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Potential of *egusi* for food and nutrition security in northern Ghana: gender perspectives and social constructs underpinning cultivation and use

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Background: Using indigenous underutilized crops as a sustainable measure to mitigate food and nutrition insecurity is recommended globally. Few studies have explored the factors influencing the value placed on indigenous underutilized crops such as *egusi* in African food systems. *Egusi*, oleaginous edible seeds of cucurbitaceous plants with inedible pulp, are cultivated for the seeds and commonly used in West African cuisines.

Objective: This study investigates the sociocultural importance of *egusi* and its value to nutrition and food security in growing communities of northern Ghana. It further explores the gender underpinnings and influences on *egusi* production and use and evaluates the strategies indigenous smallholder *egusi* farmers use to cope with the current climate dynamics.

Methods: Gender and age-differentiated Focus Group Discussions (10) and Key Informant interviews (14) were conducted in Chereponi and Kpandai Districts of northern Ghana.

Results: Our findings show that the primary factors influencing the premium placed on the crop(s) differ between males and females. There has also been a change in the social construct of *egusi* in recent years due to the impact of climate-induced food insecurities. For Chereponi which is relatively drier than Kpandai, *egusi* is now a *must-farm crop* if one's household is to survive during lean seasons. It is no longer viewed as a woman's crop. However, Kpandai, with a relatively wetter climate, has other cropping alternatives. A unanimous response from all study participants reveals latent functions of cultivating *egusi*, which includes children's education and reduced financial burdens.

Conclusions: This study underscores how *egusi* plays critical roles in the nutrition and livelihood of Ghanaian communities and can be the starting point for tailored and extensive investigations on the value of *egusi* to both enhance climate resilience and sustainable nutrition. The findings further demonstrate the critical

need for a comprehensive study of the foodscapes of malnourished communities to enable appropriate policy directives for sustainable nutrition interventions.

KEYWORDS

underutilized species, indigenous crops, climate change, cucurbit seeds, egusi, nutrition, survey, farming communities

1 Introduction

There is a global need for diverse solutions to address food and nutrition insecurity. Sub-Saharan Africa suffers extreme food insecurity and poverty, making it necessary to employ various innovative measures to enhance food sufficiency and sustainable nutrition for its populace. Neglected and underutilized crops, especially those with high resilience against harsh weather and climate change, have been recommended as having substantial potential to contribute to food and nutrition security more than they are currently exploited (FAO, 2024; Padulosi et al., 2002; Mayes et al., 2012). However, as Hunter et al. (2019) pointed out, exploration of such crops will only be effective in transforming food systems if there is empirical data informing policy and strengthened coordinated engagements between the diverse stakeholders working with these species. Limited studies have explored the social underpinnings of their value in traditional food systems, restricting their optimal and accelerated exploitation in food and nutrition intervention strategies.

Egusi crops (*Citrullus lanatus* (Thunb.) Matsum. & Nakai var. *lanatus*) are largely oleaginous edible seeds of cucurbitaceous plants with inedible pulp. They are popular in tropical Africa and Asia but remain largely underexplored, although it is highlighted as a potential food security crop (FAO, 2024; National Research Council, Global Affairs, Security, and Cooperation, 2006; Koffi et al., 2008). Cucurbitaceae is a botanical family. The several reported common names are *Citrullus Lunatus*, *Lagenaria siceraria*, *Cucumeropsis edulis*, *Citrullus vulgaris*, *Cucumeropsis manii*, *Telfaria occidentalis*, *Citrullus colocynthis*, *Cucumis melo*, and *Cucurbita pepo* (National Research Council, Global Affairs, Security, and Cooperation, 2006; Zoro Bi et al., 2006). Each of these general terms has been referred to and used as egusi in sub-Saharan Africa, giving rise to the classification of *egusi* as a food category rather than as a botanical designation (Logan, 2012).

In West Africa, the commonly attributed species to egusi are *Citrullus Lanatus* Thunb, *Citrullus lanatus* (Thunb.) Mansf, *CitrullusVulgaris* Schrader, *Citrullus vulgaris* Eckl. and Zeyh. (also, watermelon), *Colocynthis citrullus* (L.) Kuntze, and *Colocynthis citrullus* Linnaeus (National Research Council, Global Affairs, Security, and Cooperation, 2006). Other authors have ascribed egusi to *Citrullus colocynthis*, *Cucumis melo*, *Cucumeropsis edulis*, *Cucumeropsis manii*, and *Cucurbita pepo* (Zoro Bi et al., 2006; Steiner-Asiedu et al., 2014; Akusu and Emelike, 2018), and these are largely classified into two: *Egusi* (for the climbing species) and *Neri* (for the creeping species) but more loosely, *egusi*, to encompass both types. There have been very limited studies to ascertain the true taxa of the varieties found in different localities in Ghana. The multiple landraces also have diverse local names, including 'Akatuoa', 'Kel', and 'Agushie' for the climbing type and 'Wrewre/Werewere' and 'inabe' for the creeping type. In this study, the term 'egusi' is used loosely to encompass the cucurbit species present in the study communities. Where necessary, a distinction is made using its

morphological characteristics: climbing or creeping species, and the local name.

Ghana is among the major consumers of egusi in sub-Saharan Africa (National Research Council, Global Affairs, Security, and Cooperation, 2006). Its production is primarily concentrated in Northern Ghana, where many of the farming communities suffer high levels of malnutrition and food insecurity (National Development Planning Commission (NDPC), 2012; Amugsi et al., 2013) and are the most vulnerable to climate change impacts (Antwi-Agyei et al., 2012). While the crop has been consumed for many years, it has not received significant research and development attention despite its nutritional value, especially in rural areas (Fajinmi et al., 2022), and the growing urban consumer demand. The crop has also been noted as playing a critical role in ensuring food security and supporting livelihoods, particularly during the lean season. The different types of egusi are popular in making traditional soups and stews/sauces. In urban Ghana, the climbing types are best known for their importance in the popular "palaver sauce" and the creeping type for the special "werewere" soup. Both types are, however, used either for soups or stews in rural Northern Ghana. This research was undertaken to inform the exploration of *egusi* as a nutrition-security crop in rural Ghana. It was expedient to engage the growing communities of the crop and to ascertain the sociocultural factors at play in their food systems to inform the next steps in the food exploration of egusi. The objectives of this study were to (i) investigate the sociocultural importance of egusi and its value to nutrition and food security in growing communities of northern Ghana; (ii) explore the gender underpinnings and influences on egusi production and use; and (iii) evaluate the strategies indigenous smallholder egusi farmers use to cope with the current climate dynamics.

2 Methods

2.1 Study design and sites

The study was undertaken in two districts of Ghana, covering three communities, Mbowura in Kpandai district and Chombosu and Tambong in Chereponi district (Figure 1). These communities were selected based on the guidance from the Ministry of Food and Agriculture (MoFA) officials on the egusi-producing communities in Ghana and the reported malnutrition levels (Frempong and Annim, 2017).

2.2 Participants and sampling method

A purposive sampling approach (Creswell and Poth, 2016) with assistance from the Agricultural Extension Officers (AEAs) from the districts was used to identify 14 key informants (KIs) along the *egusi*

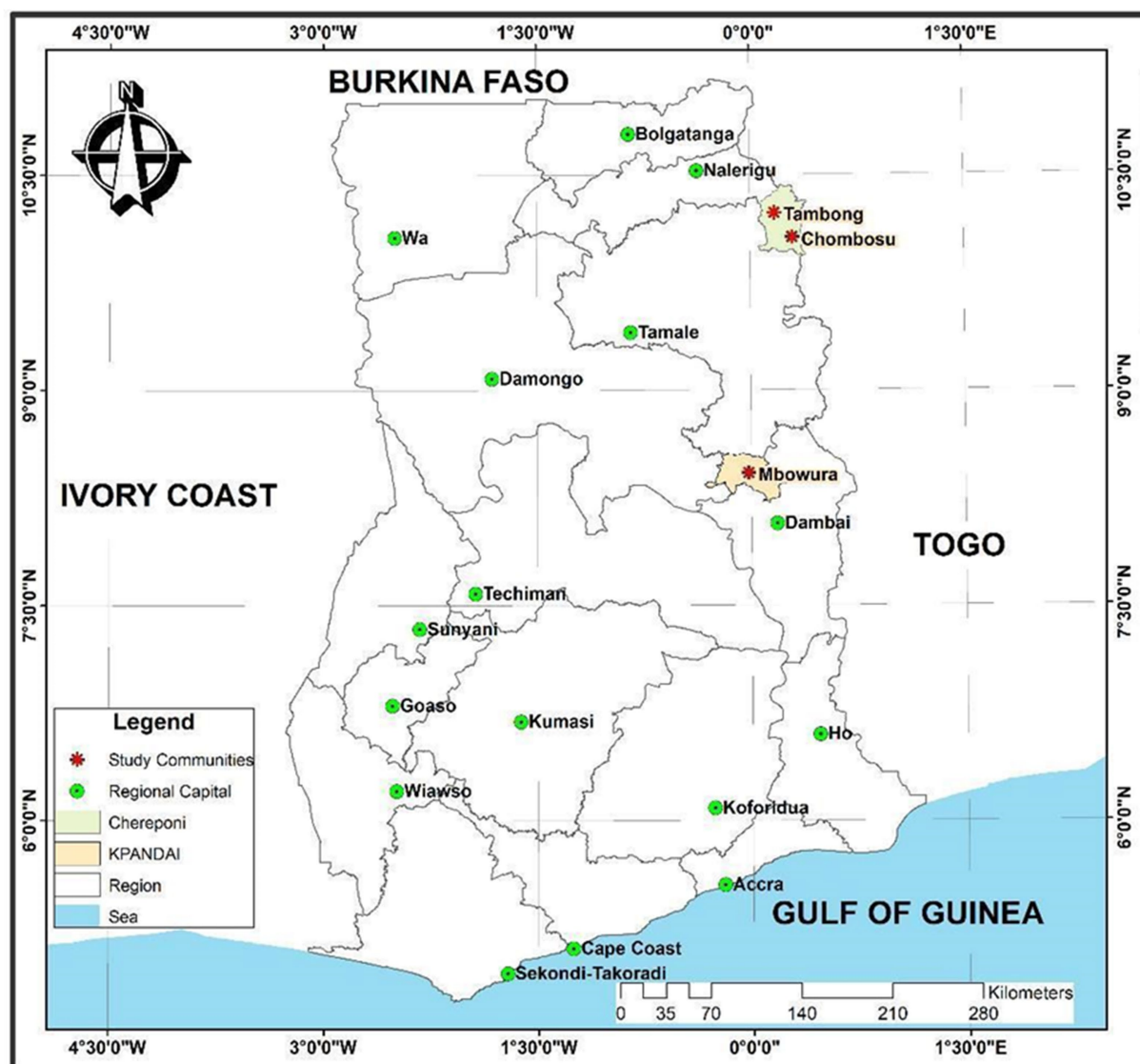


FIGURE 1
The map of Ghana showing the locations of the study communities.

value chain for individual interviews. Semi-structured interview guides were used in all interviews and focus group discussions (FGDs).

Focus groups were disaggregated by sex and age with four FGDs in each community: adult male group, adult female group, youth female group, and youth male group, except for Kpandai, where two FGDs were held, one for female and one for male groups. Youth referred to 'never married' male or female participants from 18 to 35 years. The gender and age disaggregation was undertaken for two main reasons:

1. to improve the participation of women and the youth by allowing them to express themselves freely.
2. to elucidate the gender underpinnings in the local food systems. We ensured a representation of women, men, and youth in all engagements.

A total of 10 FGDs were held, lasting between 1 and 3 h. Fourteen key informant interviews (KIIs) were conducted, four from the

Kpandai district and 10 from the Chereponi district. The selection considered social standing, occupation, and ethnicity to ensure that the in-depth information received from the key informants to triangulate and evaluate information from the FGDs was unbiased. Interviewees included community heads, experienced and respected farmers, egusi traders, and migrants to the communities.

The agriculture extension officers (AEAs) recruited all participants in the Chereponi district with assistance from their community contact farmers. The recruitment of participants was done ahead of the study visits. In the case of Kpandai, a gatekeeper in the Mbowura community supported the initial recruitment activities. The research team member went to finalize the process 2 days before the interviews. The themes were consistent across the populations, suggesting that participants were open about their experiences.

The number of FGDs was determined based on data saturation. All interviews and FGDs took place in a quiet, safe space identified by the community, including schools that were on recess.

2.3 Data collection

The research team comprised three female researchers (PI and two RAs) and two male RAs. Interpreters were used in the Chombosu and Tambong communities. The female researchers conducted the female FGDs. A male research assistant conducted the FGDs with men except for Kpandai, where the female research expert conducted both the male and female FGDs.

Data were collected in November 2022 and December 2022 for Kpandai and Chereponi districts, respectively. FGDs included seven to 18 participants. All interviews were recorded and transcribed into English. Each transcription was validated by the research team.

2.4 Data analysis

The data were analyzed through a qualitative thematic approach described by Braun and Clarke (2006). The data comprised transcripts from key informant interviews and focus group discussions, which were transcribed verbatim. The initial step involved familiarizing oneself with the data through repeated readings to gain an in-depth understanding. Following this, the transcripts were systematically coded using an open-coding process, where meaningful segments of text were labelled to identify patterns and themes related to gender roles, social norms, and cultural practices associated with egusi cultivation and use. These initial codes were then organized into broader categories, capturing the essence of the participants' experiences and viewpoints. Themes including "gender-specific labor divisions," "cultural significance of egusi," "economic empowerment through egusi," and "social barriers to equitable participation" emerged. The analysis also involved a constant comparison between data sets from different groups to highlight similarities and differences in perspectives. The thematic analysis gave a full picture of how gender and social norms affect the cultivation and usage of egusi. These findings are very important for creating agricultural policies and programs that are gender-responsive and nutrition-sensitive.

2.5 Ethical consideration

The KNUST ethical board approved the study (CHRPE/AP/831/22). Written informed consent was obtained from all participants after verbally explaining the purpose of the study.

Participants were assured of anonymity and confidentiality. The lead facilitator for each interview clearly explained to participants and interviewees their right to stop participating. They were also free not to answer any question they were uncomfortable with.

3 Results and discussion

3.1 Demography of study communities and respondents

Three main ethnic groups, Konkomba, Nawuri, and Chakosi, dominated the studied communities, with the prevalent minor ethnic group being the Fulanis (Tables 1, 2).

Table 1 reveals the demographic data on the study communities and the allocation of respondents in the survey concerning the significance of egusi for food and nutrition security in the Kpandai and Chereponi districts of Northern Ghana. It covers the projected adult population and household figures for each municipality. The data further categories focus group discussions (FGDs) by community and demography (adult and youth), including the count of male and female participants. Furthermore, the table records and captures the number of key informants interviewed in each district. The entire sample comprises 46 male and 57 female FGD participants, with eight male and six female key informants across the two districts.

Table 2 presents a summary of the ethnic mix of survey respondents who engaged in focus group discussions and key informant interviews in three egusi producing communities in the Kpandai and Chereponi districts of Northern Ghana. It reveals a clear classification of the respondents by ethnicity and gender across different communities and discussion groups (adults and youths). The table highlights the representation of Konkomba, Nawuri, Kassina, Chokosi, Fulani, and Basari ethnic groups in the survey. The Konkomba respondents constitute the majority, with notable participation from Chokosi and Nawuri groups, reflecting the ethnic diversity of egusi producers and consumers in the study area.

3.1.1 Egusi production and identified seed types

Four landraces were identified in the survey (Table 3 and Figure 2); two creeping plants, inabe (also commonly referred to as Neri) and bidelab (called brown melon seeds); and two climbing types, tijakpori/ kel/ Karkar (called white melon seeds) and a unique variation of the tijakpori, locally referred to as bunacha. There is no

TABLE 1 Demography of study communities and number of respondents in the survey on the value of egusi to food and nutrition security in Kpandai and Chereponi districts of northern Ghana.

District	Community	FGD Differentiation	Est. Adult Pop.	Est. Households	FGD Participants		Key Informants	
					Males	Females	Men	Women
Kpandai	Mbowura	Mbowura	1,258	200	7	8	2	2
Chereponi	Chombosu	Adults	258	54	10	18	3	2
		Youths			10	8		
Chereponi	Tambong	Adults	1,057	168	12	12	3	2
		Youths			7	11		
		Totals	2,573	422	46	57	8	6

FGD, Focus group discussion; Est, Estimated; Pop – Population.

TABLE 2 Overview of the ethnicity of survey respondents who participated in focus group discussions and key informant interviews in the survey from three egusi-producing communities in the Kpandai and Chereponi districts of northern Ghana.

District	Community	Differentiation	Ethnic group representation							Fulani	Basari
			Male			Female					
			Konkomba	Nawuri	Kassina	Chokosi	Konkomba	Nawuri	Chokosi		
Kpandai	Mbowura	Mbowura	6	2				6	4		1
Chereponi		Adults			1	12				19	1
	Chombosu	Youths				10				8	
Chereponi		Adults	14					12			1
	Tambong	Youths	7					13			
		Totals	27	2	1	23	32	4	28	2	1

official botanical classification of the species to inform their taxonomy. Unless otherwise differentiated, egusi is hereafter used loosely for either type of cucurbit.

Respondents identified two types of the were/neri/inabe species, but an older woman said there are rather three types of the inabe, the third being an intermediate, in terms of seed size, of the two identified. The diversity of the varieties used as egusi in the study communities corroborates its classification as a food category rather than a single botanical designation (Logan, 2012). This further suggests the need for proper taxonomic classification and nomenclature of this food category to facilitate the exploitation of research data at the species level across different geographical areas and cultures.

All three studied communities cultivated *egusi*. Mborowa largely cultivated the climbing species (locally referred to as akatuoa/agushie/karkar/kel/tijakporo) and the creeping bidelab, whereas Chombosu and Tambong communities now cultivate largely inabe (Neri). According to most participants, they no longer grow the climbing type for two main reasons: lack of easy access to tree stumps for staking due to deforestation and decline in soil fertility, which makes it almost impossible to cultivate yams, which also require staking and so were previously intercropped with the climbing species. One key informant intimated: “the last person I knew still grew egusi was my mother. In fact, we liked the soup she prepared from it, but nobody else grew it. Now everyone grows inabe because if you look around you, all this place used to be trees, but it is now desert, so where will we get the sticks for the tijakpro.” The inabe is early maturing, requires very little rainfall, less fertile soils to grow, and no staking.

3.2 Value of egusi production and related gender dynamics

In the Kpandai district, egusi production is mostly in the domain of women and is a source of livelihood for women and their children. In a focus group discussion, one discussant intimated: “I stay with my husband and do egusi to help the children. The egusi money is for me, but I use it to help my children.” This indicates how women are empowered by egusi cultivation.

A crop is considered a male crop when it has commercial or economic value. For instance, male discussants in Tambong, when asked about the crops associated with men, listed maize and yam as the top two and intimated that *maize is mostly used for feeding the family and for sales*, whereas, in Kpandai, male discussants selected yam as the most important crop because “when you grow, you get money from selling.” Female respondents also supported this assertion, with some indicating its importance for the (male) youth: “I will choose yam first because it is important... So those (male youth) who do not go to school use yam farming as a source of employment” (female discussant). Thus, the categorization of crops into male and female is socially constructed by farmers.

The direct contrast between male involvement in the production of egusi between Kpandai and Chereponi districts confirms the strength of economic gain as a strong motivation for the value placed on crops, especially for men. Considering the amenability of male-dominated communities to monetary gains, it is critical that efforts seeking to mitigate community malnutrition with indigenous species

TABLE 3 Identified egusi landraces in two major egusi-producing districts in northern Ghana.

Egusi Type	Description
Climbing species	
Kel/Karkar/yirbondu	The seeds of “kel” are white and are commonly known as <i>Akatuoa</i> within the Akan community and <i>Agushie</i> among the Gas. They are usually cultivated as an intercrop with yam and require stakes to provide support as a climber. When fully mature, the fruit is yellowish-green in colour, and the seeds have a soft seed coat. The size of the seeds can vary, with small, medium, and large sizes reported by respondents.
Bunacha	The seed of <i>bunacha</i> is similar to <i>bidelab</i> but has a round shape with a black covering around its edges. Its coat is hard, bitter, and brown, and the plant itself has broad, deep green leaves and a sturdy structure. <i>Bunacha</i> was first identified in Bunacha town, hence the use of its name.
Creeping species	
Bidelab	The seeds of “ <i>Bidelab</i> ” are brown and pointed, and it is a creeping plant that does not require staking. Its fruit is deep green and larger and has a hardy and bitter seed coat. When found in the field, it has broader leaves. <i>Bidelab</i> was first identified by indigenes among the Bidelab tribe in the Volta region, which is how it got its name.
Neri/Narte/inabe	<i>Neri</i> comes in various shades of brown and in various sizes. It has narrow leaves. The fruit is typically small and round, containing numerous small seeds with a rough seed coat firmly attached to them. The key means of identification by locals is the size, which is classified into three: big, medium, and small. The most common were the small and the big size with only one key informant alluding to the existence of the medium size. This was not physically available at the time of the data collection.

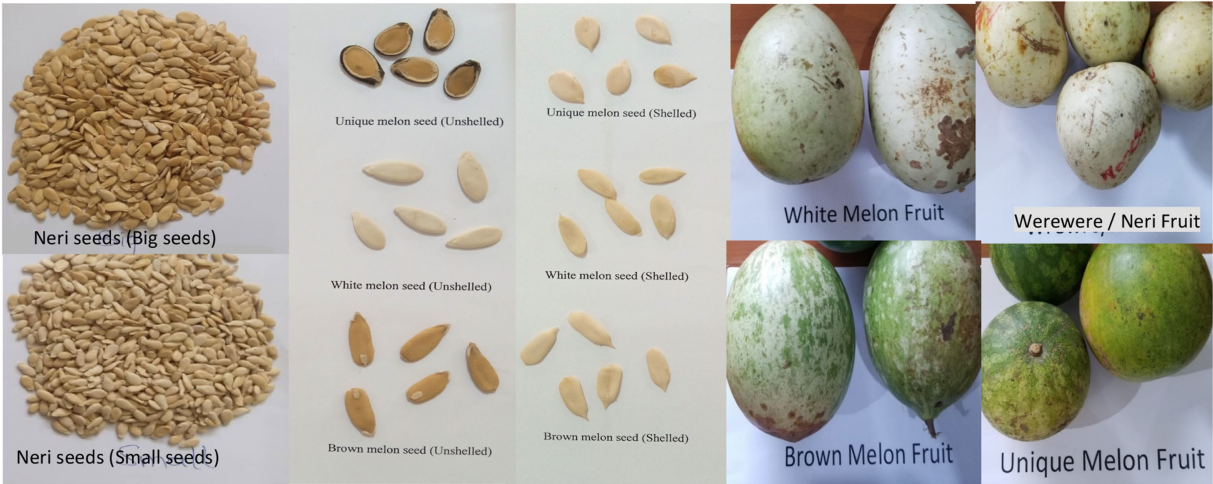


FIGURE 2
Images of seeds and fruits of the identified landraces of egusi in the Chereponi and Kpandai districts of Ghana. Labels are authors' own descriptors for ease of identification due to the lack of defined taxonomy for the landraces.

evaluate the trade-offs between household consumption for nutrition and the indigenous species becoming a high-earning cash commodity that will attract male involvement and complete ‘take-over’. This is especially important for communities where access to land by women is limited.

3.3 Sociocultural importance of egusi and its value to nutrition and food security in growing communities

All respondents in the three study communities highlighted the importance of egusi to their communities’ social and cultural fabric. “*Everybody eats it, everybody eats it.*” These were responses from both female and male focus groups and key informants in all three communities. A clear demonstration of the sociocultural value of

egusi was in the Chereponi district, where “**gifting egusi**” was a valued gesture. “*If you are invited to a wedding or important celebration, it is egusi you take as a gift.*” Moreover, a male key informant intimated that “*with the gifts when you get visitors in your house you can share with the person as a gift, even at funeral times too we share them as a gift,*” which shows the cultural value of egusi.

Respondents gave intriguing responses when asked what the most important crops to them were (Table 4).

The table reveals that no disparities existed in the valuation of egusi between adult men and women in the Chereponi area since both demographics identified it as the third most significant crop. It is interesting to note that the decision was made after much deliberation, especially among female groups, as a section was of the opinion it should be higher up in importance. Similar sentiments were shared in the Kpandai district, although the male focus group did not rank it among the top three most important crops. Key informants’ opinions

TABLE 4 Gender ranking of the top three important crops in Mborowa, Chombosu, and Tambong communities of Kpandai and Chereponi districts in Ghana.

Gender	Community				
	Mborowa	Chombusu		Tambong	
		Adults	Youth	Adults	Youth
Male	Yam	Soybean	Egusi	Maize	Yam
	Cassava	Rice	Soybean	Yam	Maize
	Maize	Egusi	Maize	Rice	Sorghum
Female	Yam	Maize	Egusi	Maize	Maize
	Groundnut	Soybeans	Maize	Sorghum	Yam
	Egusi	Egusi	Soybeans	Soybean	Soybean

Ranks were obtained from focus group discussions in the communities. Where applicable, key informant opinions were captured as part of the responses from adult focus group discussions in generating the ranks. In the Mborowa community, focus group discussions were not segregated by age.

in both districts were not different from those obtained from the focus group discussions.

The selection of egusi as the most important crop by both youth groups in Chombosu presents good prospects for exploring egusi cultivation on a commercial basis to empower the youth economically while meeting the nutritional requirements of the community. This is so as more than 70% of the youth respondents presently grow egusi, and the few who do not grow it agreed to its important role in the economic livelihood and food value to indigenes. Similar sentiments were shared in Tambong as discussants and key informants emphasized its critical role during their lean seasons. “If you will not grow egusi, how will you survive the June/July where there no food?” This was the response of an opinion leader in Tambong when asked whether men grew egusi. *It can no longer be called a woman’s crop because everyone grows it*, he stated. Here, we see ‘value’ due to food use and this reveals the potential of the crop to the food baskets of the communities.

3.3.1 Change in the social construct of egusi

Both discussants and key informants in the climate-impacted Tambong and Chombosu communities intimated a change in the social construct of egusi in their communities. A previously underrated crop, assigned as a woman’s crop, it has gained economic and social importance among all genders due to its ability to withstand harsh weather conditions exacerbated by climate change influences. “Everyone grows it.” “It does not need much water and also matures very fast, so it is very important for the June–July [period of extreme hunger in the study communities]” and “if you do not grow egusi, what will you eat” are among the statements provided to show the important social value and role of egusi in ensuring food security. The findings demonstrate how the value of indigenous underutilized crops is realized; hence, it may not be too difficult to change the mindsets and behaviours of people towards its adoption and use. Thus, in seeking to explore the underutilized crop species, it is of utmost importance that the requisite empirical data are obtained per the needs of the targeted end users to tailor appropriate interventions to motivate and accelerate acceptance.

3.3.2 Food use of egusi and contribution to nutrition security

Egusi is a main ingredient for stews and soups; everyone consumes it across the communities. A discussant in the female

focus group at Kpandai emphasized the importance of egusi to their nutrition in this way: *Egusi is blood, Egusi is blood. When your child is sick, and the doctor says he does not have blood, prepare ‘karikari gen’ [translated egusi eggs - analogue-meat balls from egusi, spiced with pepper, salt and onion] for the child, and your child will get well within few days.* An elderly woman in the group intimated that she has stopped eating meat but now consumes egusi as meat. A KI in Tambong summed up the value of egusi due to its food use in this way: “Everyone eats it, and everyone grows it. If you do not grow it, how will you survive the June–July”? When one discussant at Tambong was asked how he would rank egusi when given the opportunity, he intimated, “We will rank ‘egusi’ second because anytime you boil yam, you will have to use ‘egusi for stew and also for soup.’”—a confirmation of the food value to the community.

It is important to note that food ingredients available at a given time play a significant role in the choice of meals in the home and the nutrient value of the meals. During lunch in Tambong and Chombosu, the researchers observed that very small amounts of the sauces/soups were served as a side dish to the carbohydrate portions. Similar to other traditional dishes in Africa (Abu et al., 2019), the recipes used in the preparations lack standards in the ingredient quantity and processing protocols employed. The findings show the need for research investigations to standardize portion sizes and recipes from egusi for optimal exploitation of its nutritional benefits.

3.4 Gender perspectives of factors influencing the choice of major crop to farm

Economic gain, household food needs, level of need for agricultural input, yield, nutrition, and ability to withstand harsh environmental conditions were the factors that influenced the importance placed on crops in the communities (Table 5).

Women, irrespective of age and marital status, generally selected household food security as the primary factor influencing the choice of major crop to farm. Commercial and cultural value (primarily economic gain) was the most important factor agreed upon in all the male FGDs. This supports the assertion that women should

TABLE 5 Gender ranking on the factors influencing the premium placed on egusi in egusi-growing communities in Ghana.

Emerging factors from interviews	Ranking by gender per each study community					
	Chereponi district				Kpandai district	
	Adult female	Adult male	Youth female	Youth male	Adult female	Adult male
Household food security	1	4	1	4	1	3
Commercial and cultural value	3	1	2	1	4	1
Level of need for agro-inputs	2	2	4	2	3	4
Yield	4	3	3	3	2	2

The ranking captured the output from the pooled data of the focus group discussions. Where applicable, key informant opinions were captured as part of the responses from adult focus group discussions in generating the ranks. '1' is the most important, and '4' is the least important.

be supported in nutrition-sensitive agriculture interventions as they prioritize household food needs (Ruel et al., 2018; Heckert et al., 2019).

The land is a crucial deciding factor for crop production. In a male focus group, when asked who had the highest share of arable land, discussants intimated, “in this community, land is being possessed by men, so we use it to produce whatever we want to produce and give a small portion to the women to also produce what they would want to produce on it, so no matter the yield you will get will never match up with the men” (Male FGDs, Chombosu). This affirms inequality in patriarchal communities where land is owned by men. In this context, women are marginalized, heightening their vulnerability in crop production. Egusi production depends on the willingness of ‘husbands’ to either allow for it on their yam farms because of possible competition effect on the yams when not well managed or give a portion of land to the woman for cultivation because of land availability.

3.5 Egusi performs latent functions

The concept of latent function, derived from sociology, refers to the unintended or unrecognized consequences of an action or social structure; in the context of investigating the latent function of egusi, it involves exploring benefits beyond their primary obvious uses (Longhofer and Winchester, 2016). Probing the importance of egusi gave more insights into the value of egusi to the various communities. That is, in addition to the crucial role egusi plays in the diet of the people, it is also an important indirect contributor to promoting family stability and the economic and social livelihood of households. However, it is not a designated cash commodity.

Three latent functions of egusi were identified. The first was how heavily the probability of one’s children being educated depended on it. A discussant in Kpandai gave a succinct statement, “**No mother, no school**,” after the group had repeatedly emphasized the role growing egusi played in helping them get money for their children’s schooling. Similar sentiments were shared in all communities, with the male focus groups and key informants confirming the same. A male focus group discussant intimated, “As for the women, they are good with money; when they have money, they keep it and use it well.” Similar sentiments were shared among both male and female respondents. In an informal chat in Kpandai, a young man confirmed the same and intimated, “Here it is the practice for women to take care of their children’s education; if your mother cannot take care of you, then you cannot go to school.”

Second, “**egusi resolves divorce**.” “The reason why we are putting egusi first is that it also helps us to resolve divorce, because in the past when we were not producing egusi in this community during the lean season like the June/July/August there where our shortage of in terms of food in the households most of our parents like our mothers, they try to divorce our fathers because there is nothing for the father to give to her to prepare food for the children and the household at large, so they decided to go into egusi production which also matured early for them to sell and get money to buy maize to take care of the family and that’s why they are producing egusi.” (FGD Male Youth Chombosu). This function of egusi was corroborated in different ways throughout our interviews, spanning statements such as, when you let the women grow egusi, they have what they need to prepare food. Also, they can sell when they need to purchase things [Male FGD, in the Kpandai district where the crop is still largely viewed as a woman’s crop] to “well, I guess what they mean is that because we now grow egusi, you can have food in June–July and so you can provide food in the home, and there is peace” [KI in the Chereponi district where the social construct of egusi has changed].

Finally, the mitigating role of egusi to the financial burdens of households and men in particular was demonstrated. This, however, is presented in two opposite ways for the Chereponi and Kpandai districts. In the case of Kpandai, where egusi is still viewed as a female crop, the cultivation of the crop was an avenue of income where the women could have financial independence to largely provide for their children’s education and other household needs. In contrast, in Chereponi, men cultivate it to safeguard against poverty and household food scarcity during lean seasons.

These three highlighted latent functions underlie the value of the species and how its exploration for the Indigenes to obtain optimal benefits could ultimately provide holistic livelihoods in a more sustainable way.

3.6 Indigenous agronomic practices, challenges, and gender dynamics in egusi production

Land preparation, planting, weed control, harvesting, and pre-processing are the major activities listed as agronomic practices in egusi production. The practices, associated challenges, and local interventions employed to mitigate outlined challenges are summarized in Tables 6, 7.

TABLE 6 Agronomic practices and challenges in Egusi production.

Agronomic practices	Challenges/Limitations
Land preparation	Land preparation methods include slash-and-burn, stumping, plowing, and ridging. Some of the activities are complementary and labor-intensive. This is usually applicable for the creeping egusi since the climbing egusi are commonly intercropped with yam and thus require less pre-planting preparation as the land would have been tilled for yam cultivation.
Planting	Planting climbing egusi can be a tedious task, especially when it involves planting by each mound in the yam farm. This requires dibbling, which is also labor intensive. However, broadcasting the crops in the yam farms is also an option. The downside to this method is that a larger quantity of seeds is required for planting. Our findings further show that <i>egusi</i> is intercropped with yam due to land scarcity “ <i>Sometimes, land acquisition is very difficult here. Moreover, mostly women are the ones that farm egusi. We men do not often farm egusi like that. If the women want to farm it in abundance, they will not get land to farm the egusi separately, unless the husband has a farm, and when she gets a space, then she grows it.</i> ” This is a response to why egusi was not monocropped but intercropped with yams in Kpandai, despite the premium they place on it as a nutritious crop and serves as a household crop of choice for soups and stews.
Weed control	Since climbing egusi species are intercropped with yam, no special weed control measures are taken as it benefits from what is done for yam. The creeping species require weed control only during the seedling stage. It rather serves as a weed control measure when intercropped with others.
Harvesting	When the crop reaches maturity, labor is required for harvesting as it involves gathering the fruits at a central location for further processing. The main challenge at this stage is the cost of labor.
Processing	The initial processing stage involves the arduous task of slashing or breaking the fruits once they have been gathered. The following step includes covering the cut fruits with either a polyethylene bag or grass to initiate fermentation. After a week, the seeds are extracted, taken to the riverside to wash, and brought home to be sun-dried. The dried seeds are bagged and stored. The entire procedure is labor-intensive, time-consuming, and poses significant health risks as processors use their bare hands to extract seeds from the decomposed pulp, usually for hundreds of fruits at a time. Washing is also done with the hands.

TABLE 7 Local interventions employed to mitigate challenges in egusi production.

Local interventions	Rationale for adopting the practice
Inter-cropping	Intercropping is a farming technique in which farmers cultivate two or more crops on the same piece of land simultaneously or in sequence. Respondents indicated that intercropping allows them to make efficient use of their land and have a more diverse and resilient source of income, as different crops may have different market values and may be harvested at different times.
Planting trees	The communities engaged in tree planting to curb the impact of climate change. Government interventions such as planting for export and rural development were enumerated by a key informant in Chereponi.
Reduced bush burning	Although the progress is slow, the communities are reducing bushfires in an attempt to mitigate climate change. Respondents intimated that the Ministry of Food and Agriculture (MoFA), through their extension agents, are educating their catchment areas on the need to stop bush burning and focus on more sustainable agriculture.
Crop rotation	Reduced access to arable lands has incorporated the culture of crop rotation. The local farmers have substantial information about its relevance in soil fertility.

Some limitations that cut across the two districts for egusi production were largely gender biases, primarily being access to adequate land (for women), followed by climatic conditions—erratic rainfall and declining soil fertility—being largely attributed to climate change, and lack of research interventions on improved varieties.

3.6.1 Access to land and gender dynamics

Farmlands allocated to women were inadequate to support large-scale farming. “*In this community here, the land is being possessed by men, so we use it to produce whatever we want to produce and give a small portion to the women also to produce what they would want to produce on it, so no matter yield you will get will never match up with the men*” (FGD Chombosu Adult Male). “*Only strong women can hire land for farming,*” said a male key informant in Kpandai. “*By all means, the man will have more wealth than the lady. The woman can be wealthy but not like the man. This is because of the land.*” A response to the differences in wealth of men and women in Chereponi.

Our findings show that *egusi* is intercropped with yam due to land scarcity—“*Sometimes, land acquisition is very difficult here. Moreover, mostly women are the ones that farm egusi. We men do not often farm egusi like that. If the women want to farm it in abundance, they will not get land to farm the egusi separately, unless the husband has a farm, and when she gets a space, then she grows it.*” This is a response to why egusi was not monocropped but intercropped with yams in Kpandai, despite the premium they place on it as a nutritious crop and serves as a household crop of choice for soups and stews.

In Spencer’s view (Barnett, 2022), this is a clear manifestation of the survival of the fittest, where the strong survive through land ownership, whereas the weak perish due to lack of access to land in patriarchal societies. The findings further show how the land tenure system of the study communities disadvantages women. Many women, particularly in Chereponi, farmed near the homes on their available acreage around residential neighborhoods. To circumvent land ownership issues, financially independent women

buy farms far from their homes to work on. These norms of society reflect hegemonic masculinity, which supports men's dominance in society and supports the subordination of ordinary women, making farming practices very difficult for women (Rowlands, 2021).

3.6.2 Climate change impact and coping strategies through egusi production

The different types of egusi were available at the Chereponi markets. However, respondents intimated that only one of the creeping species, neri/inabe, was grown locally and that the other types on the market were from other places. Indigenes attributed this mainly to declining soil fertility and less rainfall due to the impacts of climate change. An opinion leader in Chombosu intimated, *"The last person who grew the climbing egusi in this community was my mother. When everybody else stopped, she grew it and we loved it. But now, because of climate change, the land is not good, and we do not have trees anymore or yam to stake them (climbing egusi)."* One of the creeping species, inabe, is drought tolerant and requires less soil fertility to grow; hence, it is becoming the crop of choice for the Chereponi communities struggling with defined changes in their climate. The opinion leader further intimated, *"Look around you. All these places used to be trees and you could not see far from here. But now look, there are no trees and everything is bare, and you can see very far, so the soil is no longer good."*

Coincidentally, one of the creeping species, inabe, is drought tolerant and requires less soil fertility to grow; hence, it is becoming the crop of choice for the Chereponi communities struggling with defined changes in their climate and associated impact on their food access. *"If you do not grow egusi (inabe), what will you do for June–July?"*—Key informant, Tambong. *"Egusi is important for June–July"* [Adult male and Male youth FGDs, Chereponi district]. *"We [men] did not grow inabe but now everybody grows it...; if you do not grow it, June–July what will you eat?"* [Key informant, Tambong]. When asked what other adaptive measures his community undertakes to mitigate food insecurities due to the changing climate, a key informant in Tambong elaborated how production and valorization interventions on sesame [an improved version of the marginalized local landrace, Kpeka] have supported their livelihood during the lean seasons. The findings show the importance of these marginalized resilient crops to the adaptive capacities of the studied rural communities to the changing climate. This empirical evidence supports the global recommendations on the critical role of marginalized/underutilized indigenous crops in meeting food and nutrition security, especially among vulnerable communities (Hunter et al., 2019; Padulosi et al., 2011).

The Mborowa community in the Kpandai district cultivated all species but produced the climbing species on a larger scale. Kpandai receives more rain in a year and has more trees and more fertile lands, thus presenting fewer obstacles to the production of climbing egusi regarding soil fertility and rainfall needs. It is one of the major yam-growing areas in Ghana. A *contract* farmer, when asked whether growing climbing egusi (specifically the akatuo) was a bother, intimated that *"No, it is not. Well, I already have the stakes for the yams so the women can grow their egusi."* He was, however, quick to add that the egusi must only be grown when the planting activities for the yam are complete, so nothing interferes with the yam production, showing

a lesser premium placed on the egusi than the Chereponi district where the egusi is a lifeline to everyone's livelihood, especially during the lean season.

3.6.3 Agricultural (research) interventions

Despite the importance of egusi to the food needs of local communities, especially during climate-induced hunger periods, there has not been any agricultural intervention to promote its production. None of the focus groups nor key informants and opinion leaders knew of any improved variety of the crop, value-addition intervention, or technological advancements to facilitate production or processing. Respondents intimated that they stored planting seeds from the previous harvests when probed about where they obtained seeds for cultivation. The MoFA office confirmed the absence of any defined interventions to get improved varieties of the crop, although they were aware of its importance. Discussions with breeders from the research institutes confirmed the same.

Our findings show an urgent need for agricultural interventions for the optimal exploitation of the species. The situation is dire, as confirmed by the lamentations of a discussant at the end of a focus group in Kpandai after they had spent almost an hour discussing the value of egusi to their livelihood.

"Tell your people to give us a machine to process egusi. We have machine for rice and everything... but nothing for egusi. We spend hours to process, and it does not help us."

The nods of approval from other members confirmed the urgent need for technological interventions for optimal crop exploitation to safeguard these communities' nutrition and food security.

4 Perspectives for improving production and utilization of egusi

Our findings show an increased awareness of climate change among community members. There is knowledge of changes in temperature, rainfall patterns, and also a decline in crop performance as indicators of climate change. However, farmers still engage in delimiting activities such as slash and burn and bush burning, exacerbating the climatic challenges, especially for the Chereponi district. When asked about the mitigating strategies they employed, respondents mentioned climate-smart strategies such as crop rotation, mixed cropping, and planting of trees.

Respondents in the FGDs could not recount any governmental intervention towards mitigating climate change in their community. However, an opinion leader in the Chereponi district mentioned an ongoing afforestation program but quickly added that not all community members adhered to the recommendations. A KI from the Ministry of Food and Agriculture (MoFA) corroborated this and mentioned the Ghana Productivity Sustenance project as distributing trees to farmers for planting. He further intimated that farmers involved in production along the water streams/dams resort to irrigation in the event of failed rains. Despite the knowledge about the consequences of felling trees, much has not been done to reduce the use of trees for fuel in the communities.

From the study, it was evident that although the importance of egusi to the food security and nutrition needs of the communities was

unquestionable, discussants except the Chombosu youth (both male and female groups) placed other crops such as maize over egusi (Table 4). This suggests that a new policy framework to improve community nutrition in relation to egusi should explore innovative ways for success, especially in male-dominated communities. For example, nutrition-sensitive agricultural policies that create opportunities for women to access communal lands designated for growing nutrient-dense climate-resilient indigenous crops such as egusi would be a good starting point to facilitate production and use. Our suggested next steps for optimal exploitation of egusi for nutrition and improved livelihoods are summarized in Table 8.

5 Conclusion

This study emphasizes how important egusi is to food and nutrition security, especially in the expanding settlements in northern Ghana. Our results show that egusi is not only an important food item but also a valuable commodity, especially for women. Egusi has profound societal importance beyond its nutritional and financial worth, influencing family food plans and resilience to food insecurity due to climate change influences. Egusi's function in

sustainable food systems is highlighted by the fact that it acts as a vital buffer against hunger brought by climate change in major-growing communities such as Tambong and Chombosu in the Chereponi district. These findings highlight the need to implement policy changes that explore locally grown non-cash crops to improve nutrition and food security.

Again, the study found that gender dynamics underpin the production and use of egusi across the study areas. The findings showed that women put the food security of their households before economic gains, contrary to the men, whose primary decisions on the choice of crop to grow, all things being equal, prioritize the economic worth of a crop to its use as food for the home. Furthermore, since they have control over land access, men continue to dominate agricultural production decision-making. Notwithstanding the economic and nutritional importance of egusi to their homes, this structural imbalance restricts women's capacity to grow it on their own, especially in the Kpandai district, where the social construct of the crop is unchanged, and egusi remains a woman's crop. Based on the empirical evidence of this study, new ways of getting land, like shared farming areas, could increase egusi production in the localities where it remains a female crop to optimally explore its food and nutrition potential.

TABLE 8 Next steps toward the optimal exploitation of egusi for nutrition and overall wellbeing.

SN	Limitation/Challenge	Lessons Learned [effect on production/ food use/optimal exploitation]	Proposed Intervention(s)	Anticipated Impact	Responsible Stakeholder(s)
1.	Access to Land	The lands are largely owned by men because they have the responsibility to fend for the household. This hinders the production of egusi by women.	Intercropping Communal farming Education	Intercropping is a farming technique that could help farmers make efficient use of their land by maximizing the productivity of a given area. Obtaining group resources will enhance agricultural resources. Area under cultivation of crops that male farmers regard as female crops will increase.	Farmers
2.	Erratic Rainfall	The rain patterns have drastically changed, leading to different start and end periods. Consequently, crops in this community do not yield well.	Afforestation – Planting Trees Development of drought-resistant crop varieties	Communities engaged in tree planting to curb the impact of climate change to lessen the impact on rainfall.	Government Farmers Researchers
3.	Declining Soil fertility	The regular cultivation of the land causes soil nutrient losses	Crop Rotation Intercropping	Crop rotation is very relevant in maintaining the fertility of the soils, leading to increased yields.	Farmers
4.	Drudgery in Processing	Due to the labor involved in the post-harvest processing of egusi (especially the climbing varieties), most farmers have less interest in the production of the crop.	Technological interventions.	Interventions to aid in the processing of the crop could reduce the drudgery and result in a high throughput of the crops for increased availability on the market which would create opportunity for international trade through the export of the surplus.	Researchers Government Donor agencies

(Continued)

TABLE 8 (Continued)

SN	Limitation/Challenge	Lessons Learned [effect on production/ food use/optimal exploitation]	Proposed Intervention(s)	Anticipated Impact	Responsible Stakeholder(s)
5.	Lack of Value-addition interventions No standardised recipe for existing traditional dishes	Food use being limited to traditionally difficult-to-prepare dishes limits food exploitation which, when enhanced, could drive production The absence of standard recipes limits consumers from obtaining the full benefits from food use of egusi	Develop novel food products targeted at new and wider markets to expand food use of egusi Important to standardise existing recipes to update the nutritional value and also inform on the recommended serving size	Translate into business start-ups to meet existing and new market demands, thereby creating jobs and additional income. Output will support community nutrition endeavors to reduce further the burden of hidden hunger and food insecurity in rural communities.	Researchers (Food Scientists) Private sector; SME/startup funding sources Researchers; Community nutrition and District health officers, Women in Agriculture and Development 7. reps in District offices of the communities
6.	Uncertainty of the specific taxa of indigenous varieties from different geographical areas	Limits the exploitation of available empirical data across countries.	Need to provide an overview of the taxonomic reference and employed nomenclature in every scientific study for accurate information dissemination and use.	Ability to use empirical data on the nutrient composition and other quality parameters in the literature (knowing the specie of interest) would expedite research interventions and food applications of local varieties.	Researchers
7.	Lack of improved varieties	Limits the exploration of the full potential of egusi in food security and nutrition interventions.	Funding support to breeders to investigate drought-tolerant varieties, the climbing species, and also have varieties to meet other food applications.	New and improved varieties to meet household and industry needs for optimal exploration.	Policymakers Researchers
8.	Economic-driven agriculture	Focus on cash crops with little attention to the nutrition needs of households.	Increase awareness of nutrition-sensitive agriculture and what the benefits are to the community. This can be successful when in-depth investigations are done to ascertain the foodscapes of targeted regions to tailor interventions.	Scaled-up production of egusi and other nutrient-dense indigenous crops; Household nutrition, especially of vulnerable groups, improved.	Government agencies spearheaded by MOFA Farmers Researchers

The conventional social structures around egusi farming have changed in certain areas due to climate change influences. Egusi, formerly assigned as a woman's crop, is now grown by both men and women in response to rising food insecurity in climate-change-induced food-insecure communities in Chereponi district. This change emphasizes how indigenous crops are becoming more and more important in local climate-change adaptation plans. The empirical evidence from this study thus suggests the urgent need for policymakers to include these indigenous resilience strategies in larger frameworks for climate adaptation and food security, thereby designing lasting interventions to alleviate food poverty and malnutrition in communities at risk from climate change.

Ultimately, the shifting dynamics of egusi production, as a coping strategy against climate-induced food insecurity, underscore the pressing need for multi-stakeholder, inter-, and trans-disciplinary initiatives to fully realize the promise of native crops in addressing food and nutrition security. A critical first step in creating long-term, climate-resilient initiatives is a thorough analysis of what "food value"

means in these communities. It is also crucial to investigate the cropscape of such vulnerable communities to inform appropriate solutions that are culturally acceptable and will last beyond project cycles.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Ethics statement

The studies involving humans were approved by Committee on Human Research Publication and Ethics, School of Medical Sciences, Kwame Nkrumah University of Science and Technology, Kumasi,

Ghana. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

AB: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. MB: Data curation, Formal analysis, Investigation, Methodology, Validation, Writing – review & editing. JD: Conceptualization, Methodology, Supervision, Writing – review & editing. DA: Data curation, Formal analysis, Investigation, Visualization, Writing – original draft, Writing – review & editing. TT: Formal analysis, Supervision, Writing – review & editing. CN: Data curation, Formal analysis, Investigation, Visualization, Writing – original draft, Writing – review & editing. AK: Data curation, Investigation, Writing – review & editing. AM: Conceptualization, Writing – review & editing. HL: Conceptualization, Writing – review & editing. WE: Conceptualization, Supervision, Writing – review & editing.

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- ## Conflict of interest
- The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
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