Journal of Ethnic Foods

ORIGINAL ARTICLE Open Access

Types of indigenous vegetables consumed, preparation, preferences and perceived benefits 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. IVs 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 respondents. Among these, about 13.3% of women and 15.3% of men indicated they consume okra. Eight per cent of the women respondents and 6.7% of the men consumed jute mallow. Almost 57% of the respondents said the IVs were used to prepare 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. Women respondents' frequency of IVs consumption was significantly different [X^2 (4, $n = 1393$) = 30.11, $p = 0.000$] from the men. The frequency of consumption of IVs for the elderly was significantly higher [X^2 (12, $n = 1393$) = 30.53, $p = 0.002$] as compared to the younger respondents. The main perceived benefits of IVs were nutrition- and health-related. The major barriers to the consumption of IVs were cost, non-availability, palatability and cultural. The IVs were largely wet-cooked and consumed as stews or sauces and soups. These findings form good bases for further empirical studies on the nutritional and other health-benefiting attributes of the specific IVs found in this study for sustainable promotion and utilisation in Ghana.

Keywords: Availability, Indigenous, Preference, Preparation, Stew, Soup, Utilisation

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 [1]. 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 [2].

The Ghanaian ecology is endowed with a wide range of nutrient-rich IVs [3, 4] that adapt well to the characteristic adverse climatic conditions and marginal soils [5]. These unique characteristics of the IVs do not only make them a potential food- and nutrition-security crop but also an income generation venture among most rural poor households [6, 7]. Their micronutrients and other

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phytochemical contents are important for human health [6]. The consumption of IVs is recommended as a positive means of improving nutrition and potentially reducing the onset of chronic diseases [8].

IVs are high in vital nutrients (e.g. Fe, Ca, Mg); thus, increased consumption of these vegetables may alleviate some micronutrient deficiencies [9]. Micronutrient deficiencies are a public health issue, particularly in rural Ghana, where there is an overreliance on staples such as starchy roots and cereals that are usually low in important micronutrients, particularly iron and vitamin A [10]. The consumption of fruits and vegetables that are relatively high in some of these micronutrients is rather below the recommended amount [11]

There is a large diversity of IVs consumed across Ghana; some IVs are commonly consumed in specific regions due to their availability, suitable climate and cultural preference [3]. For example, IVs such as amaranth, roselle, kenaf, cowpea leaves, *Corchorus*, pumpkin and baobab leaves are more available in the northern part of the country [12, 13]. On the other hand, IVs including cocoyam leaves, luffa fruits and Turkey berry are more common in the southern Ghana [12]. Some IVs such as okra and garden eggs seem to be common throughout the country [14]. However, as more efforts are being made to diversify the cultivation and consumption of fruits and vegetables, farmers cultivate IVs from other ethnographical locations [15, 16]. The distribution of IVs to other parts of the nation is particularly enhanced by the movement and settlement of people at different parts of the country other than their ancestral locations [17–19] as a result of job posting, quest for economic opportunities, or conflicts.

Despite the huge nutritional, economic, agronomic and environmental potentials, their production, consumption and utilisation have not been purposively pursued [20]. This neglect has contributed to the under-exploitation and underestimation of their potential value, invariably leading to loss of biodiversity, particularly the IVs collected from the wild, because of extinction [20–23].

Previous studies on IVs have focused on the nutritional value of leafy green vegetables [9, 24–26]; their use in the preparation of Ghanaian dishes [24]; their conservation, utilisation and potential for commercialisation [27]; market share and preference by consumers [28, 29]; viability cost and popularity [30]; and agro-morphological characterisation [31]. Although these studies confirmed the importance of IVs in Ghanaian communities, there is no research that simultaneously reports the types of IVs consumed in the various regions of Ghana, the consumption patterns. This study attempted to identify the types of IVs and their distribution, the consumption pattern, utilisation preference, perceived benefits and barriers to the consumption of IVs in Ghana. The study also reviewed relevant literature on the chemical composition—in Ghana and the West African Sub-region.

Materials and methods

Study design and setting

A cross-sectional study was conducted using online Google Forms [32] and a community-level survey to collect quantitative data from respondent in August 2020 in Ghana. The republic of Ghana lies within latitude 4° 44′′ and 11° 11′′N and 3° 11′′W and 1° 11′′E [33]. The country is bordered by Togo to the east, Cote d'Ivoire to the west, and Burkina Faso to the north with 16 administrative regions (Fig. 1) and 216 administrative metropolitan, municipal and district assemblies. The population of Ghana is 30,832,019 million according to the 2021 census [34] with a population density of 129.3 person/sq.km. About 60.4% of the population falls between the age of 18 and 64 years old and the proportion of men and women of 49.3 and 50.7%, respectively [34]. A little more than half (56.7%) of the population dwell in the urban areas and 43.3% live in rural Ghana. According to the 2021 census, 30.2% of persons of 6 years and older are not literate in any language which is higher among women (34.4%) than men (25.9%) [34].

The country can be categorised into six major ecological zones, largely defined and characterised by soil, vegetation and climate which directly affect the types of food crops and IVs grown in a particular ecological zone. The agro-ecological zones include Rain Forest, Deciduous Forest, Coastal Savanna, Transitional Zone, and Northern Savanna (subdivided into Guinea and Sudan Savanna). The different agro-ecological zones exhibit different climate characteristics. The Coastal Ghana has 26.1 °C mean annual temperature, while the far North has 28.9 °C [35] Similarly, Guinea Savanna and Sudan Savanna receive a mean annual rainfall of 1100 mm and 1000 mm, respectively, and is characterised by wooded savannah with trees such as baobab, acacias and shea trees, which have adapted to the environment over time. The rain forest receives a mean annual rainfall of about 2200 mm [35]. For bimodal rainfall zones, the major rainfall season starts from March to July, while the minor season is from September to October. In the case of mono-modal rainfall zones, the season starts from July to September [35]. These therefore reinforce the major and minor farming seasons in Ghana.

Data collection and tools

A semi-structured questionnaire was used to assess the types of IVs consumed, the frequency of consumption, preparation preferences and the perceived benefits ascribed to them by consumers. The questionnaire was

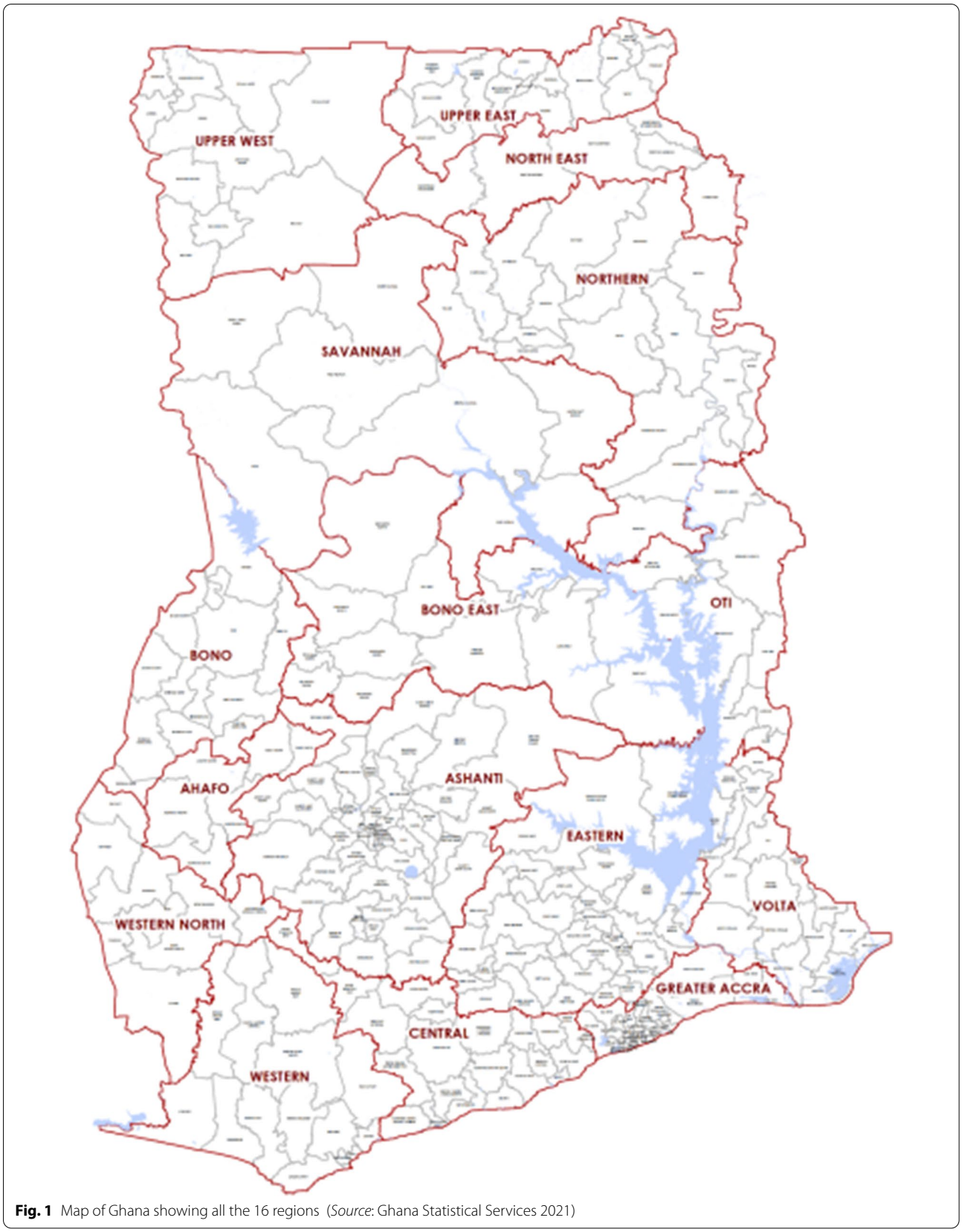

Fig. 1 Map of Ghana showing all the 16 regions (*Source*: Ghana Statistical Services 2021)

pre-tested electronically (email and WhatsApp contact) and physically. Feedback was solicited on clarity of questions, order of questions, skip patterns, timing, and task difficulty. Questions were adapted accordingly, and the questionnaire was finalised. The survey tool was deployed to respondents through known emails, partner organisations, and social media platforms, mainly WhatsApp and Facebook, for the online survey. Only one response was allowed per device, hence increasing the reliability of the data.

For the community-level survey, a multistage cluster sampling technique was used primarily to ensure an easier acquisition of data and access to diverse groups of people [34, 36–39] with each region being a cluster. Per each cluster, a district (sub-cluster) was randomly selected from a group of four divisions made on their respective regional maps [34]. The questionnaire was administered by enumerators using the Kobo toolbox with the features of recoding global positioning system (GPS) location and timestamp for quality control purposes, speed and efficiency, and reduced cost in data collection [40]. In total, 345 respondents participated in the online survey and 1048 participated in the community-level survey.

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 coded as "could not be identified" (CNBI).

Statistical analysis

The cleaned data were uploaded into the IBM Statistical Package for the Social Sciences version 23 (SPSS Inc., Chicago, IL, USA) and analysed using the descriptive scores procedure. Respondents were also categorised into age groups as reported elsewhere [41] to enable an analysis of the responses with age. To correct for unequal sample size between gender (women, men) and life-stage group (juvenile [15 – 19 years], youth [20 – 39 years], adult [40 – 59 years] and elderly [≥ 60 years]), percentages within their respective category were used [6]. The chi-square test of independence was used to explore the association between gender, age category and frequency of indigenous vegetable consumption.

Ethical consideration

The present study considered the guidelines for ethical issues for data collection according to [42], particularly the principle of autonomy, privacy, and indebtedness. Permission was obtained from the respondents for the online and community/household-level survey by informing participants about the nature and overall aims of the research, the purposes for the data collection, and the task participants are required to perform [42]. Participation in the survey was entirely voluntary, and participants had the option of declining to answer-specific questions or leaving the entire questionnaire blank if they did not wish to participate; however, none opted out of the interviews. The completed questionnaire did not contain any identifying information about the individual subjects. All data were kept confidential, and data protection was observed at all stages of the study.

Results and discussion

Demographic characteristics of respondents

Approximately 61% of the total respondents (n = 1393) were women. In general, there was a higher proportion of women respondents than men respondents in each of the 16 regions. This perhaps indicates the fact that vegetables are culturally ascribed to women in most parts of Ghana since women normally do the purchasing and cooking in households. Hence, women tended to volunteer more for the survey. Generally, females are known to consume more vegetables per weak than males in all agro-ecological zones of Ghana [8]. The majority (60.7%; n = 846) of the respondents were within the youth (20–39 years) category (Fig. 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 relatively high number of respondents being in the youth life-stage category could be related to the mode of questionnaire administration, particularly the Google Forms that were administered online. Combining the responses of the youth and the adult groups, their contributions amounted to approximately 88%. Since these groups are considered the working class (20–59 years), the data generated are relevant for making important deductions about IVs in Ghana.

Range of IVs consumed

The respondents indicated they consumed Amaranth (*Amaranthus spp.*), okra (*Abelmoschus esculentus*), cocoyam (*Xanthosoma sagittifolium*) leaves, jute mallow (*Corchorus olitorius*), kenaf (*Hibiscus cannabinus*) leaves, cowpea (*Vigna unguiculata*) leaves, sweet potato (*Ipomoea batatas*) leaves, luffa fruits (*Luffa spp.*), bitter leaf (*Vernonia amygdalina*), African eggplant (*Solanum melongena*) leaves and fruits, roselle (*Hibiscus sabdariffa*), garden eggs (*Solanum macrocarpon*), waterleaf (*Talinum fruticosum*), African spider plant (*Cleome gynandra*), west Indian *nettle (Laportea aestuans)*, pumpkin (*Cucurbita maxima*) leaves and fruit, moringa

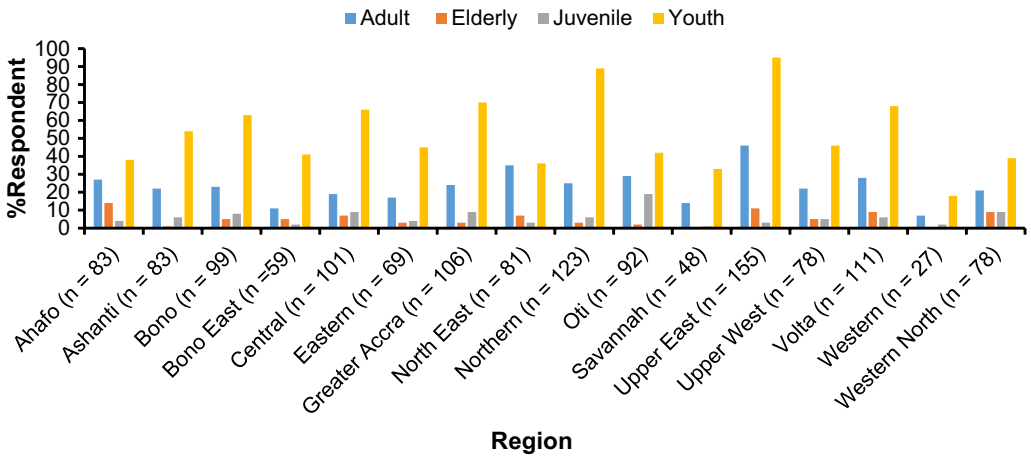

Fig. 2 Age distribution of respondents

(*Moringa oleifera*) leaves and baobab (*Adansonia digitata)* leaves (Fig. 3). Okra, garden egg, cocoyam leaf and jute mallow were most widely consumed across all the regions in Ghana (Fig. 4). This finding corroborates the study of Kpodo et al. [43], who reported that cocoyam leaf, okra and garden egg are among the most commonly consumed vegetables in Ghana. Issaka et al. [44] also reported similar IVs in Northern Ghana. The extensive consumption of these IVs could be attributed to the fact that they are complements to most of the cereal-based staples including *banku, tuo zaafi, kenkey*, etc. Another reason for the popularity of these IVs could be that they are readily available and could be bought from local markets, grown in home gardens and easily collected in the wild [45]. These four IVs are good sources of protein, fibre, vitamins (A, B, C and E), antioxidants and minerals (Ca, K and Fe). The respondents also justified that the consumption of these IVs helps to prevent or control constipation, anaemia, diabetes and heart diseases and helps to improve immunity and general body health. The

Fig. 3 Commonly consumed IVs in Ghana

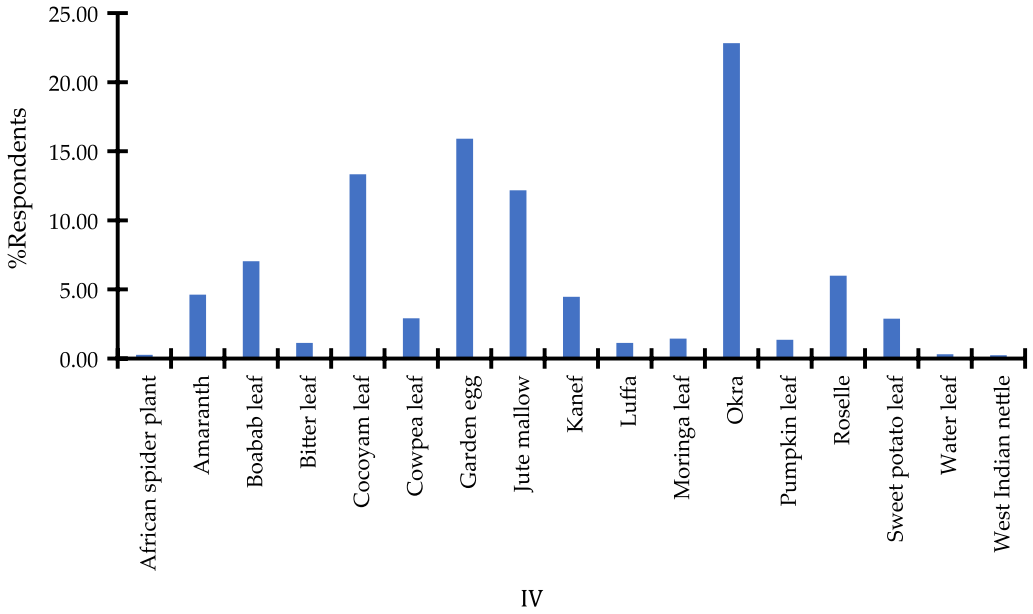

Fig. 4 IVs consumption preference

IVs were also indicated to have good sensorial properties and hence make soups and stews very delicious and appetising. Nutritional value, sensorial appeal and health benefits are also cited as reasons for the consumption of IVs in Tanzania [46].

Nutritional information of selected IVs in Ghana

Available data on the nutritional composition of some of the IVs covered in this study have been reviewed and are presented in Table 1. The information presented in this study is based on a review of relevant related literature in Ghana and the West African Sub-region. The selected IVs have previously been reported to be 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 has been assessed by Kwenin et al. [47] 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 [48]. 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 [49]. The nutritional value of garden egg leaves and fruits has been extensively studied [50–52]. Recently, FAO/INFOODS compiled some nutritional properties (proximate, mineral, bioactive compounds and antinutrients) of most of the IVs (fresh, dried, raw and boiled) in West Africa into a composition table [53].

The chemical composition data on IVs as presented in Table 1, which are relevant to Ghana, show that the under-listed IVs are nutritionally rich, as such their improved dietary use and consumption could play a significant contribution to food and nutrition security. However, the nutritional content of the IVs does not imply bioavailability. For example, iron from plant sources has a low bioavailability of 5–12% [54]. Therefore, there is a need *for* in vivo or in vitro studies to ascertain the bioavailability of the listed nutrients.

Consumption preferences

Among the most popular IVs reported, 13.3% of women and 15.3% of men indicated they consume okra (Fig. 5). For jute mallow, this was 8% for women and 6.7% for men; an equal number of women and men respondents said they consume garden egg (9.8%) and cocoyam leaf (8% *vs.* 8.5%, respectively). A higher preference by women as in the case of jute mallow might be expected because according to Baker and Wardle [62] women consume higher levels of vegetables than men because they are better informed about healthier diets. Moreover, the preference for IVs requires knowledge of preparation and cooking techniques. Men are less likely to have adequate knowledge on these matters because culturally women are believed to possess more knowledge regarding IVs collection. Notwithstanding, preference is highly affective and may not necessarily be directly linked to frequency of use, which could partially explain the higher preference by men for okra and cocoyam leaf. One reason that the

Table 1 Summarised nutritional information of selected IVs consumed in Ghana

Name of IV	Nutrients											
	Protein (g/100 g)	Fat (g/100 g)	Ash (g/100 g)	Fibre (g/100 g)	CHO (g/100 g)	Moisture (g/100 g)	Fe (mg/100 g)	Ca (mg/100 g)	Mg (mg/100 g)	K (mg/100 g)	Zn (mg/100 g)	β-carotene (µg/100 g)
Amaranth	3.8–4.5 [47, 53, 55]	0.33 [9, 47, 53, 55]	2.1–3.0 [53, 55]	1.4–10.4 [47, 53]	3.04.6 [53, 55]	72.9–90.3 [47, 53, 55, 56]	6.2–7.2 [53, 55]	368–380 [53, 55]	93–160 [53, 55]	545–602 [53, 55]	0.71 [53, 55]	2890 [53, 55]
Okra fruit	1.7 [53, 55]	0.2 [53, 55]	0.7 [53, 55]	3.2- 4.1 [53, 55]	4.2–4.3 [53, 55]	86.6–89.1 [53, 55]	0.80 [53, 55]	84- 87 [53, 55]	13–59 [53, 55]	303–382 [53, 55]	0.550.60 [53, 55]	313–515 [53, 55]
Okra leaf	2.5–2.7 [53, 55]	0.3–0.6 [53, 55]	1.6–1.7 [53, 55]	4.9 [53, 55]	4.4–5.1 [53, 55]	85.2–89.8 [55]	0.60 [53, 55]	297–303 [53, 55]	38–77 [53, 55]	199–297 [53, 55]	0.46–0.88 [53, 55]	672–802 [53, 55]
Cocoyam leaf	3.2–4.7 [47, 53, 55]	0.7–3.2 [47, 55]	1.3–1.4 [53, 55]	1.6–10.0 [47, 53, 55]	2.4–6.8 [47, 53, 55]	85.8–90.2 [47, 53, 55]	2.1–14.6 [47, 53, 55]	63–74 [53, 55]	42–64 [53, 55]	418–443 [53, 55]	0.41–0.62 [53, 55]	3570–4510 [53, 55]
Jute mallow	3.9–4.2 [53, 55]	0.30 [53, 55]	2.2–1.8 [53, 55]	2.0–8.3 [53, 55]	3.2–9.1 [53, 55]	82.0–82.90 [53, 55]	4.2–7.2 [53, 55]	282–360 [53, 55]	58–77 [55]	273–437 [53, 55]	0.44–0.76 [53, 55]	3130–3500 [53, 55]
Kenaf	2.8 [53]	0.6 [53]	1.3 [53]	4.6 [53]	5.2 [53]	85.5 [53]	7.7 [53]	145 [53]	83 [53]	260 [53]	0.65 [53]	5280 [53]
Cowpea leaf	4.4–4.6 [53, 55]	0.3 [53, 55]	1.6 [53, 55]	3.6–4.9 [53, 55]	1.7–3.3 [53, 55]	86.6–87.1 [53, 55]	4.9–5.1 [53, 55]	258–265 [53, 55]	55–60 [53, 55]	475 [53, 55]	0.50–0.56 [53, 55]	1800–2440 [53, 55]
Sweet potato leaf	4.4–27.5 [55, 57]	0.2–2.23 [55, 57]	1.8–2.0 [53, 55]	2.3–5.3 [53, 55]	4.9–6.7 [53, 55]	80.2–88.2 [53, 56, 57]	3.6 [53, 55]	37–78 [53, 55]	61–70 [53, 55]	522–569 [53, 55]	0.29 [53, 55]	1710–5870 [53, 55]
Luffa fruits	0.46 [58]	0.10 [58]	0.26 [58]	3.3 [59]	3.86 [58]	94.6 [58]	34.1 [58]	99.78 [58]	27.38 [58]	160 [59]	9.52 [58]	NA
Bitter leaf	4.4–5.0 [53, 55]	0.6–0.9 [53, 55]	1.6–2.0 [53, 55]	5.1 [53, 55]	5.5–6.7 [53, 55]	80.3–82.8 [53, 55]	2.1–2.8 [53, 55]	162–170 [53, 55]	58–95 [53, 55]	437–594 [53, 55]	1.01–1.88 [53, 55]	2900 [53, 55]
African egg-plant fruit	1.10 [53, 55]	0.2–0.30 [53, 55]	0.6–0.70 [53, 55]	2.6–4.0 [53, 55]	4.0–4.6 [53, 55]	90.0–90.9 [53]	0.9–1.4 [53, 55]	13–14 [53, 55]	8–12 [53, 55]	264–295 [55]	0.14–0.28 [53, 55]	30–47 [53, 55]
African egg-plant leaf	4.4 [53, 55]	0.7–0.8 [53, 55]	1.7 [53]	1.9–4.2 [53, 55]	3.7–4.2 [53, 55]	85.3–87.1 [53, 55]	3.2–4.3 [53, 55]	332 [53, 55]	58–81 [53, 55]	437–443 [53, 55]	0.73 [53, 55]	3550–3560 [53, 55]
Turkey berry	1.4–2.3 [60, 61]	0.3–1.8 [60, 61]	0.1–2.5 [60, 61]	0.7–4.0 [60, 61]	7.0–11 [60, 61]	84.4–86.2 [60, 61]	77–78 [60, 61]	67–222 [60, 61]	NA	695 [61]	22 [60]	78–95 [60, 61]
Roselle leaf	2.7–2.8 [53, 55]	0.2–0.3 [53, 55]	1.20 [53, 55]	4.2–5.0 [53, 55]	4.1–4.5 [53, 55]	86.7–87.1 [53, 55]	4.1–5.0 [53, 55]	212 [53, 55]	58–79 [53, 55]	211–437 [53, 55]	0.66–0.90 [53, 55]	2580–2610 [53, 55]
Waterleaf	2.30 [53]	0.70 [53]	1.60 [53]	3.90 [53]	4.30 [53]	87.20 [53]	1.10 [53]	100 [53]	163 [53]	413 [53]	0.84 [53]	3330 [53]
African spider plant	4.8 [53]	0.9 [53]	2.5 [53]	4.3 [53]	1.9 [53]	85.6 [53]	6.9 [53]	268 [53]	92 [53]	478 [53]	0.75 [53]	3190 [53]
Baobab leaf	3.9 [55]	0.4 [55]	2.8 [55]	10.8 [55]	5.4 [55]	76.7 [55]	3.5 [55]	313 [55]	52 [55]	376 [55]	0.90 [55]	2558 [55]
West Indian nettle	3.7 [48]	0.6 [48]	2.1 [48]	6.4 [48]	7.1 [48]	89.0 [48]	1.2 [48]	278 [48]	NA	NA	NA	5035 [48]
Pumpkin leaf	3.7–4.1 [53, 55]	0.2–0.3 [53, 55]	1.9–2.5 [54, 55]	2.3–2.4 [53, 55]	1.3–2.4 [53, 55]	88.6–90.4 [53, 55]	2.20 [53, 55]	39–383 [53, 55]	38–142 [53, 55]	468–500 [53, 55]	0.2–0.9 [54, 55]	1230–1350 [53, 55]
Moringa leaf	6.6–8.4 [47, 53]	1.4- 1.5 [47, 53]	2.4 [53]	8.2–13.5 [47, 53]	4.5 [53]	75.0–75.1 [47, 53]	10.3 [53]	595 [55]	68 [55]	405 [53]	1.20 [53]	19700 [55]

Data sources are in parentheses

NA No data available

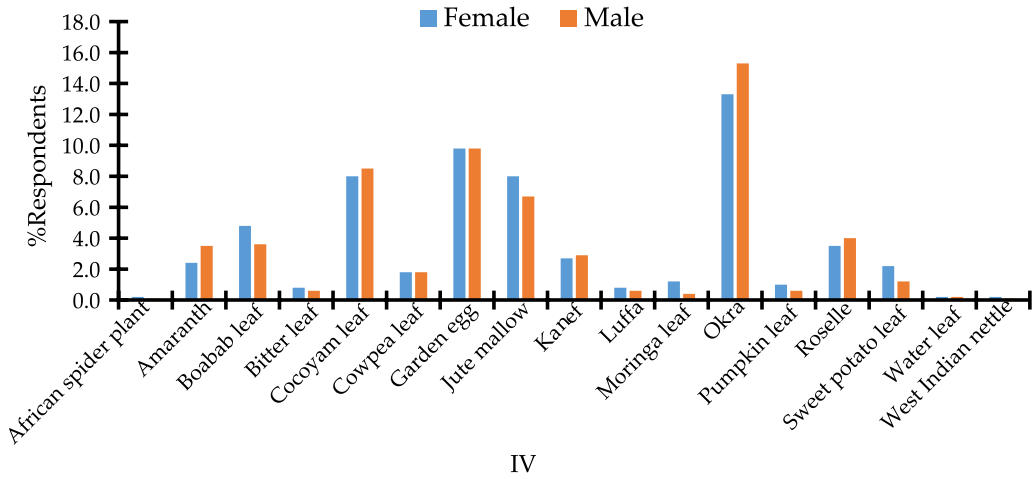

Fig. 5 Gender preference of IVs

male respondents gave for the consumption of okra and cocoyam leaf was that these two IVs boost sperm production. Much as this opinion may be mythical, with no empirical data to support, it could be the main reason for the higher preference by men for okra and cocoyam leaves recorded in the study.

Utilisation preference of selected IVs

The IVs were generally wet-cooked and consumed as a stew or soup, more than half (57%) of the respondents used the selected IVs to prepare stew and soup, while 27% of respondents indicated they used them for soups only (Fig. 6). Kpodo et al. [43] reported a similar percentage (52%) of respondents who used vegetables for stew. This is expected because most Ghanaian staples (*fufu*, *banku*, *tuo zaafi*, *kenkey*, rice and *rice balls*) are eaten with stew or soup as an accompaniment. This observation is consistent with those of Nti et al. [63] who reported that vegetables and by extension IVs form part of the main meal.

Although cooking of IVs is practised to improve their texture, colour, aroma and appearance, it may have implications on nutrient bioavailability and content. Prolonged cooking (>15 min) of IVs results in a significant decrease in nutritional value [64] and is a key barrier to the consumption of dishes prepared from IVs [49]. Only 0.3% of the respondents indicated they

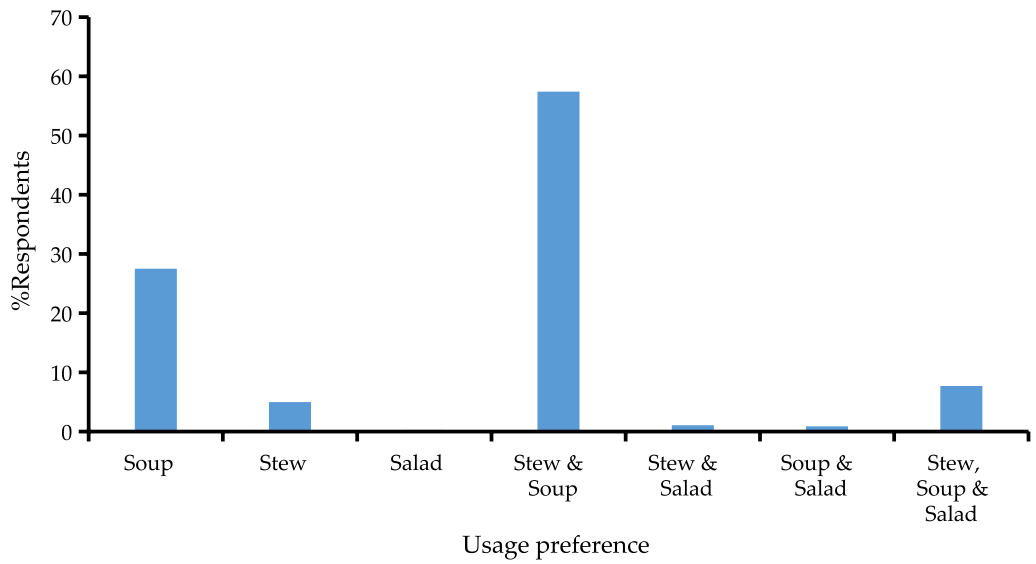

Fig. 6 Preferred usage of IVs

use IVs for salad, which is a form likely to retain most of the micronutrients but with limited bioavailability. Therefore, there is a need to modify the current domestic cooking processes that generally take more than 15 min, to preserve or improve nutrient retention and bioavailability thereof.

Consumption frequency of IVs

Respondents were asked how often they consumed the IVs they indicated as their preferred IVs, which was used to obtain the frequency of consumption. More than a third (39%) of the respondents stated that they consumed IVs either daily or more than once a week (Fig. 7). About 13% of the respondents said they consumed the IVs once a week, almost twice the number of respondents who consumed them occasionally. About 1% of the respondents said they hardly consumed IVs (Fig. 7). The daily consumption of IVs in the current study is slightly higher than the 21–33% daily consumption of dark green vegetables okra and garden eggs [63]. These recent 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 vegetable(s) including IVs as the base ingredient, although often the quantities are quite small. The relatively high frequency of daily or more than once a week consumption is contrary to the Ghana Demographic and Health Survey report of 2014 found that on average, women and men consumed vegetables on 4 of the 7 days before the administration of the survey [65]. This is likely to be under-reporting of vegetable consumption owing to the Ghanaian food consumption pattern of soup and/or stew at least once daily.

Consumption frequency based on gender

About 43% of men indicated they consumed IVs daily compared to 37% of the women (Fig. 8). Conversely, about 42% of the women respondents consumed IVs more than once a week relative to their men (34%) counterparts. Almost the same number of men and women respondents indicated they consumed IVs once a week (13%) or rarely consumed them (1%). This assertion supports our earlier suggestion that IVs consumption is relatively high owing to how meals are prepared in Ghana. These findings, however, differed from the findings of similar studies in Tanzania and Zimbabwe [46, 66] where higher numbers of women more frequently consumed IVs than men.

A chi-square test of independence was performed to test the association between gender and frequency of consumption of IVs. The relation between gender and frequency of IV consumption was significantly different [X^2 (4, $n=1393$) = 30.11, $p<0.001$]. Thus, women respondents were more likely to consume IVs than their men counterparts. The results agree with earlier works that showed that more women than men were likely to show preference for fresh vegetables [67] including IVs such as okra [43]. The observed difference may be that women have nutrition-related knowledge on IVs, confidence in accessing and preparing nutrient-rich foods or perceive to lose weight by eating vegetables compared to men. Ghanaian women are also more aware of the ingredients for preparing stew and soup as they are often preparing them. Hence, they report more accurately on how often they consume IVs than their men counterparts.

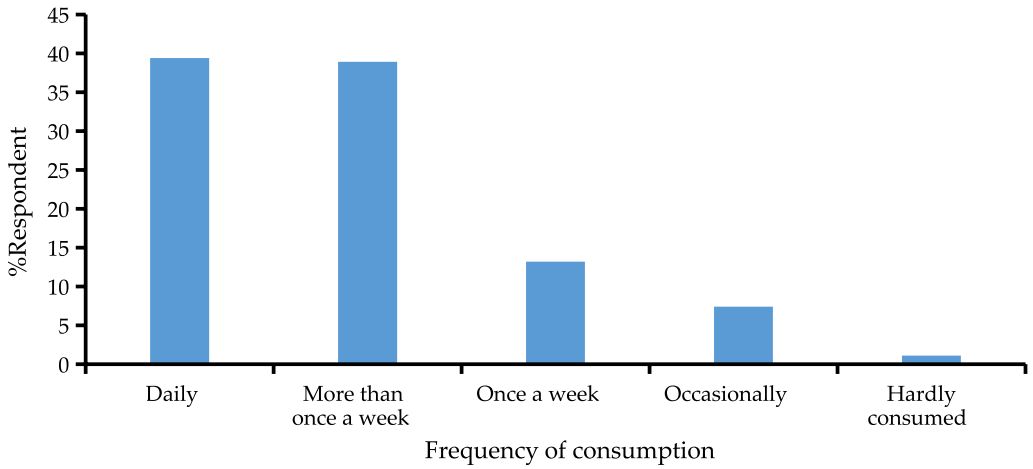

Fig. 7 Frequency of consumption of the selected IVs in Ghana

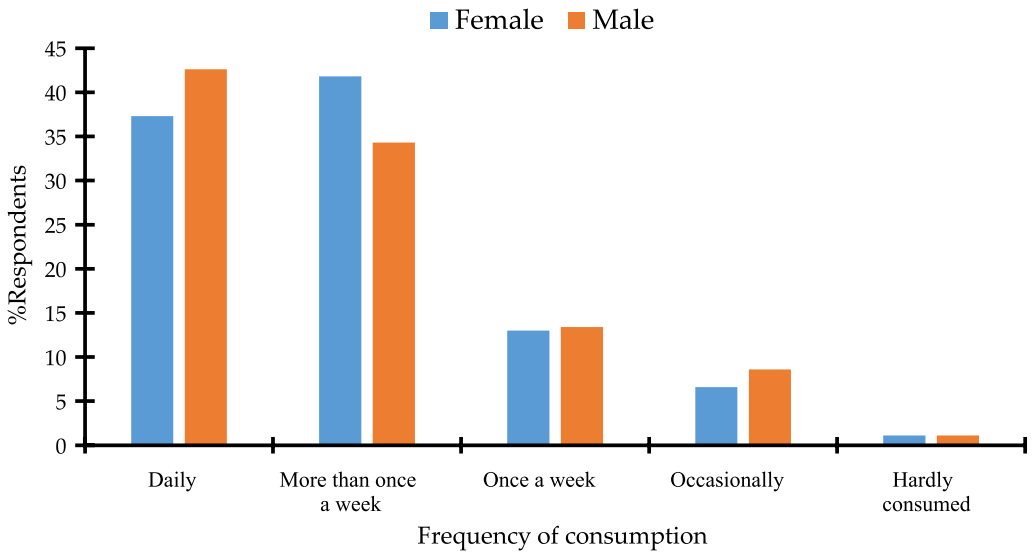

Fig. 8 Consumption pattern of selected IVs based by gender

Besides, earlier studies have shown that women are more particular about weight loss than men, hence are more likely to choose more energy-deficient and high-fibre diets like fruit and vegetables [68]. On the other hand, men mostly engage in higher energy-demanding tasks than women, so maybe more prone to the consumption of high-energy dense foods [8]. Adequate consumption of fresh vegetables has also been reported to cause skin lightening through the enhancement of skin carotenoid concentration [69–71]; a lighter skin is preferred by women [8, 72] may be the motivating factor for women preference for fresh vegetables.

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 [X^2 (12, $n=1393$) = 30.53, $p=0.002$] (Fig. 9). With age, IVs are more likely to be consumed. 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. [73], who reported a significant increase in the frequency of IV consumption with the advancement of the respondent's

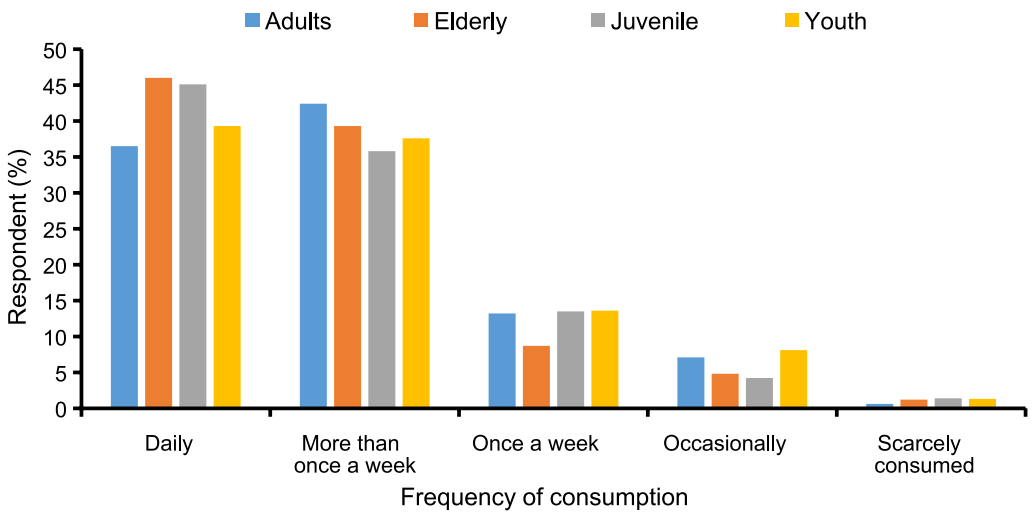

Fig. 9 General consumption pattern of selected IVs based on gender (confirm the spelling of the third category: juvenile)

age. Knowledge on how to prepare medicinal and nutritional benefits are likely to be higher in older people compared with the youth, leading to more vegetable consumption in the former [74]. Moreover, the IVs are also perceived to be more natural and organic.

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 aid digestion as presented in Table 2. This finding corroborates earlier works by Kansiime et al. [46] who also reported that the key health benefit of IVs perceived by respondents in Northern Tanzania includes improving vision, increasing haemoglobin in the body (reduced anaemia), and increasing body immunity; giving the body energy, healthy skin development, repair of body tissues, and helping children grow. Although there is a diversity of IVs across Africa, there is some homogeneity in terms of their perceived nutrition and health benefits. Comparing the empirical nutritional information of the IVs (Table 1) with the perceived benefits the respondents gave, there seemed to be some correlation. For example, most of the IVs (Table 1) have higher values of protein, fibre, carbohydrate, calcium, potassium, magnesium and β-carotene which are

Table 2 Summary of respondent's perceived benefit of IVs

Perceived benefits	Nutrition	Health	Sensory
Provides vitamins, minerals and gives fibre	√		
Gives blood and energy	√	√	
Improves health and muscle growth		√	
Boost appetite and ease swallowing			√
Prevents disease and provides water-soluble vitamins	√	√	
Act as a catalyst in the human system and is good for diabetic patients	√	√	
Easy digestion and avoiding constipation	√		
Protects the body and reduces cholesterol levels		√	
Nourishments of skin and repair of worn-out tissues		√	
Controls blood pressure and anaemia and increases sperm production		√	
Reduces fat content and provides protein	√		
Boosts immune system and free bowels	√	√	
Prevents anaemia and prevents fever		√	
Boosts immune system and enhances blood circulation		√	
Gives clear vision		√	
Treatment of throat infections		√	
Enhances growth and vitality	√	√	
Stimulates milk production in lactating mothers	√		
Medicinal benefits		√	
Contains antioxidants	√	√	
Prevents stress and ageing and enhances sperm production		√	
Prevents blood clotting and provides anti-inflammatory compounds		√	
Reduces stomach ulcer		√	
Provides folic acid	√		
Prevents weight gain and obesity and reduces diabetes	√	√	
Prevents malaria and relief joint pains		√	
Boosts bone density and has antibacterial properties	√	√	
Contains bioactive compounds for good health		√	
Enhances child labour in pregnant women		√	
Enhances strong teeth and bone marrow formation		√	
Enhances satiety	√		
Absorbs toxins and prevents allergy in food		√	
Aids in foetal growth	√	√	

key sources of most of the perceived benefits. Similar benefits were highlighted by respondents for IVs elsewhere [46, 75]. IVs may potentially improve overall well-being in marginal sectors of the community and nutrition in communities with lower income levels [76].

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 (financial) access [8], knowledge of how to prepare, allergy and non-familiarity (Fig. 10). Some respondents cited the seasonal availability of some IVs such as false sesame and West Indian nettle as a factor that inhibited their consumption, while other respondents regarded IVs as non-existent which might indicate that the specific IVs are uncommon in their localities. The seasonality and non-existence of some IVs set as a key consumption barrier to some of the respondents. For example, some respondents from the southern part of the country indicated that amaranth, baobab leaf, cowpea leaf, and sweetpotato leaf were unavailable in their localities. On the other hand, respondents from the northern part of the country gave the non-availability of cocoyam leaf in their communities as a reason for not consuming it. Respondents ascribed the unappealing taste of Turkey berry, African spider plant, cassava leaf and bitter leaf as a reason for not consuming them. It is also interesting to note that some of the IVs were not consumed because of cultural beliefs (food taboo) and could either have positive or negative effects on human nutrition. This could go a long way to undermine health and nutritional needs of people, especially the vulnerable in society. On the other hand, certain allergies and depression are associated with the consumption of certain foods so if such food items which are causal agents for the allergies are declared food taboos, the health of such individuals would be protected [77]. For example, some respondents from the Northern Region considered the baobab tree to be a god and that consuming the baobab leaf would attract a death penalty from the gods or may weaken them during battles because of how slippery the soup of the IV appears. This corroborates previous works by Gadegbeku and co-workers [78] who advance similar reasons why some people from Dagbon (Northern region) do not consume okra. Some Volta Region respondents believed okra to cause waist lock and joint pains, resulting in sexual weakness among men, while respondents from the Upper East believed okra leaf induces blindness in men. Respondents from the Western Region said jute mallow and okra were not suitable for men because they reduce men fertility, while some respondents from the North East Region said their gods forbid the consumption of pumpkin leaf.

That aside, the high price was a reason hindering the consumption of IVs such as Turkey berry, false sesame and eggplant. Lack of knowledge of how to use IVs such as cocoyam leaf, cowpea leaf, amaranth, okra leaf and fresh cocoa leaf was why some respondents did not consume them. Some respondents said they vomited any time they consumed IVs such as cowpea leaf and bitter leaf, while others said they got stomach upset when they consumed African spider flower. MacLellan et al. [79] and Zulu et al. [80] reported similar barriers to vegetable and

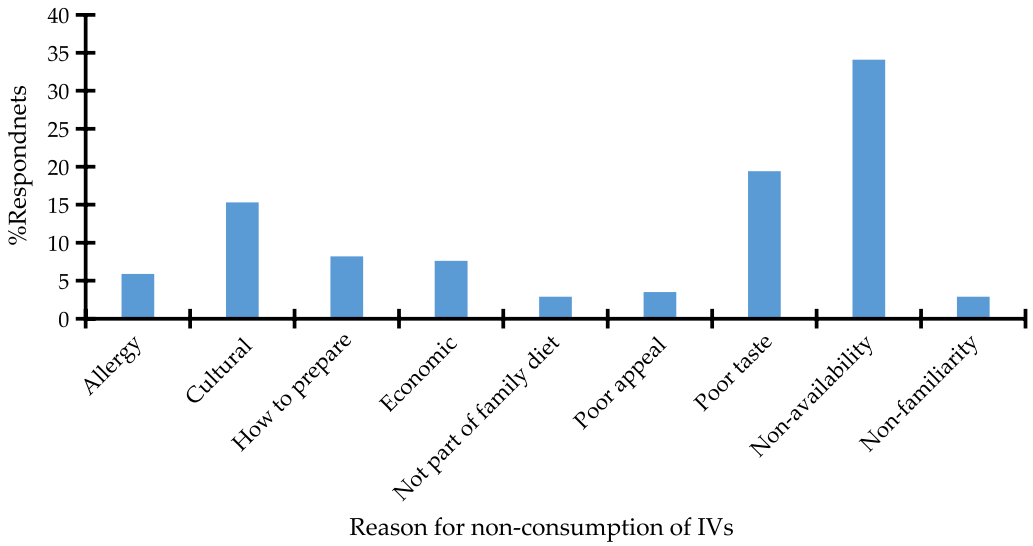

Fig. 10 Barriers to IVs consumption

fruit consumption. These findings may offer many useful insights that could help fashion effective nutritional campaigns as an information dissemination strategy and their role in changing perceptions about IVs in Ghana. Besides, the results shed light on gaps that require further attention, to further support production and consumption of micronutrient-dense IVs for better nutrition. The results also indicate that strong cultural food beliefs and taboos still exist, which strongly influence attitudes towards traditional vegetables.

Study limitation

Due to the design of the study, the portion or quantity of vegetables consumed at each serving could not be assessed, limiting our ability to make deductions of the adequacy of the quantity consumed. In addition, the online survey was limited to owners of smartphones as the survey was done online. The compositional analysis of the popular IVs consumed in Ghana is based on available data in the literature but was not analysed in this study.

Conclusion

The priority IVs that the respondent consume are okra, cocoyam leaf, garden egg, 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 are wet-cooked and used in stew and/or soup. Generally, the perceived benefits of IV consumption were mostly nutrition- and health-related. The responses suggest that the benefits of consuming IVs were related to nutrition- and health-related; some stated responses are "give blood", "give energy/strength" and aid digestion. Lack of money to purchase, unavailability, poor taste and cultural reasons were some of the reasons 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 than the youth. There is a potential for promoting the consumption, product development for value addition and commercialisation of selected IVs. Based on the benefits of IVs and their limited cultivation as most are picked from the wild, there is a need to develop a functional seed system for IVs in Ghana.

Future work should consider the composition and bioavailability of essential key nutrients (iron, zinc and β-carotene) from would-eaten samples and not on a dry matter basis as previously reported in the literature. Although reporting the compositional data of IVs on would-be-eaten basis may limit comparison with other studies due to the difference in moisture, it accurately measure the amount of a particular nutrient in a food sample when consumed. This has important nutritional implications because reporting IV data on dry matter basis may overestimate the composition of nutrients and does not actually reflect the amount of nutrient in the IVs in the form it is consumed and can significantly affect nutritional outcomes. Hence, the need to focus on estimating the nutrient in IVs as would-be-eaten and not on dry matter basis.

The non-availability barriers to IVs consumption could be addressed by raising the reputation of IVs, and this goes a long way to convince policy-makers at local level to support optimisation of the value chain, e.g. by allocating funds to support farmers to obtain quality seeds and provide irrigation facilities and extension services to promote the production of IVs. Besides, improved processing technology and recipe refinement using IVs will also help improve their sensorial and minimise the levels of antinutrients that may cause allergies when consumed. Proper documentation and campaigns through radio talk shows, farmer field schools and workshops on the nutritional value of IVs and their processing method will also help address barriers such as non-familiarity and how to prepare.

Acknowledgements

We wish to thank our field officers and the respondents for their time during the household-level survey.

Author contributions

All authors were involved in the research design, data collection and analysis. RAA and MAA drafted the manuscript, while JD, SB, LD, MOK, GKM, IK and FKA edited the manuscript. All authors read and approved the final manuscript.

Funding

This study was done as part of the HortiFresh programme, funded by the Embassy of the Netherlands, Accra (grant number 4000001025).

Availability of data and materials

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

Declarations

Ethical approval and consent to participate

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

Competing interests

The authors declare that they have no competing interests.

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Received: 17 November 2021 Accepted: 1 September 2022
Published online: 08 September 2022

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