Distribution and consumption patterns of indigenous vegetables in Ghana

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Abstract

Indigenous vegetables (IVs) are rich sources of essential nutrients, particularly vitamins and minerals, and other non-nutritive phytochemicals, and play a critical role in the food culture of the Ghanaian people. Despite their importance, they have over the years been mostly associated with the resource-poor. In this study, the types of IVs, preparation preferences, frequency of consumption and some perceived benefits ascribed by some Ghanaian consumers (n = 1393) were investigated in a cross-sectional survey. Descriptive analysis and a Chi-square test of independence were conducted to summarise and determine the relationship between gender, age and consumption frequency of the IVs. The study identified okra (*Abelmoschus esculentus*), cocoyam (*Xanthosoma sagittifolium*) leaves, jute mallow (*Corchorus olitorius*) and garden egg (*Solanum melongena*) as the popular IVs consumed by Ghanaians. Among these, about 13.3% females and 15.3% males indicated they consume okra. Eight per cent of the female respondents and 6.7% of the males consumed jute mallow. Almost 57% of the respondents said the IVs were used in the preparation of stew and soup. More than a third (39%) of the respondents indicated that they consumed the IVs either daily or more than once a week. Female respondents' frequency of IVs consumption was significantly different [X^2 (4, n = 1393) = 30.11, p = 0.000] from the males. The elderly self-reported frequency of consumption of IVs were significantly higher [X^2 (12, n = 1393) = 30.53, p = 0.002] compared with the younger respondents. Among the perceived benefits of IVs consumption were nutrition- and health-related; some stated responses were "give blood", "give energy/strength" and aids in digestion. Lack of money to purchase, non-availability, bitter taste and cultural reasons were some of the reasons given for the non-consumption of IVs.

Keywords: availability; preference; preparation; utilisation; gender; age; Ghana

Introduction

Indigenous vegetables herein referred to as IVs, are plant species that are native or introduced and have become part of the culture and tradition of a community (Maundu, 1997). They can also be referred to as traditional vegetables due to their long-time use, or they are plant species grown and consumed in specific locations, and mostly form part of traditional recipes.

Ghana is endowed with a wide range of nutrient-rich IVs (Abbiw, 1990; International Plant Genetic Resources Institute, 1997) that are well adapted to the characteristic adverse climatic conditions and marginal soils (Hughes and Ebert, 2013). These unique characteristics of the IVs do not only make them a potential food- and nutrition-security crops but also an income generation venture among most rural-poor households (Amagloh et al., 2017; Schippers,

2000). They are important for human health because of their micronutrients and other phytochemical contents (Amagloh et al., 2017). Phytochemicals are non-nutritive bioactive plant compounds that provide benefits; generally thought to act as antioxidants protecting the body from free radical damage (Holst and Williamson, 2008). Hence, the consumption of IVs is recommended as a positive way of improving nutrition and potentially reducing the onset of chronic diseases (Amo-Adjei and Kumi-Kyereme, 2015). IVs are also high in vital nutrients (e.g., Fe, Ca, Mg); thus, increased consumption of these vegetables may alleviate some micronutrient deficiencies (Nyadanu and Lowor, 2015). Micronutrient deficiencies are still a public health issue particularly in rural Ghana, where there is an overreliance on starchy root and cereal staples that are usually low in important micronutrients particularly iron and vitamin A (FAO, 2009).

There is a large diversity of IVs consumed across Ghana. Some of these IVs are commonly consumed in certain regions due to their availability, suitable climate and cultural preference (Abbiw, 1990). Notwithstanding the huge nutritional, economic and environmental potentials of IVs, their production, consumption and utilisation have not been purposively pursued (Nyaruwata, 2019). This has contributed to the underestimation and under exploitation of their potential value; invariably leading to loss of biodiversity, particularly the IVs collected from the wild, because of extinction.

Previous studies on IVs have focused on the nutritional value of leafy green vegetables (Dari and Mahunu, 2010; Darkwa and Darkwa, 2013; Glew et al., 2009; Nyadanu and Lowor, 2015); their use in the preparation of Ghanaian dishes (Darkwa and Darkwa, 2013); their conservation, utilisation and potential for commercialisation (Amisah et al., 2002); market share and preference by consumers (Osei-Kwarteng et al., 2012; Quaye et al., 2009); viability cost and popularity (Asase and Kumordzie, 2018); and agro-morphological characterisation (Nyadanu et al., 2014). Although these studies confirmed the importance of IVs in Ghanaian communities, there is no study reporting the distribution of IVs and their consumption patterns simultaneously in all the regions of Ghana. This study sought to identify the types of IVs and their distribution, the consumption pattern, utilisation preference, the perceived benefits and barriers to the consumption IVs in Ghana. The study also reviewed relevant literature on the chemical composition of IVs in sub-Saharan Africa.

Materials and Methods

Data collection

A cross-sectional survey was used to assess the types of IVs consumed, the frequency of consumption, preparation preferences and the perceived benefits ascribed to them by consumers. Google Forms and the KoBo collect toolbox were deployed for the online, household and community level surveys, respectively. The survey included respondents from the 16 regions of Ghana (Figure 1). For the community-level survey, a multistage cluster sampling technique was applied where each region represented a cluster. For each cluster, a district (sub-cluster) was randomly selected from a group of four divisions made on their respective regional maps.

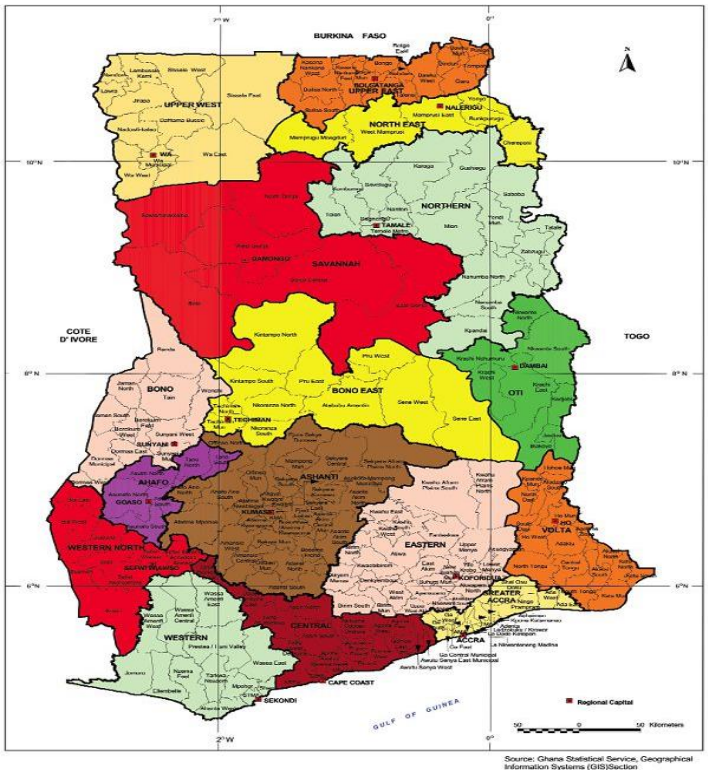

Figure 1 Map of Ghana showing all the 16 regions

The data collected from both the Google forms and community-level using Kobo collect were exported as a comma-separated values file to a Microsoft Office Excel document for pre-processing. Incomplete responses were removed, and follow-up calls were made to validate some responses. Local names of IVs that could not be ascertained after the follow-up calls were also coded as "could not be identified".

Statistical Analysis

The cleaned data was transported into the IBM Statistical Package for the Social Sciences version 23 (SPSS Inc., Chicago, IL, USA) and analysed using a descriptive scores procedure. Respondents were categorised into age groups (Horng et al., 2001) to enable an analysis of the responses with age and to correct for unequal sample size between gender (female, male) and the life-stage group as follows; (juvenile [15 – 19 years], youth [20 – 39 years], adult [40 – 59 years] and elderly [≥60 years]). Percentage within their respective category was used. Chi-square test of independence was used to explore the association between gender, age category and frequency of indigenous vegetable consumption.

Results and discussion

Demographic characteristics of respondents

Approximately 61% of the total respondents (n = 1393) were female. In general, there was a higher proportion of female respondents than male respondents in each of the 16 regions. The majority (60.7%; n = 846) of the respondents were within the youth (20-39 years) category (Figure 2). About a quarter (n = 370) of the respondents were adults (40-59 years), while the teenage (15-19 years) and the aged (>60 years) were 6.9% and 6.0%, respectively. The reason for the relatively high respondents within the youth life-stage category could be related to the mode of questionnaire administration, particularly the Google Forms administered online.

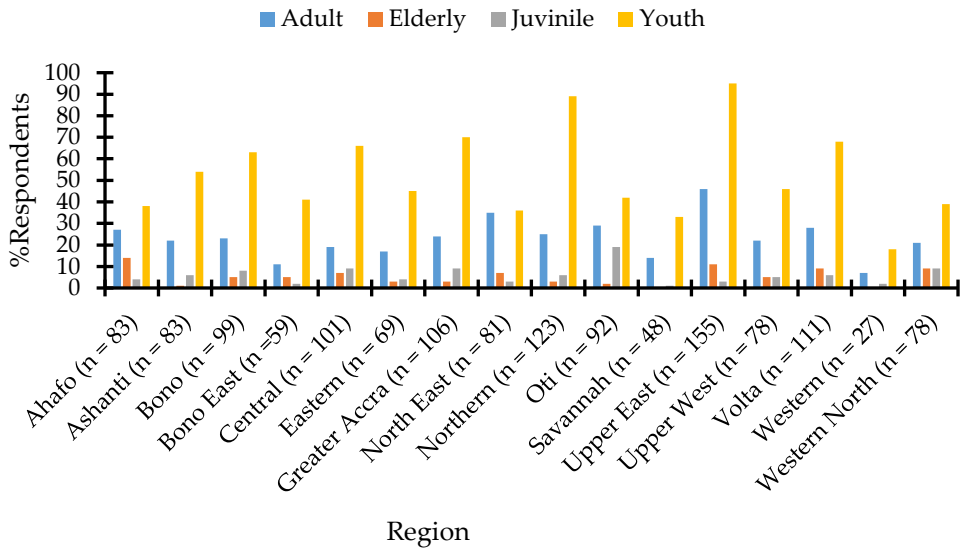

Figure 2 Age distribution of respondents

Range and consumption preferences of IVs consumed in Ghana

Figure 3 shows the IVs consumption preferences by respondents, the specific IVs are depicted in Figure 4. Okra, garden egg, cocoyam leaf and jute mallow were most widely consumed across all the regions in Ghana (Figure 3). This finding corroborates the study of Kpodo et al. (2015) who reported that cocoyam leaf, okra, and garden egg are among the commonly consumed vegetables in Ghana.

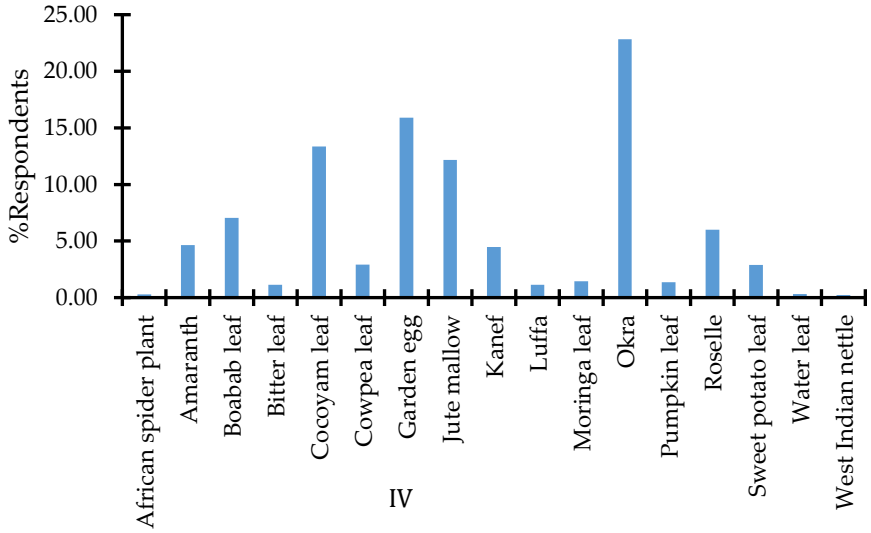

Figure 3 Consumption preference of IVs

Figure 4 Some commonly consumed IVs in Ghana

Among the most popular IVs reported, about 13.3% of females and 15.3% of males indicated they consume okra (Figure 5). For jute mallow, this was 8% of the female and 6.7% of the male, a similar number of female and male respondents said they consume garden egg (9.8%) as well as cocoyam leaf (8% *vs.* 8.5%, respectively).

Preferences of IVs based on gender

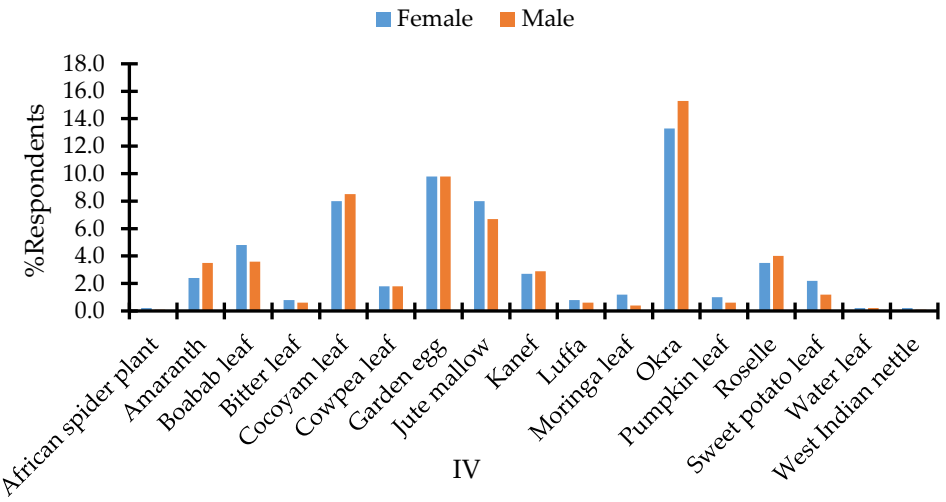

Figure 5 Gender preference of IVs

Nutritional information on selected IVs in Ghana

The selected IVs shown in Table 1 are rich sources of nutrient compositions as well as important phytochemicals such as β-carotene. The nutritional quality of cocoyam leaf, Amaranth leaf, waterleaf and Moringa leaf have been assessed by Kwenin et al. (2011) and found to contain significant levels of protein, fibre, and iron. The nutritional properties of raw, cooked and blanched West Indian nettle showed substantial levels of protein, fibre, β-carotene, calcium and iron (Rutto et al., 2013). Spider plant and cowpea leaves have been reported to contain good densities of protein, fibre, calcium, iron, and β-carotene even after subjecting them to varied blanching times and temperatures and solar-drying (Njoroge et al., 2015). The chemical composition data on IVs show that they are nutritionally rich. Their improved dietary use and consumption could play a significant contributory role in our quest to attain a food- and a nutrition-secured Ghana and beyond.

The content of these nutrients as shown in Table 1 do not necessarily imply bioavailability. For example, iron from plant sources has a low bioavailability of 5 – 12% (Hurrell and Egli, 2010). Therefore, there is a need for in vivo or in vitro studies to ascertain the bioavailability of the listed nutrients.

Table 1. Summarised nutritional information of selected IVs consumed in Ghana.

Name of IV	Chemical composition											
	Protein (g/100g)	Fat (g/100g)	Ash (g/100g)	Fibre (g/100g)	CHO (g/100g)	Moisture (g/100g)	Fe (mg/100g)	Ca (mg/100g)	Mg (mg/100g)	K (mg/100g)	Zn (mg/100g)	β-carotene (µg/100g)
Amaranth	3.8-4.5[bcd]	0.33[bcdf]	2.1-3.0[bc]	1.410.4[cd]	3.04.6[bc]	72.9-90.3[bcdj]	6.2-7.2[bc]	368-380[bc]	93-160[bc]	545-602[bc]	0.71[bc]	2890[bc]
Okra fruit	1.7[bc]	0.2[bc]	0.7[bc]	3.2- 4.1[bc]	4.2-4.3[bc]	86.6-89.1[bc]	0.80[bc]	84- 87[bc]	13-59[bc]	303-382[bc]	0.550.6[bc]	313-515[bc]
Okra leaf	2.5-2.7[bc]	0.3-0.6 [bc]	1.6-1.7 [bc]	4.9 [bc]	4.4-5.1 [bc]	85.2-89.8[b]	0.60 [bc]	297-303 [bc]	38-77 [bc]	199-297 [bc]	0.46-0.88 [bc]	672-802 [bc]
Cocoyam leaf	3.2-4.7 [bcd]	0.7-3.2[ad]	1.3-1.4 [bc]	1.6-10.0 [bcd]	2.4-6.8 [bcd]	85.8-90.2 [bcd]	2.1-14.6 [bcd]	63-74 [bcd]	42-64 [bc]	418-443 [bc]	0.41-0.62 [bc]	3570-4510 [bc]
Jute mallow	3.9-4.2 [bc]	0.30 [bc]	2.2-1.8 [bc]	2.0-8.3 [bc]	3.2-9.1[bc]	82.0-82.90 [bc]	4.2-7.2 [bc]	282-360 [bc]	58-77[b]	273-437 [bc]	0.44-0.76 [bc]	3130-3500 [bc]
Kenaf	2.8[c]	0.6[c]	1.3[c]	4.6[c]	5.2[c]	85.5[c]	7.7[c]	145[c]	83[c]	260[c]	0.65[c]	5280[c]
Cowpea leaf	4.4-4.6 [bc]	0.3 [bc]	1.6 [bc]	3.6-4.9 [bc]	1.7-3.3 [bc]	86.6-87.1[bc]	4.9-5.1 [bc]	258-265 [bc]	55-60 [bc]	475 [bc]	0.50-0.56 [bc]	1800-2440 [bc]
Sweetpotato leaf	4.4-27.5[bg]	0.2-2.23[bg]	1.8-2.0 [bc]	2.3-5.3 [bc]	4.9-6.7 [bc]	80.2-88.2[cgj]	3.6 [bc]	37-78 [bc]	61-70 [bc]	522-569 [bc]	0.29 [bc]	1710-5870 [bc]
Luffa fruits	0.46[k]	0.10[k]	0.26[k]	3.3[e]	3.86[k]	94.6[k]	34.1[k]	99.78[k]	27.38[k]	160[e]	9.52[k]	NA
Bitter leaf	4.4-5.0 [bc]	0.6-0.9[bc]	1.6-2.0 [bc]	5.1[bc]	5.5-6.7 [bc]	80.3-82.8 [bc]	2.1-2.8 [bc]	162-170 [bc]	58-95 [bc]	437-594 [bc]	1.01-1.88 [bc]	2900 [bc]
African eggplant fruit	1.10[bc]	0.2-0.30[bc]	0.6-0.70 [bc]	2.6-4.0[bc]	4.0-4.6[bc]	90.0-90.9[c]	0.9-1.4 [bc]	13-14[bc]	8-12[bc]	264-295[b]	0.14-0.28[bc]	30-47[bc]
African eggplant leaf	4.4[bc]	0.7-0.8[bc]	1.7[c]	1.9-4.2[bc]	3.7-4.2[bc]	85.3-87.1[bc]	3.2-4.3[bc]	332[bc]	58-81[bc]	437-443[bc]	0.73[bc]	3550-3560[bc]
Turkey berry	1.4-2.3[af]	0.3-1.8[af]	0.1-2.5[af]	0.7-4.0[af]	7.0-11[af]	84.4-86.2[af]	77-78[af]	67-222[af]	NA	695[f]	22[a]	78-95[af]
Roselle leaf	2.7-2.8[bc]	0.2-0.3[bc]	1.20[bc]	4.2-5.0[bc]	4.1-4.5[bc]	86.7-87.1[bc]	4.1-5.0[bc]	212[bc]	58-79[bc]	211-437[bc]	0.66-0.90[bc]	2580-2610[bc]
Waterleaf	2.30[c]	0.70[c]	1.60[c]	3.90[c]	4.30[c]	87.20[c]	1.10[c]	100[c]	163[c]	413[c]	0.84[c]	3330c
African spider plant	4.8[c]	0.9[c]	2.5[c]	4.3[c]	1.9[c]	85.6[c]	6.9[c]	268[c]	92[c]	478[c]	0.75[c]	3190[c]
Baobab leaf	3.9[b]	0.4[b]	2.8[b]	10.8[b]	5.4[b]	76.7[b]	3.5[b]	313[b]	52[b]	376[b]	0.90[b]	2558[b]
West Indian nettle	3.7[i]	0.6[i]	2.1[i]	6.4[i]	7.1[i]	89.0[i]	1.2[i]	278[i]	NA	NA	NA	5035[i]
Pumpkin leaf	3.7-4.1[bc]	0.2-0.3[bc]	1.9-2.5[bc]	2.3-2.4[bc]	1.3-2.4[bc]	88.6-90.4[bc]	2.20[bc]	39-383[bc]	38-142[bc]	468-500[bc]	0.2-0.9[c]	1230-1350[bc]
Moringa leaf	6.6-8.4[cd]	1.4- 1.5[cd]	2.4[c]	8.2-13.5[cd]	4.5[c]	75.0-75.1[cd]	10.3[c]	595[b]	68[b]	405[c]	1.20[c]	19700[b]

NA –Not available

[a] Akoto, O., Borquaye, L.S., Howard, A.S., and Konwuruk, N. (2015). Nutritional and mineral composition of the fruits of Solanum torvum from Ghana. International Journal of Chemical and Biomolecular Science *1*, 222-226.

[b] FAO (2012). West African Food Composition Table. (Rome: FAO).

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[i]Rutto, L.K., Xu, Y., Ramirez, E., and Brandt, M. (2013). Mineral properties and dietary value of raw and processed stinging nettle (Urtica dioica L.). International journal of food science *2013*.
[j]Tayie, F., and Asibey-Berko, E. (2001). Mineral contents of some indigenous vegetables of Ghana. Ghana journal of science *41*, 49-54.
[k]Jaysingrao, J. S., & Sunil, C. N. (2014). Nutritional Assessment of Fruits of Luffa acutangula var. amara. International Journal of Science and Research, 3(10), 2205–2207.

Utilisation preference of selected IVs

More than half (57%) of the respondents used the selected IVs in the preparation of stew and soup, while 27% of respondents indicated they used them for soups only (Figure 6). Kpodo et al (2015) reported a similar percentage (52%) of respondents who used vegetables for stew. The IVs were generally wet-cooked and consumed as a stew or soup. This is expected because most Ghanaian staples (*fufu*, *banku*, *tuo zaafi*, *kenkey*, rice and *rice balls*) are eaten with stew and/or soup as an accompaniment. Although cooking of IVs is practised to improve their texture, colour, aroma and appearance, it may have implications on nutrient bioavailability and content. For instance, Acho and co-worker (2014) reported that prolonged cooking (>15 min) of IVs resulted in a significant decrease in nutritive value. Therefore, there is a need to modify the current domestic cooking processes that could take more than 15 minutes to preserve or improve nutrient retention and bioavailability of these IVs. Only 0.3% of the respondents indicated they use IVs for salad, which is a form likely to retain most of the micronutrients but with limited bioavailability.

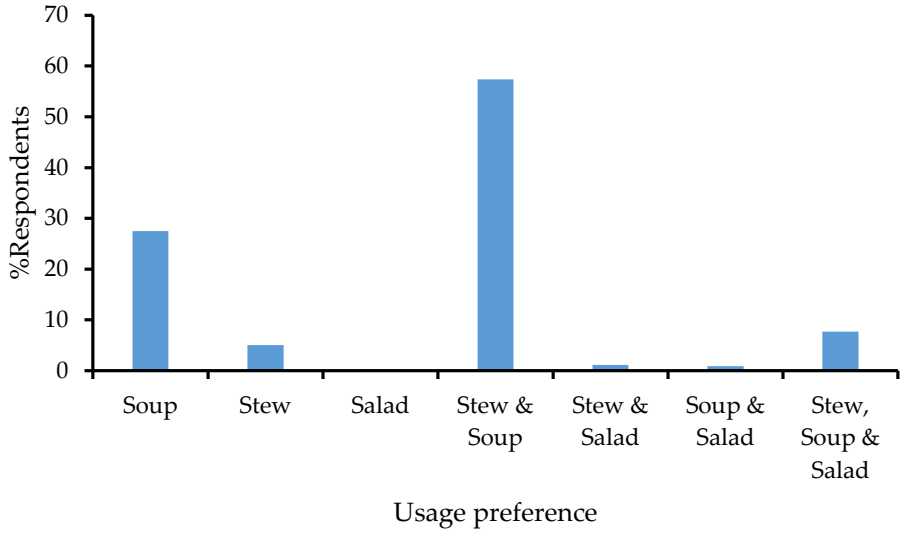

Figure 6 Preferred usage of IVs

Consumption frequency of IVs

More than a third (39%) of the respondents indicated that they consumed IVs either daily or more than once a week (Figure 7). About 13% consumed the IVs once a week, almost twice the number of respondents who consumed them occasionally. About 1% hardly consumed IVs (Figure 7). These findings suggest that the consumption of IVs is generally high among Ghanaians. This can be explained as it is not likely for a Ghanaian to eat a meal that excludes soup or stew, and these accompaniments include vegetables such as IVs as the base ingredient. The high frequency of daily or more than once consumption is contrary to the Ghana Demographic and Health Survey report of 2014 found that on average, women and men consumed vegetables on four of the seven days before the administration of the survey (GSS et al., 2015). It is likely that there is under-reporting of vegetable consumption owing to Ghanaian food consumption pattern that has soup or/and stew, at least once daily.

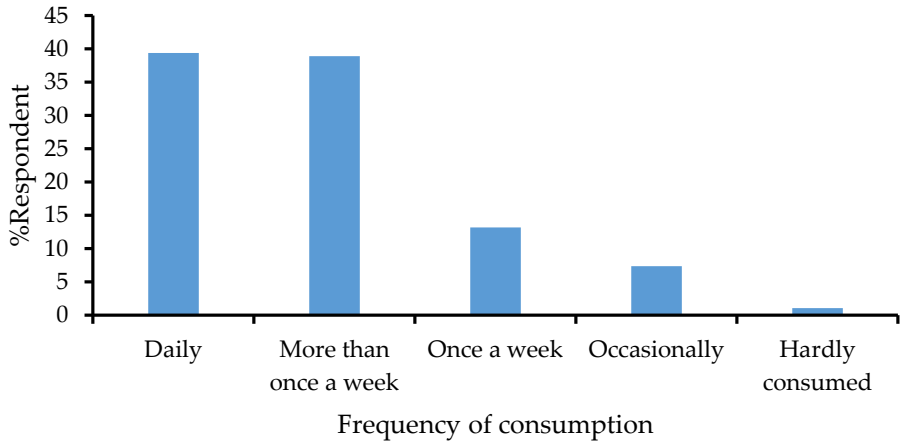

Figure 7 Frequency of consumption of the selected IVs in Ghana

Consumption frequency based on gender

About 43% of males indicated they consumed IVs daily compared to 37% of the females (Figure 8). Conversely, about 42% of the female respondents consumed IVs more than once a week relative to their male (34%) counterparts. Almost the same number of male and female respondents indicated they consumed IVs once a week (13%) or rarely consumed (1%). This supports our earlier suggestion that IVs consumption is relatively high owing to how meals are prepared in Ghana. Based on the benefits of IVs and their limited cultivation as most are picked from the wild, there is the need for the development of a functional seed system for IVs in Ghana.

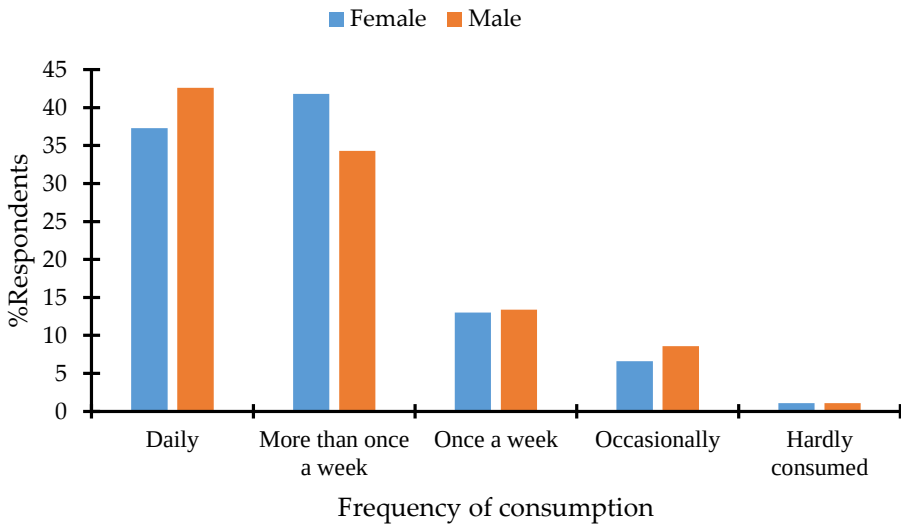

Figure 8 General consumption pattern of selected IVs based on gender

The relation between gender and frequency of IV consumption was significantly different, [X^2 (4, n = 1393) = 30.11, p < 0.001]. Thus, female respondents were more likely to consume IVs compared with their male counterparts. The results agree with earlier works that showed that more females than men were likely to show likeness for IVs such as okra (Kpodo et al., 2015). The reasons for the observed difference may be that females have nutrition-related knowledge on IVs, confidence in accessing and preparing nutrient-rich foods or perceive to lose weight by eating vegetables compared to males. Ghanaian women are also more aware of the ingredients for preparing stew and soup as they are often the ones preparing them. Hence they report more accurately on how often they consume IVs than their male counterparts.

Consumption frequency based on age

A Chi-square test results, aimed at exploring association between frequency of indigenous vegetable consumption and age, indicated a significant difference in self-reported frequency of IV consumption [X2 (12, n = 1393) = 30.53, p = 0.002] (Figure 9). This implies that, as one ages, there is an increased likelihood of consumption of IVs. Almost 46% of the respondents in the elderly category indicated they consumed IVs daily while about 43% of adults consumed IVs more than once a week. This finding is consistent with that of Gido et al. (2017), who reported a significant increase in the frequency of IV consumption with the advancement of the age of the respondent. Knowledge on how to prepare, medicinal and nutritional benefits are likely to be higher in elderly people compared with the youth leading to more vegetable consumption in the former.

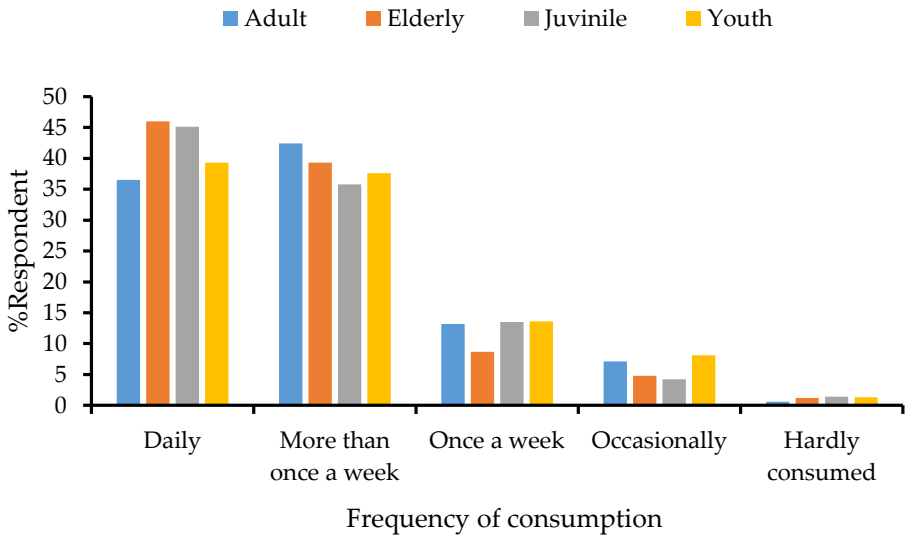

Figure 9 General consumption pattern of selected IVs based on gender

Perceived benefits of IVs

Almost all the perceived benefits of selected IVs mentioned by the respondents were related to improved nutrition and health. Consumption of IVs was reported to "give blood", "give energy/strength" and to aid in digestion as presented in Table 2. IVs provide families with alternative sources of nutrients that are cheaper and easily accessible (Lewu and Mavengahama, 2010; Padulosi et al., 2019).

Table 2 Summary of respondent's perceived benefit of IVs consumption

Perceived Benefits	Category
Provides Vitamins, Minerals and gives fibre	Nutrition
Gives blood and energy	Health and Nutrition
Improves health and muscle growth	Health
Boost appetite and ease swallowing	Sensory appeal
Prevents disease and provides water-soluble vitamins	Health and Nutrition
Act as a catalyst in the human system and good for diabetic patients	Health and Nutrition
Easy digestion and avoid constipation	Nutrition
Protects the body and reduces cholesterol levels	Health
Nourishments of skin and repair worn-out tissues	Health

Controls blood pressure, anaemia, increase sperm production	Health
Reduces fat content and provides protein	Nutrition
Boost immune system and free bowels	Health & Nutrition
Prevents anaemia and prevents fever	Health
Boost immune system and enhances blood circulation	Health
Gives clear vision	Health
Treatment of throat infections	Health
Enhances growth and vitality	Health & Nutrition
Stimulates milk production in lactating mothers	Nutrition
Medicinal benefits	Health
Contains Antioxidants	Health & Nutrition
Prevents stress and ageing and enhances sperm production	Health
Prevents blood clothing (*clotting)* and provides anti-inflammatory compounds	Health
Reduces stomach ulcer	Health
Provides folic acid	Nutrition
Prevents weight gain, obesity and reduces diabetes	Health & Nutrition
Prevents malaria and relief joint pains	Health
Boost bone density and has antibacterial properties	Health & Nutrition
Contains bioactive compounds for good health	Health
Enhances child labour in pregnant women	Health
Enhances strong teeth and bone marrow formation	Health
Enhances satiety	Nutrition
Absorption of toxins and prevents allergy in food	Health
Aids in foetal growth	Health & Nutrition
Protects the nervous system	Health

Perceived barriers to consumption of IVs

The study results indicate that the key barriers to IVs consumption are related to non-availability (seasonality and non-existence), poor sensorial quality (taste and colour), sociocultural (taboos and beliefs), lack of (economic) access, knowledge of how to prepare, allergy and non-familiarity (Figure 10). MacLellan and others (2004) reported similar barriers to vegetable and fruit consumption. An understanding of these perceived barriers to IVs consumption is important in addressing them and can increase the range of available IVs to consumers for improved food and nutrition security.

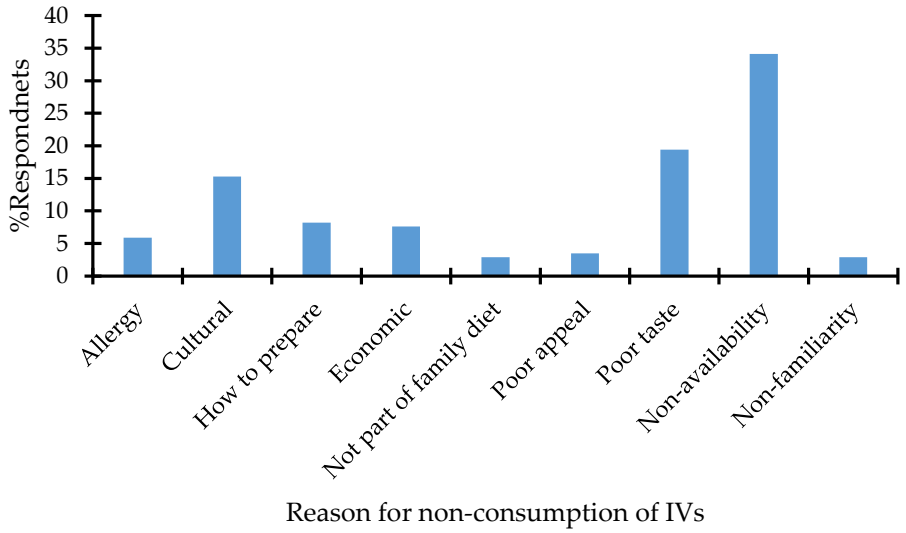

Figure 10 Barriers to IVs consumption

Study limitation

The study could not assess the portion/quantity of vegetable consumed at each serving, and this limited our ability to make deductions of the adequacy of the quantity consumed. Also, the online survey was limited to owners of smartphones as the survey was done online.

Conclusion

The priority IVs that are consumed by the respondents are cocoyam leaf, garden egg, okra, luffa, turkey berry, jute mallow, baobab leaf, roselle, cowpea leaf, kenaf, sweet potato leaf, and west India nettle. Only a few of the respondents said they hardly consumed IVs. These IVs were wet-cooked and used in stew and/or soup. Generally, the perceived benefits of IV consumption were mostly nutritional and health-related; some stated responses are "give blood", "give energy/strength" and aids in digestion. Lack of money to purchase, unavailability, poor taste, cultural reasons were some of the reasons given for the non-consumption of IVs.

The consumption of the priority IVs is not restricted to a life-stage group. However, the elderly were more inclined to consume the IVs daily compared with the youth. There is a potential for promoting the consumption, product development for value addition and commercialisation of selected IVs. Future work should consider the composition and bioavailability of essential key nutrients (iron, zinc and β-carotene) from as would-be-eaten basis and not on a dry matter basis as previously reported in the literature.

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Availability of data and materials

All data and materials are publicly available and are cited in the text. Stated products are for information only and do not imply a recommendation by the authors.

Ethical approval and consent to participate

This was a low-risk survey. However, consent was sought from the respondents who can decide on their own before completion of the questionnaire both online and face-to-face in the community.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

RAA and MAA drafted the manuscript while JD, SB, LD, MO-K, GKM, IK and FKA edited the manuscript. All authors read and approved the final manuscript.

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