crude protein, 0.68±0.0% crude fat, 73.03±0.06% total carbohydrates and 4.06± 0.10% ash in garlic on the dry weight basis. A study by Yusuf et al. 2018 also observed that the moisture, carbohydrate, crude protein, fat and ash contents in garlic were 4.55 mg, 73.22 mg ,15.33 mg, 0.72 mg and 2.10 mg per 100 gm on dry basis, respectively [16]. This is also

4

consistent with the study by Bi M et al., 2016 which revealed that garlic contains 3.91±0.03% moisture, 19.75±0.12 g protein, 0.49±0.02 g Fat, 1.73±0.01 g/100 g crude fiber, 66.36±0.11 g of Carbohydrate, 348.85±2.11 Kcal, 3.39±0.02 g total ash [17]. A previous study by Otunola, Oloyede, Oladiji, & Afolayan, 2011 is also in accordance to the present outcomes as they too found moisture, crude protein, crude fat, total carbohydrates, fiber and ash contents in garlic sample were 4.55±0.1%, 15.33±0.0%, 0.72±0.0%, 73.22±0.0%, 2.10±0.0%, 4.08± 0.10% respectively on the dry weight basis [18].

Fig. 3 shows the comparative trend of the major nutrient composition observed by proximate analysis of three garlic varieties. Indigenous multi-clove contained the best of carbohydrate contents but the least of moisture and ash contents. Indigenous single clove garlic was composed of the highest moisture but lowest protein among all varieties studied.

**Table 1.Proximate composition (Mean ± SD) of Studied garlic varieties (n=3) on dry basis**

| Garlic variety | Moisture (%) | Carbohydrate (g/100 g) | Protein (g/100 g) | Fat (g/100 g) | Ash (g/100 g) |
|---|---|---|---|---|---|
| 1 | 6.53±0.08 | 70.25±0.27 | 18.92±0.04 | 0.57±0.16 | 3.72±0.03 |
| 2 | 7.80±0.04[a*] | 71.41±0.09[a*] | 17.37±0.06[a*] | 0.19±0.01 | 3.22±0.01[a*] |
| 3 | 6.51±0.04[b*] | 72.73±0.06[a*,b*] | 17.40±0.04[a*] | 0.21±0.02 | 3.14±0.02[a*,b**] |

*where, 1=Imported Large Multi-clove garlic, 2= Indigenous Single clove garlic, 3= Indigenous Multi-clove garlic.[a] Significantly different from Imported Large Multi-clove garlic, [b] Significantly different from Indigenous Single clove garlic, ** P<0.01, * P<0.001*
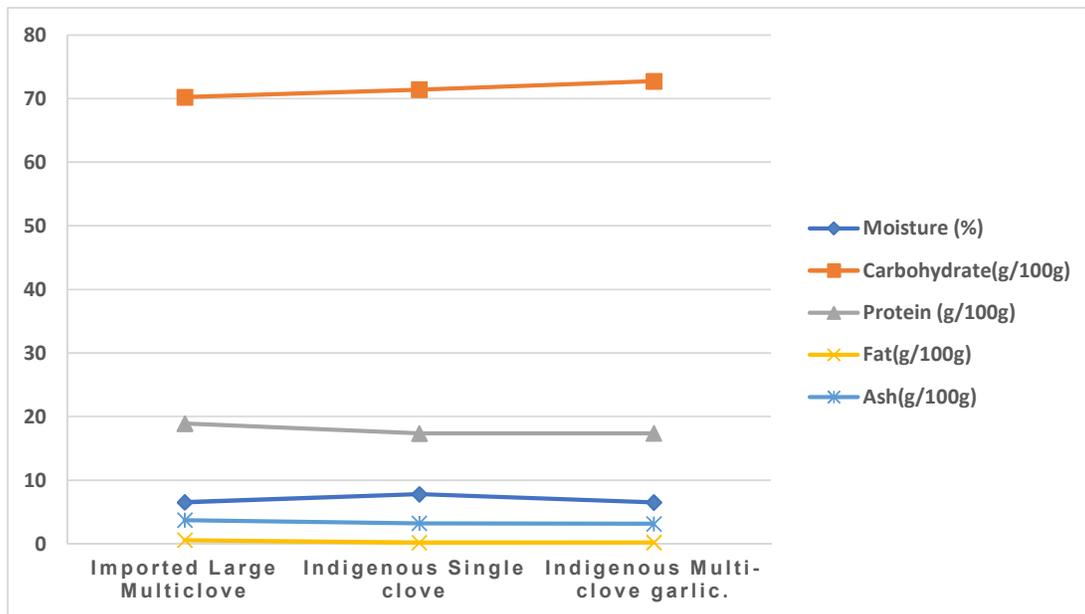


**Fig. 3. Proximate compositions of studied garlic varities**

**Table 2. Amount of energy (Kcal/100 gm) provided by studied garlic varieties (n=3)**

| Garlic variety | Amount of energy (Kcal) |
|---|---|
| Imported Large Multi-clove | 361.84±0.76 |
| Indigenous single clove | 356.90±0.17[a*] |
| Indigenous multi clove | 362.45±0.22[b*] |

*[a] Significantly different from Imported Large Multi-clove garlic, [b] Significantly different from Indigenous Single clove garlic, * P<0.001*

Table 2 reveals that 100 g of Imported Large Multi-clove garlic, Indigenous Single-clove garlic and Indigenous Multi-clove garlic provided 361.84±0.76 Kcal, 356.90±0.17 Kcal and 362.45 ±0.22 Kcal energy respectively. Correspondingly, a similar study by Nwinuka et al. [15] observed that 100 g of garlic sample provided 367.64 Kcal energy.

According to Table 1, the moistur of Indigenous Single-clove garlic was highest and Imported Large Multi-clove garlic and Indigenous Multi-clove garlic showed a significant difference in moisture from Indigenous Single-clove garlic. Protein content was significantly higher in Imported Large Multi-clove garlic than the two other rivals. No significant difference was present in their fat content. garlic showed significantly higher ash content than two other varieties. Table 2 clearly demonstrates that in the case of energy, Imported Large Multi-clove garlic and Indigenous Multi-clove garlic had highly remarkable differences from Indigenous Single-clove garlic. This result is also consistent with that of Petropoulos et al. 2018 who observed significant differences among various garlic genotypes in the context of their moisture, carbohydrate, protein, fat, ash and energy content [19].

Table 3 demonstrates that the main minerals that were present in the test ingredients include: Potassium (K) and Calcium (Ca), while Magnesium (Mg), Iron (Fe) and Zinc (Zn) were also detected in considerable amounts.

Statistical analysis of K, Ca and Mg content showed highly significant differences among them. Higher K content was observed in Imported Large Multi-clove garlic. Ca content was higher in Indigenous Multi-clove garlic than the other two varieties. Higher Mg content was observed in Indigenous Multi-clove garlic in contrast with two other varieties. Imported Large Multi-clove garlic and indigenous multi-clove garlic witnessed highly significant differences in Zn content from indigenous single-clove garlic. Higher Fe content was observed in Indigenous Single-clove garlic in comparison with other varieties and significant distinctions were observed within all varieties. On the other hand, non-volatile toxic heavy metals Copper (Cu), Cadmium (Cd), Arsenic (As), Lead (Pb) and Chromium (Cr) were found below the detection level. These findings are comparable with thestudy by Vadalà et al. [20] who found significant differences in the content of K (ranging from 2537 to 7441 mg/kg), Ca (ranging from 618 to 1989 mg/kg), Mg (ranging from 145.96 to 379. 12.34 to 30.81 mg/kg) and Zn (ranging from 5.92 to 23.69 mg/kg) and Fe (ranging from 12.34 to 30.81 mg/kg) among various garlic samples [20].

Fig. 4 clearly illustrates that K (potassium) was the highest among the detected minerals, followed by Ca (calcium). Interestingly, Indigenous Single Clove contained the least quantity of K, Ca an Mg (magnesium) among all varieties.
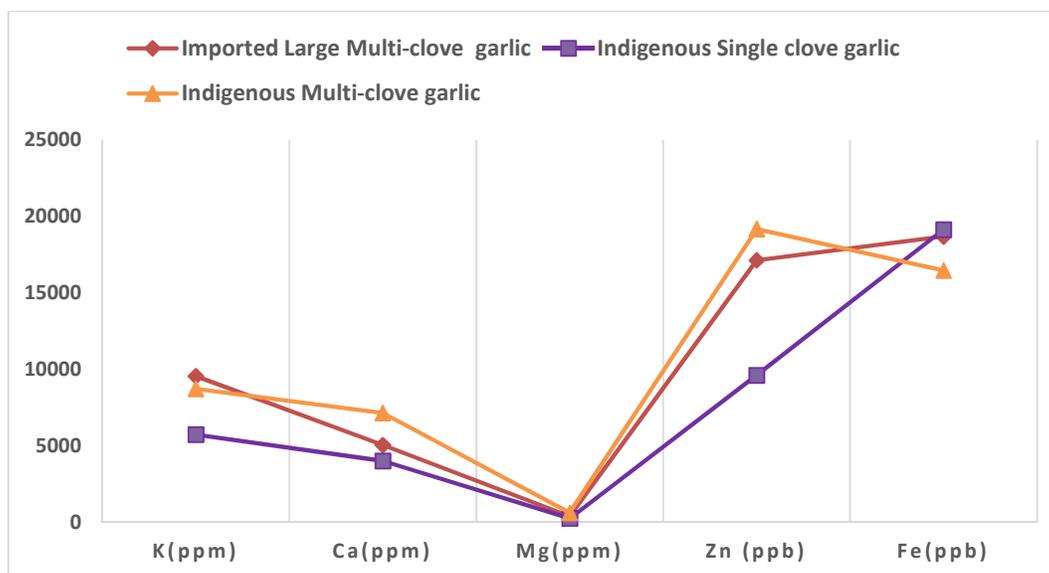


**Fig. 4. Mineral composition of studied garlic varieties (Cu, Cd, As, Pb and Cr<Detection Limit)**

**Table 3. Mineral composition (Mean±SD)of studied garlic varieties (n=3)**

| Mineral | Imported Large Multi-clove garlic (ppm) | Indigenous single clove garlic (ppm) | Indigenous multi-clove garlic (ppm) | Lower limit | Upper limit |
|---|---|---|---|---|---|
| K | 9549±89.9 | 5726±46.78[a*] | 8723±29.29[a*,b*] | 0.1ppm | 1 ppm |
| Ca | 5050±45.94 | 4008±37.8[a*] | 7146±33.6 [a*,b*] | 0.5 ppm | 2 ppm |
| Mg | 381.26±8.61 | 251.13±6.39[a*] | 611±21 [a*,b*] | 0.05 ppm | 0.2 ppm |
| Zn | 17.13±0.74 | 9.61±0.91[a*] | 19.18±1.3[b*] | 0.1 ppm | 1 ppm |
| Fe | 18.68±0.11 | 19.13±0.05[a**] | 16.47±0.46[a**,b**] | 0.1 ppm | 2 ppm |
| Cu | Below detection limit | Below detection limit | Below detection limit | 0.1 ppm | 2 ppm |
| Cd | Below detection limit | Below detection limit | Below detection limit | 0.05 ppm | 0.5 ppm |
| As | Below detection limit | Below detection limit | Below detection limit | 2 ppb | 20 ppb |
| Pb | Below detection limit | Below detection limit | Below detection limit | 0.5 ppm | 5 ppm |
| Cr | Below detection limit | Below detection limit | Below detection limit | 0.2 ppm | 2 ppm |

[a] *Significantly different from Imported Large Multi-clove garlic,* [b] *Significantly different from Indigenous Single clove garlic, ppm=Parts Per Million,* ** *P<0.05,* * *P<0.001*

## .4. CONCLUSION

Among three garlic cultivars, no one was individually superior or inferior to others in terms of gross nutritive value. Imported Large Multi-clove garlic cultivar was relatively high in protein, fat and ash content, whereas Indigenous Multi-clove garlic composed of greater carbohydrate and total energy value. Likewise, mineral contents varied between cultivars. The content of K was higher in Imported Large Multi-clove garlic, while Ca, Mg and Zn were higher in Indigenous Multi-clove garlic but the Indigenous Single-clove garlic had higher Fe content when compared with the two other varieties. Despite considerable variance in nutrient contents of these garlic varieties, they are playing an important role in human nutrition. Because of the rarity of its kind, the present comparative study besides adding benefits to better understanding food chemistry may contribute facilitating the socio-economic and nutritional choice of these three cultivars by the consumers.

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

It is not applicable.

## FUNDING

## ACKNOWLEDGEMENTS

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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