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Exploring Barriers to the Consumption of Neglected and Underutilized Green Leafy Vegetables in Rural and Urban Populations of the Tribal Regions of Garo Hills, Meghalaya, India

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Authors' contributions

This work was carried out in collaboration among all authors. Author SN wrote the first draft of the manuscript and managed the analyses and literature searches of the study. Authors NRM, CRNM, CBD and PD designed the study, wrote the protocol, and provided guidance for the research. Author PK performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To identify and analyze the barriers to the consumption of neglected and underutilized Green Leafy Vegetables (GLVs) in urban and rural settings of Garo Hills, Meghalaya, focusing on key determinants influencing consumption patterns.
Study Design: Cross-sectional survey-based study.
Place and Duration of Study: Urban and rural areas of Garo Hills, Meghalaya, conducted from January to May 2024.
Methodology: A total of 90 respondents, 45 each from urban and rural areas, were surveyed using a structured questionnaire. The study assessed five key determinants: availability, perception of taste/flavor, knowledge of nutritional benefits, difficulty in preparation, and cost/affordability. Weighted averages were calculated to rank the barriers based on their perceived significance in each setting. Data were analyzed using descriptive statistics to identify differences in consumption patterns and barriers across the two settings.
Results: Limited availability emerged as the most significant barrier for urban respondents, with a weighted average score of 7.5, highlighting poor access to GLVs in urban markets. In contrast, rural respondents identified a lack of knowledge about nutritional benefits as the primary barrier, scoring a weighted average of 13.2, indicating a critical need for awareness campaigns. Taste perception influenced consumption, ranking as the second-highest barrier in rural areas (4.7) and third in urban areas (5.6). Preparation difficulties were ranked second by urban respondents (5.7) and third by rural respondents (4.1). Cost and affordability were the least significant barriers in both settings, suggesting that financial constraints play a minor role compared to other factors.
Conclusion: The study reveals significant differences in the barriers to GLV consumption in urban and rural Garo Hills. Addressing limited availability in urban areas and enhancing knowledge of nutritional benefits in rural areas are essential for improving GLV consumption. Tailored interventions are required to mitigate these barriers and promote the inclusion of GLVs in diets.

Keywords: Neglected and underutilized green leafy vegetables (GLVs); consumption barriers; Garo hills; urban and rural settings; availability of GLVs; nutritional awareness; taste perception; food preparation challenges.

1. INTRODUCTION

Meghalaya, a state in northeastern India, is renowned for its rich flora and is believed to be the origin of many underutilized leafy vegetables. Located between latitudes 20° 1' N and 26° 5' N and longitudes 85° 49' E and 92° 52' E, the region is home to numerous leafy green crops that remain largely unexplored and underutilized. These vegetables, though less popular outside the local community and with limited market demand, hold significant potential for enhancing dietary security and income generation. They are often grown in wild and semi-wild conditions with minimal care and attention (Buragohain et al., 2013). Green leafy vegetables are an important source of essential nutrients, yet their consumption remains low, especially for underutilized and neglected varieties (Gido et al., 2017). The importance and potential of underutilized food crops in Meghalaya are significant and diverse and have the potential concerning improve nutritional content and the benefits they possess (Patel et al., 2013).

Barrier Analysis aimed at identifying the determinants influencing specific behaviors within a community (Davis et al., 2004). Through a comprehensive examination of these determinants, valuable insights into the motivators and barriers influencing behavior adoption or avoidance had been gained. Through this approach, insights into the barriers and motivators influencing GLV consumption in both rural and urban populations were gained. These findings informed the development of targeted interventions to promote the consumption of neglected and underutilized GLVs, thereby addressing nutritional deficiencies and fostering healthier dietary habits among diverse communities.

Barrier analysis studies have identified various factors influencing the consumption of green leafy vegetables (GLVs) in different contexts. In Vietnam and Nigeria, family preferences, home production, perceived benefits, and affordability were key determinants (De Filippo et al., 2021). Rural Nigerian households showed limited knowledge and consumption of some indigenous

vegetables, with seasonal availability affecting intake (Adepoju & Aka, 2019). Time constraints, culinary skills, and nutritional knowledge were identified as barriers to leafy green vegetable consumption among women (McMahon et al., 2013). Despite these challenges, traditional GLVs have the potential to significantly contribute to micronutrient requirements, particularly vitamin A and iron, for women and children in rural Nigeria (Ejoh et al., 2019).

Neglected and underutilized green leafy vegetables are a rich source of essential nutrients and phytochemicals that can play a crucial role in combating malnutrition, food insecurity, and chronic disease (Palanisamy et al., 2019). However, their consumption has declined over time, particularly in developing countries (Sivakumar et al., 2020). Understanding the barriers to the consumption of these nutritious vegetables is crucial for promoting their integration into mainstream diets and addressing the pressing issues of nutritional deficiencies. This study aims to explain the factors influencing the consumption of these GLVs among rural and urban populations in the Garo Hills by comparing the knowledge, availability, and consumption patterns of GLVs, identifying key barriers that prevent their widespread adoption and propose strategies to promote these nutrient-rich vegetables.

2. MATERIALS AND METHODS

2.1 Study Area and Selection of Respondents

The study was conducted in two districts of Meghalaya, namely West Garo Hills and East Garo Hills. The West Garo Hills situated between 26° and 25° 2' North latitude and 90° 30' and 89° 40' East longitude and the East Garo Hills situated between 25° 25' and 25° 50' North latitude and 90° 15' and 91° 100' East longitude is predominantly inhabited by the Garo Tribe following a matrilineal society (Singh et al., 2014). The two districts selected for this study are two of the three districts covered by the Nokrek Biosphere Reserve, one of the 17 Biosphere reserves recognized under UNESCO's Man and Biosphere programme. The reserve is renowned for its citrus sanctuary. For the study as per the Barrier Analysis Facilitator's Guide, a sample size comprising 45 individuals classified as doers and 45 as non-doers was advocated (Davis et al., 2004). Individuals categorized as "doers" represented consumers residing in villages or rural areas, particularly from Daribokgre village in West Garo Hills and Darechikgre village in East Garo Hills, where consumption of GLVs was typically prevalent. Conversely, individuals classified as "non-doers" comprised consumers residing in urban areas, particularly from Tura in West Garo Hills, where the consumption of GLVs may have been comparatively lower.

2.2 Methods of Data Collection

For this study, Barrier Analysis was employed to investigate the consumption patterns of neglected and underutilized GLVs at the individual level by using structured interview schedule and informal discussions. This analysis utilized quota sampling, a purposive sampling approach, to select participants. Quota sampling allowed for the deliberate selection of participants from specific demographic groups or geographical locations to ensure the representation of diverse perspectives. By focusing on both rural and urban settings, variations in GLV consumption behaviors as well as knowledge of these GLVs across different populations contexts were captured.

2.3 Statistical Analysis

MS Excel was used to analyze the data using statistical tools like average mean, standard deviation and weighted mean.

3. RESULTS AND DISCUSSION

The findings revealed significant differences in the knowledge and consumption of Green Leafy Vegetables (GLVs) between urban and rural populations in the Garo Hills. The study surveyed a total of 90 respondents, comprising 16 males and 29 females from urban areas, and 23 males and 22 females from rural areas. Urban respondents listed an average of 8.04±2.2 wild and 7.2±2.3 cultivated GLVs, while rural respondents identified a broader range with an average of 14.56±2.08 wild and 9.47±1.52 cultivated varieties. The data reveals notable differences in the variety of wild and cultivated Green Leafy Vegetables listed by respondents from urban and rural settings, suggesting potential disparities in knowledge and access to these resources between the two populations.

Table 1. Frequency of consumption of the neglected and underutilized GLVs in their meals

	Urban(n_1=45)		Rural(n_2=45)		Total(n=90)	
	f	**%**	***f***	**%**	***f***	**%**
Daily	16	35.56	22	48.89	38	42.22
Weekly	12	26.67	18	40	30	33.33
Monthly	6	13.33	1	2.22	7	7.78
Rarely/Never	8	17.78	1	2.22	9	10
Seasonally	3	6.67	3	6.67	6	6.67

Table 2. Factors influencing the decision to not consume neglected and underutilized

Factors	Urban (n_1=45)		Rural (n_2=45)		Total (n=90)	
	f	**%**	***f***	**%**	***f***	**%**
Lack of availability in local markets/ stores	23	55.11	4	8.89	27	30
Limited knowledge about their nutritional benefits	3	6.67	38	84.44	41	45.56
Perception of undesirable taste or flavor	10	22.22	11	24.44	21	23.33
Difficulty in preparation/cooking	12	26.67	8	17.78	20	22.22
Cost or affordability	5	11.11	0	0	5	5.56
Preference for other vegetables	29	64.44	22	48.89	51	56.67
Seasonality	9	20	18	40	27	30

#Multiple response

Table 1 depicts the consumption of neglected and underutilized GLVs among urban and rural populations. Notably, 35.56% of urban inhabitants and 48.89% of rural residents consume these GLVs daily, while 26.67% of urban and 40% of rural populations consume them weekly. Monthly consumption stands at 6% for urban and 2.22% for rural areas, with 8% of urban and 2.22% of rural residents consuming these GLVs rarely or never. Interestingly, 6.67% of both urban and rural populations consume these GLVs seasonally. It reveals distinct consumption patterns, with a higher percentage of rural residents consuming these GLVs daily and weekly compared to their urban counterparts. Additionally, a greater proportion of urban dwellers consume these GLVs less frequently or rarely. These findings highlight significant differences in GLV consumption habits between rural and urban communities, indicating potential variations in dietary preferences and access to nutritious foods across different environments.

Table 2 presents factors influencing the decision to abstain from neglected and underutilized GLVs. A significant proportion of urban respondents (55.11%) cite the lack of availability in local markets and stores as a deterrent, compared to only 8.89% of rural respondents. Limited knowledge of the nutritional benefits is identified by 6.67% of urban respondents and the majority of rural respondents (84.44%). Additionally, 22.22% of urban respondents and 24.44% of rural respondents highlight this factor. Perception of undesirable taste or flavor dissuades 26.67% of urban and 17.78% of rural respondents from consuming these GLVs. Similarly, the difficulty in preparation/cooking is a concern for 26.67% of urban and 22.22% of rural respondents. These findings suggest differing perceptions and challenges surrounding GLV consumption between urban and rural populations, emphasizing the need for targeted interventions to promote their consumption across diverse settings.

The table additionally illustrates that 11.11% of the urban population and 5.56% of rural inhabitants perceive the cost or affordability of these GLVs as a hindrance to consumption. Furthermore, a majority of urban respondents (66.64%) and 56.67% of rural individuals prefer other vegetables over neglected and underutilized GLVs. These findings highlight significant factors influencing GLV consumption patterns among both urban and rural populations. Addressing these factors could contribute to promoting the uptake of neglected and underutilized GLVs in diverse dietary contexts.

The perception of undesirable taste or flavor dissuades 26.67% of urban and 17.78% of rural respondents from consuming these GLVs. Similarly, the difficulty in preparation or cooking is a concern for 26.67% of urban and 22.22% of

rural respondents. These findings indicate differing perceptions and challenges surrounding GLV consumption between urban and rural populations, underscoring the need for targeted interventions to promote their consumption across diverse settings. In urban settings, the changing dietary patterns and preferences towards more processed and convenient foods can lead to a decline in the consumption of traditional and neglected green leafy vegetables (Sivakumar et al*.,* 2020).

The barrier analysis of the consumption of neglected and underutilized green leafy vegetables (GLVs) in Garo Hills reveals significant differences between urban and rural settings are shown in Table 3 and Table 4. In urban areas, availability is a prominent concern, with 31.11% of respondents identifying it as a minor barrier and 11.11% as a major barrier. This suggests a need for improved supply chains to ensure consistent access to GLVs. Furthermore, the perception of taste and flavor is a substantial issue, with 51.11% of urban respondents perceiving it as a minor barrier and 28.89% as a moderate barrier. This highlights the necessity for interventions aimed at enhancing the culinary appeal of GLVs through community cooking classes or promotional campaigns showcasing delicious recipes.

Table 3. Likert scale result of barriers influencing the consumption of neglected and underutilized Green Leafy Vegetables (GLVs) in urban setting

Sl no.	Statements	Urban(n_1=45)									
		Categories									
		Not a Barrier		Minor Barrier		Moderate Barrier		Significant Barrier		Major Barrier	
		f	%	*f*	%	*f*	%	*f*	%	*f*	%
1.	Availability of these GLVs in your area	14	31.11	11	24.44	8	17.78	7	15.56	5	11.11
2.	Perception taste/flavor of these GLVs	23	51.11	13	28.89	3	6.67	4	8.89	2	4.44
3.	Knowledge about nutritional benefits	21	46.67	17	37.78	4	8.89	2	4.44	1	2.22
4.	Difficulty in preparing/cooking these vegetables	24	53.33	11	24.44	3	6.67	4	8.89	3	6.67
5.	Cost/affordability of these vegetables	24	53.33	14	31.11	5	11.11	2	4.44	0	0

Table 4. Likert scale result of barriers influencing the consumption of neglected and underutilized Green Leafy Vegetables (GLVs) in rural setting

Sl no.	Statements	Rural(n_2=45)									
		Categories									
		Not a Barrier		Minor Barrier		Moderate Barrier		Significant Barrier		Major Barrier	
		f	%	*f*	%	*f*	%	*f*	%	*f*	%
1.	Availability of these GLVs in your area	39	86.67	4	8.89	2	4.44	0	0	0	0
2.	Perception taste/flavor of these GLVs	26	57.78	14	31.11	4	8.89	1	2.22	0	0
3.	Knowledge about nutritional benefits	0	0	4	8.89	2	4.44	11	24.44	28	62.22
4.	Difficulty in preparing/cooking these vegetables	34	75.56	7	46.67	3	6.67	1	2.22	0	0
5.	Cost/affordability of these vegetables	45	100	0	0	0	0	0	0	0	0

Knowledge about the nutritional benefits of GLVs is also a critical barrier in urban areas, with 66.22% of respondents citing it as a major barrier and % as a significant barrier. Educational initiatives could significantly mitigate this issue by increasing awareness of the health benefits of these vegetables. Additionally, the difficulty in preparing and cooking GLVs is perceived as a barrier by 53.33% of urban respondents, indicating the potential benefit of providing easy-to-follow cooking guides and demonstrations.

In rural settings, the barriers differ markedly. Availability is overwhelmingly identified as a minor barrier by 86.67% of respondents, which highlights that this determinant does not hinder the consumption of these GLVs. Cost and affordability emerge as the least barriers, with 100% of rural respondents recognizing it as a minor barrier. In rural areas, the accessibility and availability of neglected and underutilized green leafy vegetables can be a significant barrier to their consumption (Chandra et al*.,* 2016). These vegetables may not be widely cultivated or readily available in local markets, making it challenging for individuals to incorporate them into their daily diets (Govender et al*.,* 2007).

Moreover, the lack of knowledge about nutritional benefits is a significant issue in rural areas, with 62.22% of respondents identifying it as a major barrier. This suggests that rural communities would greatly benefit from targeted educational programs to enhance their understanding of the nutritional value of GLVs. Lack of awareness and knowledge about the nutritional benefits of these vegetables can contribute to their underutilization (Govender et al*.,* 2007).

The Table 5 presents the weighted averages and rankings of barriers influencing the consumption of neglected and underutilized Green Leafy Vegetables (GLVs) in urban and rural settings of the Garo Hills. In urban areas, availability emerged as the most significant barrier, ranked first with a weighted average of 7.5, highlighting limited access to GLVs in these settings. Conversely, in rural areas, the primary barrier is a lack of knowledge about the nutritional benefits of GLVs, ranked first with a high weighted average of 13.2, underscoring a critical gap in awareness. Taste perception was a more pressing issue in rural areas (4.7, ranked 2nd) than in urban areas (5.6, ranked 3rd). Both settings faced challenges related to preparation, with urban respondents ranking it second (5.7) and rural respondents ranking it third (4.1). Cost and affordability ranked lowest in both urban and rural areas, suggesting it is not a dominant concern. These findings indicate that addressing the availability and preparation challenges in urban areas, alongside improving nutritional awareness and taste acceptability in rural settings, could significantly enhance GLV consumption across diverse communities.

The p-value<0.01 from the one-tailed test confirms that difference between the mean is statistically significant, especially in key barriers like availability and knowledge of nutritional benefits. These findings suggest that urban and rural population face different challenges when it comes to consuming GLVs.

According to the National Family Health Survey (NFHS-5) (2019-2021), the prevalence of anaemia in Meghalaya is notably high across various demographics. Specifically, 64.2% of children aged 6-59 months were found to be anaemic, highlighting a critical health concern for the younger population. Among women aged 15-49 years, the anaemia rate is 53.8%, and this is even more pronounced in pregnant women, with 53.3% affected. Men in the same age group also exhibit a significant prevalence, with 26.6% being anaemic. These figures underscore the

Table 5. Weighted averages and rankings of barriers influencing the consumption of neglected and underutilized Green Leafy Vegetables (GLVs) in urban and rural settings

Sl no.	Statements	Urban Weighted AveragE	Rank	Rural Weighted AveraGE	Rank
1.	Availability of these GLVs in your area	7.5	1	3.5	4
2.	Perception taste/flavor of these GLVs	5.6	3	4.7	2
3.	Knowledge about nutritional benefits	5.3	4	13.2	1
4.	Difficulty in preparing/cooking these vegetables	5.7	2	4.1	3
5.	Cost/affordability of these vegetables	5	5	3	5

considerable burden of anaemia in Meghalaya, particularly among children and women, indicating an urgent need for targeted nutrition and health interventions to combat iron deficiency and address the underlying factors contributing to anaemia in the state. This highlights the need for increased awareness, nutritional education, and the promotion of consumption of neglected and underutilized GLVs to address anaemia in the Garo Hills region.

The consumption of these neglected and underutilized GLVs is crucial in combating anaemia, especially in regions like the Garo Hills where iron deficiency is prevalent. Increasing awareness about the health benefits of GLVs and integrating them into daily diets can play a significant role in improving iron intake and overall health. Teaching communities about the importance of a balanced diet, the role of micronutrients in preventing anaemia, and how to incorporate GLVs into meals can have a lasting impact on health outcomes. Public health initiatives that focus on nutrition education and promote the consumption of these underutilized, nutrient-dense foods are vital for addressing anaemia in the Garo Hills region.

The data from Table 7 highlights the differences in willingness between urban and rural populations to try new recipes or cooking methods involving green leafy vegetables (GLVs). Rural consumers showed a stronger tendency to experiment with new cooking approaches, with 53.33% of respondents indicating they were "very likely" to try new recipes, compared to 33.33% of urban consumers. Additionally, 42.22% of rural participants reported being "likely" to experiment with new cooking methods, while 37.78% of urban consumers shared this sentiment. This indicates that rural populations are generally more open to trying new ways of preparing GLVs, which could be due to their traditional reliance on GLVs or a higher level of exposure to such vegetables in their daily diets.

Interestingly, a small percentage of urban respondents (13.33%) remained neutral about trying new recipes, and 4.44% were unlikely to explore new cooking methods, suggesting a more conservative or resistant attitude towards culinary changes among certain segments of the urban population. In contrast, none of the rural respondents expressed reluctance to try new recipes, highlighting a potential area for targeted interventions in urban areas, where enhancing familiarity with GLV-based recipes could increase their consumption. This calls for culinary programs and educational initiatives to introduce diverse, palatable recipes to urban consumers to increase the likelihood of adopting GLVs into their diets.

Table 6. Comparison of barriers to GLV consumption in urban and rural settings based on mean frequencies

Sl. No.	Statements	Urban	Rural	P(F<=f) one-tail
1.	Availability of these GLVs in your area	7.53	3.53	0.0077
2.	Perception taste/flavor of these GLVs	5.60	4.67	(Significant at
3.	Knowledge about nutritional benefits	5.33	13.20	p<0.01)
4.	Difficulty in preparing/cooking these vegetables	5.73	4.07	
5.	Cost/affordability of these vegetables	5	3	
	Variance	0.97	17.99	

Table 7. How likely they want to try new recipes or cooking methods involving these GLVs

	Urban(n_1=45)		Rural(n_2=45)		Total(n=90)	
	f	%	*f*	%	*f*	%
Very likely	15	33.33	24	53.33	39	43.33
Likely	17	37.78	19	42.22	36	40
Neutral	6	13.33	2	4.44	8	8.89
Unlikely	2	4.44	0	0	2	4.44

Table 8. Accessibility of these GLVs in their local area

	Urban(n_1=45)		Rural(n_2=45)		Total(n=90)	
	f	**%**	***f***	**%**	***f***	**%**
Very Accessible	16	35.56	45	100	61	67.78
Somewhat Accessible	16	35.56	0	0	16	17.78
Neutral	11	24.44	0	0	11	12.22
Not Very Accessible	2	4.44	0	0	2	2.22

Table 8 reveals a significant disparity between urban and rural consumers in terms of the accessibility of green leafy vegetables in their local areas. A striking 100% of rural respondents stated that GLVs are "very accessible," suggesting that rural areas have abundant access to these vegetables. In contrast, only 35.56% of urban respondents found GLVs to be "very accessible," indicating that access to these vegetables might be more challenging in urban environments.

Additionally, urban consumers were divided on accessibility, with another 35.56% reporting that GLVs are "somewhat accessible," and 24.44% remaining neutral about the ease of access. This implies that while GLVs are available in urban areas, their accessibility is inconsistent. Only a small proportion (4.44%) of urban respondents stated that GLVs are "not very accessible," indicating that a minority might face significant barriers to obtaining these vegetables. Efforts to improve the availability of GLVs in urban areas, through initiatives like urban gardening or ensuring better supply chains to supermarkets, could be crucial for increasing their consumption among urban populations.

4. CONCLUSION

This study highlights the divergent barriers to Green Leafy Vegetable (GLV) consumption in urban and rural settings of Garo Hills, revealing that urban areas are primarily challenged by availability, while rural areas face a significant knowledge gap regarding the nutritional benefits of GLVs. In urban settings, the limited market access for GLVs is a crucial barrier, with a weighted average of 7.5 indicating substantial issues with supply and distribution. To address this, enhancing the availability of GLVs through better market integration and logistical improvements is essential. Additionally, increasing the visibility of these vegetables in urban markets and collaborating with vendors to stock and promote GLVs could help mitigate this barrier.

In rural areas, the lack of knowledge about the nutritional benefits of GLVs is the predominant challenge, as indicated by a high weighted average of 13.2. Educational initiatives are needed to raise awareness and provide information on the health benefits of GLVs. Partnering with local health workers and utilizing community-based programs for educational outreach can effectively bridge this knowledge gap. Moreover, improving taste acceptability through recipe demonstrations and culinary training can address issues related to taste preferences. Although cost was the least significant barrier, ensuring that GLVs remain affordable through support programs can further support their consumption. By implementing these targeted strategies, both urban and rural communities can benefit from increased GLV consumption, leading to improved dietary diversity and overall nutritional health in the Garo Hills.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS DISCLAIMER

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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