Discover Food

RESEARCH Open Access

Consumption patterns and perceived health benefits of underutilized legumes among women in selected local government areas of Niger State, Nigeria

Florence Adetutu Udofia[1,2], Oladejo Thomas Adepoju[2], Dangana Mohammed Chata[3], Olaniyi Ajewole Oyatomi[1] and Michael T. Abberton[1*]

*Correspondence:
Michael T. Abberton
m.abberton@cgiar.org
[1]Genetic Resources Center, International Institute of Tropical Agriculture (IITA), PMB 5320, Oyo Road, Ibadan 200001, Oyo State, Nigeria
[2]Department of Human Nutrition and Dietetics, Faculty of Public Health, College of Medicine, University of Ibadan, P. O. Box 22133, Ibadan, Oyo State, Nigeria
[3]Department of Plant Biology, School of life Sciences, Federal University of Technology, Minna PMB 65, Minna, Niger, Nigeria

Abstract

Food insecurity remains a major challenge in Africa, disproportionately affecting women and children. Despite their favorable nutrient profiles for underutilized legumes especially Bambara groundnut (*Vigna subterranea*), African yam bean (*Sphenostylis stenocarpa*), and lima bean (*Phaseolus lunatus*) are rarely consumed in Nigerian diets. This study assessed socio-economic determinants, awareness, perceived benefits, and consumption patterns of these legumes among women in Niger State. A cross-sectional survey of 420 rural and 420 urban women were conducted using stratified random sampling, interviewer-administered questionnaires divided into socio-demographics, legume awareness, consumption behaviors, and perceived drivers section. Data were analyzed in R Studio using descriptive statistics, Spearman correlation, and path coefficient analyses. Awareness was highest for Bambara groundnut, moderate for lima bean, and lowest for African yam bean. Educated women had greater nutrition knowledge than those with less schooling. Bambara groundnut was consumed two to four times weekly by 68% of rural women but 15% of urban women; African yam bean and lima bean consumption were mostly seasonal. Among rural women, religion strongly influenced Bambara groundnut consumption, while occupation and religion were correlated of lima bean intake. In contract, among urban women, none of the demographic factors was statistically significant predictors of African Yam Bean and Bambara Groundnut but Lima Bean consumption was influenced by Education and Religion. The Key barriers included cooking difficulty, antinutritional factors, and limited perceived benefits in both rural and urban areas. Targeted nutrition education is needed to raise awareness, and increase consumption of underutilized legumes among women in Niger State, Nigeria.

Keywords Underutilized legumes, Bambara groundnut, African yam bean, Lima bean, Consumption patterns, Niger state, Nigeria

1 Background

Food and nutrition security remain pressing public health challenges in sub-Saharan Africa, where undernutrition, micronutrient deficiencies, and diet-related non-communicable diseases continue to disproportionately affect women and children [1, 2]. Despite the abundance of diverse, nutrient-rich crops, food systems in many developing countries, including Nigeria, remain heavily dependent on a limited range of staple crops, notably rice, maize, and wheat [3, 4]. Concurrently, rapid dietary urbanization, changing food choices, poor nutrition knowledge, and income disparities are contributing to significant changes in dietary patterns, often leading to the consumption of food that is energy–dense but poor in essential nutrients [5–7]. To address this nutritional gap, increased attention is being directed toward the role of underutilized legumes as affordable, nutrient-rich alternatives capable of enhancing dietary diversity and resilience in food systems.

Underutilized legumes especially including Bambara groundnut (BGN or *Vigna subterranea*), African yam bean (AYB or *Sphenostylis stenocarpa*), and Lima bean (LB or *Phaseolus lunatus*); represent a significant yet largely untapped nutritional resource that is indigenous to many parts of Africa [8, 9]. These three legumes were selected because, although they are indigenous to Nigeria and well adapted to local agro-ecological conditions, they remain orphan crops that receive far less research attention and policy support than conventional staples, yet they hold considerable promise for closing nutritional gaps in the region [10]. BGN, for instance, demonstrates exceptional drought tolerance and thrives in marginal soils where conventional crops fail [11], while AYB exhibits remarkable resilience to pests and diseases endemic to West African farming systems [12]. LB, though less extensively cultivated than in previous decades, remains valued for its adaptability to diverse soil types and climatic conditions across Nigerian agroecological zones [13].

Beyond their agronomic resilience, these legumes possess superior and distinctive nutritional and phytochemical profiles that position them as functional foods with therapeutic potential [14]. BGN contains significant amounts of protein (15–25%), complex carbohydrates, dietary fiber, iron, and folate [15, 16], and is notably rich in phenolic compounds and flavonoids, particularly catechins and quercetin derivatives, which contribute to its potent antioxidant activity and potential cardiovascular protective effects [17, 18]. AYB demonstrates the highest protein content among the three legumes (21–29%) [19], and is distinguished by its abundant content of bioactive peptides, saponins, and tannins, which have been associated with antidiabetic properties and enhanced immune function in experimental studies [20, 21]. LB provides substantial amounts of protein (8.61–26.02%), dietary fiber, iron, zinc, and B-vitamins, and contains unique cyanogenic glycosides (linamarin) which, when properly processed, pose no health risk, alongside significant levels of anthocyanins and polyphenols that exhibit anti-inflammatory and antioxidant activities [22]. Collectively, these phytochemical profiles and bioactive compounds underscore the potential of these legumes not only as sources of essential macronutrients and micronutrients critical for combating malnutrition among women of reproductive age [23], but also as functional foods with disease-preventive properties [24, 25]. Moreover, these underutilized legumes are resilient to harsh environmental conditions [26], thereby classifying them as climate-smart crops critical for sustainable

food systems, particularly in the face of climate change, land degradation, and socioeconomic constraints [27, 28].

Despite well-established advantages, production and consumption of these legumes remain relatively low in both rural and urban food systems, largely due to low consumer awareness, limited market availability, and shifting cultural preferences [29]. Previous research on underutilized legumes has predominantly focused on agronomic characteristics and nutritional assessment, with limited attention to socio-cultural, economic, and behavioral determinants influencing their consumption [30]. However, some studies have previously mentioned that barriers to the consumption of underutilized legumes include the hard-to-cook phenomenon, cultural biases labeling these legumes as "food for the poor," and seasonal availability [31, 32]. The adoption and utilization of underutilized legumes are influenced by multiple socio-cultural and economic factors, including knowledge of their existence, perceptions of health benefits, and consumption habits particularly among women, who play a central role in household food selection, preparation, and nutrition decisions [33]. Understanding these drivers is essential for developing effective interventions aimed at promoting NUL consumption as part of broader strategies for improving food and nutrition security. However, important factors such as consumer nutritional knowledge, perceptions about health benefits, market availability, have not been adequately investigated in the context of neglected legumes [34].

In Niger State, Nigeria, agriculture constitutes the primary occupation, particularly among rural populations [35]; however, considerable nutritional disparities persist between urban and rural communities [36]. Thus, Specifically, this study aims to identify the key socio-economic characteristics of women in Niger State, Nigeria; assess women's awareness of underutilized legumes as food sources; evaluate their knowledge of the nutrient composition of these legumes and quantify and compare consumption frequency, preparation methods and forms of utilization between rural and urban cohorts; and determine how socio-economic factors relate to actual consumption practices of underutilized legumes among these women. The study contributes to informing research and the design of interventions in the legume value chain to enhance the utilization of underutilized legumes in the diets of vulnerable populations.

2 Methods

2.1 Study area and sample selection

The study was carried out in Niger State, located in the North Central geopolitical zone of Nigeria. A map of the selected Local Government Areas (LGAs) is presented in Fig. 1. Niger State shares borders with Zamfara to the north, Kebbi to the northwest, Kaduna to the northeast, Kogi to the south, Kwara to the southwest, and the Federal Capital Territory (FCT) to the southeast. The state's economy is predominantly agrarian, with major livelihood activities including farming, fishing, and livestock rearing.

A total of 840 women aged 15 to 49 years participated in the survey. All participants had resided continuously in any of the twelve randomly selected LGAs for at least three years. Eligibility criteria included being in good health, non-pregnant, non-lactating, and not currently taking medications that could interfere with dietary intake.

2.2 Sample size determination

The sample size was calculated using the Fischer formula [37].

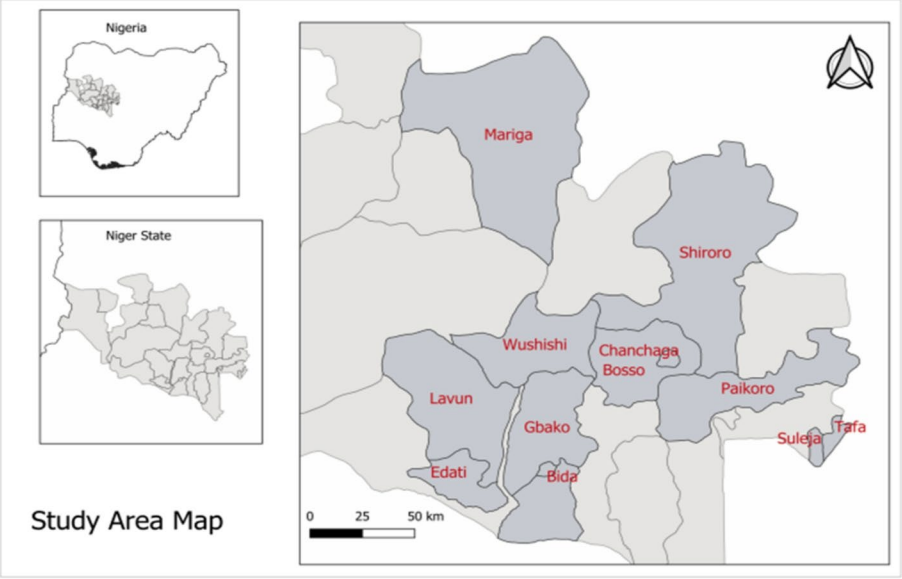

Fig. 1 Map of Niger State, Nigeria showing the selected LGAs

$$N = Z^2 p\ (1-q)/D = 1.96\,(0.5)\ \ (0.5)/0.05^2 = 384$$

N = Minimum Sample size; Z = constant (1.96); p = Prevalence at 50%; q = 1-p; D = 0.05 (50% tolerance).

To account for a 7% attrition of 26.9, the required minimum sample size for this study was scaled to 410.9, which was approximated to 420 from each rural and 420 from urban areas.

A three-stage sampling technique was adopted. First, the 25 LGAs in the state were stratified by senatorial district. Urban and rural LGAs were then selected by simple random sampling from each stratum. Within each selected community, household listings were obtained through the assistance of community leaders. Eligible women were then systematically selected to obtain 420 rural and 420 urban participants.

2.3 Questionnaire design and administration

A structured, interviewer-administered questionnaire was developed to address five core objectives: respondents' familiarity with underutilized legumes (AYB, BGN, and LB), accessibility, consumption patterns, drivers and constraints to use, and knowledge of their nutritional and health benefits.

The instrument comprised three sections:

1. Socio-demographics

Age, religion, marital status, education level, occupation and ethnicity.

2. Awareness and consumption

For each legume (AYB, BGN, LB), respondents indicated prior familiarity (Yes/No) and reported consumption frequency. Consumption pattern was reported as once a week, 2-4times per week, 1-3times a month, seasonal or occasional and never.

3. Knowledge, constraints and reasons for consumptions.

Knowledge, drivers and Constraints: using closed-ended options respondents were asked reasons or limitation consumption.

Prior to fieldwork, the questionnaire was pilot-tested with 15 individuals; no major revisions were required. It was translated into Gwari, Hausa and Nupe, allowing respondents to choose their preferred language.

2.4 Interviewer training and quality assurance

A team of trained research assistants received two days of intensive instruction on study objectives, ethical conduct, standardized interviewing techniques and informed-consent procedures. Each assistant practiced administering the instrument in English and the three local dialects to ensure clarity.

During data collection, Daily supervision and random spot-checks were conducted; any inconsistencies triggered follow-up visits for clarification and Completed questionnaires were reviewed each evening for completeness and consistency prior to data entry.

Individual interviews took approximately 15–20 min. Only participants who had reviewed and signed an informed-consent form were included. This rigorous training and ongoing oversight ensured high data quality and reliable measurement of awareness, consumption patterns, and perceptions surrounding these underutilized legumes.

2.5 Ethical considerations

The Joint Ethics Review Committee of the University of Ibadan and University College Hospital (UI/EC/21/0747) approved the study protocol. Further approval was obtained from the Niger State Ministry of Agriculture and relevant local authorities. All participants gave written informed consent. All data collected were treated with strict confidentiality and used solely for research purposes.

2.6 Data analysis

Descriptive statistical analysis was conducted, with relative frequencies used to summarize categorical variables across key domains. The relationships among the participants' socio-demographic characteristics and their reported legume consumption behaviors were assessed using a non-parametric approach. Specifically, the strength and direction of the association were quantified using the Kendall's Tau correlation coefficient, as this method is appropriate for assessing the monotonic relationship between ranked variables. All correlation tests were performed in R programming studio (version 4.4.2), and associations were considered statistically significant at $p > 0.05$. In order to identify the cause and effect relationship, particularly the effect of demographic factors on the consumption pattern of the three legumes considered in the study, path coefficients analyses were performed using the Lavaan package [38] in R programming studio.

3 Results

3.1 Sample profile

Main characteristics of the respondents are presented in Table 1. The age distribution revealed that most women in rural areas were aged between 26 and 35 years (47.1%), while a higher proportion of urban women were aged 36–49 years (41.4%). A relatively small proportion of respondents were aged 16–25, with slightly more in urban (24.5%) than rural areas (19.5%).

Table 1 Socio-demographic characteristics of the respondents

Characteristics	Rural (Frequency %)	Urban (Frequency %)
Age	82 (19.5)	103 (24.5
16–25		
26–35	198(47.1)	143(34.1)
36–49	140(33.3)	174(41.4)
Religion	93(22.1)	137(32.6)
Christianity		
Islam	310 (73.8)	281(66.9)
Traditional	17(4.1)	2(0.5)
Marital status		
Single	12(2.9)	19(4.5)
Married	401(95.5)	391(93.1)
Divorced	0(0)	3(0.7)
Widow	7(1.7)	7(1.7)
Education level	176(41.9)	49(11.7)
Uneducated		
Primary	111(26.4)	85(20.2)
Secondary	104(24.8)	207(49.3)
Tertiary	29(6.9)	79(18.8)
Occupation	35 (8.3)	34(8.1)
Artisans		
Farming	131 (31.2)	84(20)
Trading	73 (17.4)	95(22.6)
Fisherman	63 (15)	2(0.5)
Salary/Wage workers	27 (6.4)	175(41.7)
Others	91 (21.7)	30(7.1)
Ethnicity	103 (24.5)	120(28.6)
Gbagyi		
Hausa	87 (20.7)	68(16.2)
Nupe	225 (53.6)	191(45.5)
Others	5 (1.2)	41(9.8)

Islam was the predominant religion in both settings, particularly in rural areas (73.8%), while Christianity was more commonly practiced in urban areas (32.6%). Traditional religion was rarely reported.

The majority of women in both rural and urban areas were married (95.5% and 93.1%, respectively). Very few were single, widowed, or divorced, with divorce reported only in urban areas (0.7%).

Educational attainment varied considerably by location. A large proportion of rural women (41.9%) were uneducated, compared to only 11.7% in urban areas. In contrast, secondary (49.3%) and tertiary education (18.8%) were more common in urban areas, while these were lower among rural women (24.8% and 6.9%, respectively).

Occupational patterns differed between the two settings. Rural women were more engaged in farming (31.2%) and fishing (15%), while urban women were predominantly salary/wage earners (41.7%) and traders (22.6%).

Nupe was the most represented ethnic group across both rural (53.6%) and urban (45.5%) areas, followed by Gbagyi (24.5% rural, 28.6% urban) and Hausa (20.7% rural, 16.2% urban). Other ethnic groups were more commonly reported in urban areas (9.8%) than rural (1.2%).

Familiarity or encounter of AYB, BGN and LB are illustrated in Fig. 2 and these varied considerably between rural and urban areas. Overall, awareness was highest for BGN,

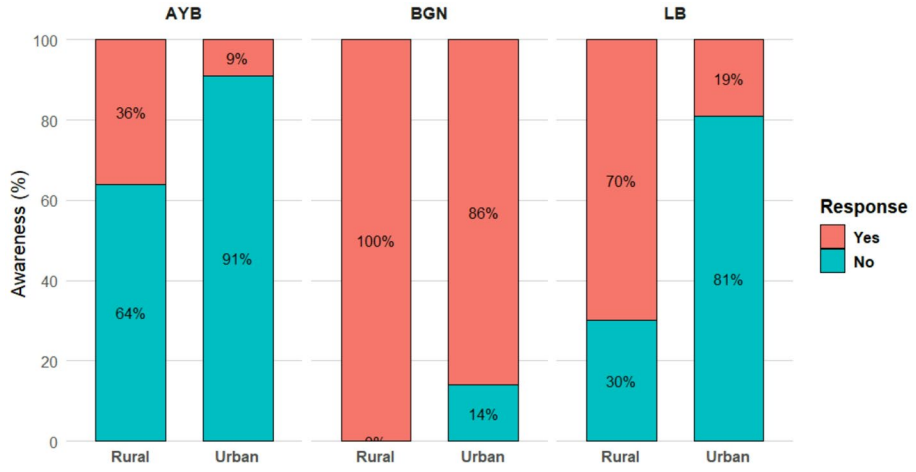

Fig. 2 Awareness of the selected underutilized legumes

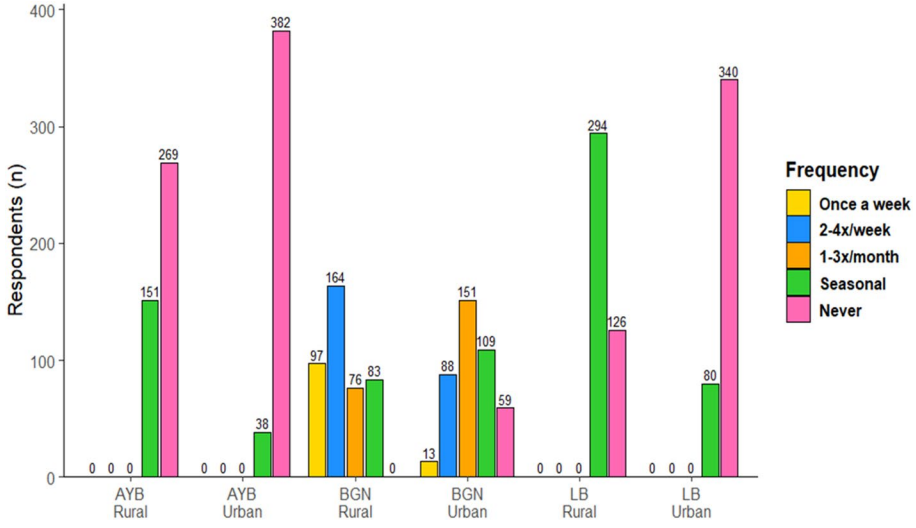

Fig. 3 Comparative consumption pattern of selected underutilized legumes

with all rural respondents (100%) and the majority of urban respondents (86%) reporting familiarity with the legume. In contrast, awareness of AYB was limited, especially in urban settings, where only 9% of respondents reported knowing the legume, compared to 36% in rural areas. Similarly, LB showed a significant disparity between rural (70%) and urban (19%) respondents.

Consumption frequency of the three selected underutilized legumes are represented in Fig. 3 above, AYB, BGN, and LB varied considerably between rural and urban areas. Overall, seasonal and never consumed dominated for AYB and LB. In contrast, BGN was most frequently eaten 2–4 times per week in rural areas (162) but only rarely in urban areas (15).

The result of the analysis of the consumption forms, reasons for consuming, and barriers to consumption of the selected legumes is presented in Table 2. AYB, BGN and LB.

The analysis showed that AYB and LB were mostly consumed in soaking or boiling form while roasting accounts for 17% rural and 14% urban consumption.

Table 2 Consumption form, constrain and reasons for consumption of selected legumes

	AYB %		BGN (%)		LB (%)	
Best Form of Consumption	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**
Fresh immature	0	0	4	0	0	0
Milling/Frying	0	0	19	24	0	0
Porridge/Okpa	0	0	6	16	0	5
Soaking/Boiling	73	86	55	59	100	95
Roasting	17	14	10	1	0	0
Fermentation	0	0	6	0	0	0
Reason for consuming						
Taste and Satiety	0	0	84	37	0	0
Nutrients contents	0	13	11	25	0	11
Health benefit	0	17	5	19	0	12
Market Availability	100	80	0	19	100	77
Reason for not consuming						
Hard to cook	33	9	85	76	0	0
Lack Nutritional values	64	91	0	14	30	81
Cultural reasons	0	0	0	0	0	0
Antinutritional constituent	3	0	15	10	70	19

Fig. 4 Various form of BGN consumption in Niger state, Nigeria

Regarding reasons for consumption, the analysis showed that AYB and LB consumption is driven almost entirely by market availability .In contrast, BGN is primarily consumed for taste and satiety (84% rural, 37% urban), followed by nutrient content (11% rural, 25% urban) and health benefits (5% rural, 19% urban). Barriers to consumption differs with AYB non-consumption is attributed to difficulty of cooking (33% rural, 9% urban) and poor awareness of nutritional values (64% rural, 91% urban). BGN non-consumers cite it as hard to cook (85% rural, 76% urban), with some noting antinutritional constituents (15% rural, 10% urban) or low awareness (14% urban). For LB, antinutritional factors deter 70% of rural and 19% of urban non-consumers, while 30% rural and 81% urban respondents report lack of awareness of health benefits.

BGN is well consumed in many forms as shown in Fig. 4 above. 55% rural and 59% urban consume it by soaking/boiling, 19% rural and 24% urban by milling/frying, 6% rural and 16% urban as porridge/Okpa, 10% rural and 1% urban by roasting, fermentation.

The relationship between the consumption of underutilized legumes and socio-demographic factors among rural participants is summarized in the correlation matrix (Fig. 5).

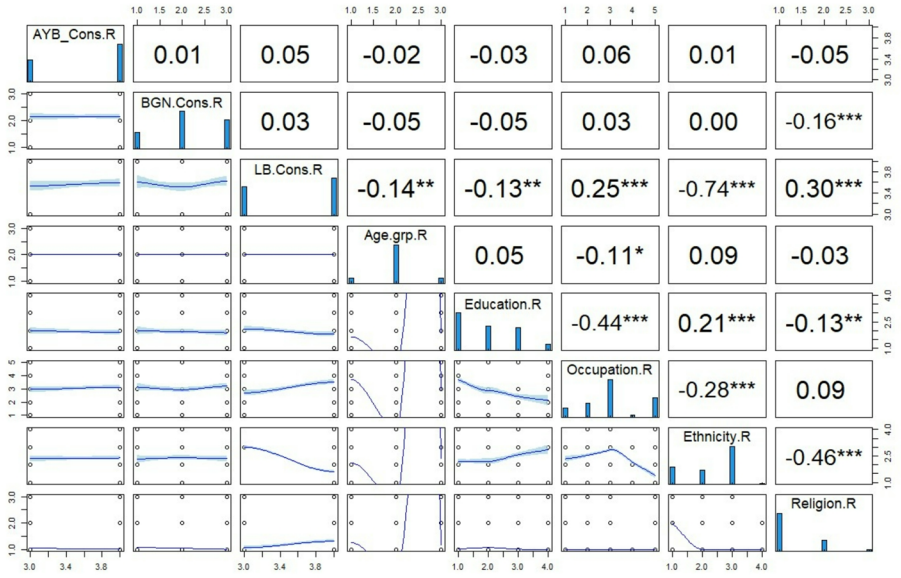

Fig. 5 Relationship between the consumption rates of selected utilized legumes and sociodemographic factors among rural respondents

Table 3 Path coefficient analysis showing the influence of socio-demographic factors on consumption AYB, BGN and LB in selected rural areas of Niger state

Socio-Demographic factors	Estimate	S.E	*P*-Value
AYB-Cons.R			
Age group	-0.01	0.05	0.80
Education	-0.01	0.03	0.65
Occupation	0.03	0.02	0.25
Ethnicity	0.03	0.03	0.42
Religion	-0.01	0.05	0.86
BGN-Cons. R			
Age group	-0.09	0.08	0.26
Education	-0.04	0.04	0.29
Occupation	-0.01	0.03	0.75
Ethnicity	− 0.07	0.05	0.15
Religion	-0.28	0.07	0.00
LB-Cons.R			
Age group	-0.08	0.04	0.03
Education	0.02	0.02	0.28
Occupation	0.03	0.02	0.04
Ethnicity	-0.41	0.02	0.00
Religion	-0.04	0.04	0.29

The analysis revealed LB consumption showed a significant positive correlation with occupation type ($r = 0.25$, $p < 0.001$) and religion ($r = 0.30$, $p < 0.001$), while significant negative correlations were observed with age group ($r = -0.14$, $p < 0.01$), education level ($r = -0.13$, $p < 0.01$), and ethnicity ($r = -0.74$, $p < 0.001$), For BGN, a weak but significant negative correlation was found with religion ($r = -0.16$, $p < 0.001$) while the consumption of AYB showed no statistically significant correlation with the socio-demographic factors measured.

Table 3 shows the influence of sociodemographic factors on the consumption of underutilized legumes in rural areas of Niger State. AYB consumption showed only small,

non-significant effects of age, education, occupation, ethnicity, and religion (For age: Estimate (B) = – 0.01, 95% CI – 0.11 to 0.09;

BGN consumption was strongly associated with religion (B = – 0.28, 95% CI – 0.42 to – 0.14; $p < 0.001$), indicating markedly lower consumption in some religious groups; all other predictors were small and non-significant (B = age: –0.09, – 0.25 to 0.07; education B = – 0.04, – 0.12 to 0.04).

LB consumption was influenced by age, occupation, and ethnicity. Age showed a small negative effect (B = – 0.08, 95% CI – 0.16 to – 0.00; $p = 0.03$), occupation a small positive effect (B = 0.03, 95% CI ≈ 0.00 to 0.07; $p = 0.04$), and ethnicity the largest effect in absolute terms (B = – 0.41, 95% CI – 0.45 to – 0.37; $p < 0.001$). Education (0.02, – 0.02 to 0.06) and religion (– 0.04, – 0.12 to 0.04) were not significant for LB.

Figure 6 summarizes the associations between the consumption of underutilized legumes and selected sociodemographic characteristics among urban women notably, age group exhibited a significant positive correlation with AYB consumption ($r = 0.10$, $p < 0.05$), suggesting that older age cohorts are more likely to consume AYB. Education level was strongly associated with AYB consumption ($r = 0.64$, $p < 0.001$), marking it as the most significant predictor among all measured variables, while education showed a weak and non-significant association with BGN and LB consumption. BGN consumption was positively associated with age ($r = 0.12$, $p < 0.05$), but otherwise exhibited no significant correlations with education, occupation, or religion. LB, however, displayed a negative correlation with age (r = -0.10, $p < 0.05$), suggesting that younger urban women were more inclined to include it in their diets.

Table 4 shows the influence of sociodemographic factors on the consumption of underutilized legumes in urban areas of Niger State. For AYB and BGN, none of the sociodemographic variables were statistically significant and the effects were small, with coefficients close to zero (estimate (B) = – 0.01, 95% CI – 0.05 to 0.03; while for BGN; religion: B = – 0.05, 95% CI – 0.17 to 0.07).

For LB, borderline associations were observed for education and religion. Each one-level increase in education was linked to a small decrease in LB consumption (B = – 0.04,

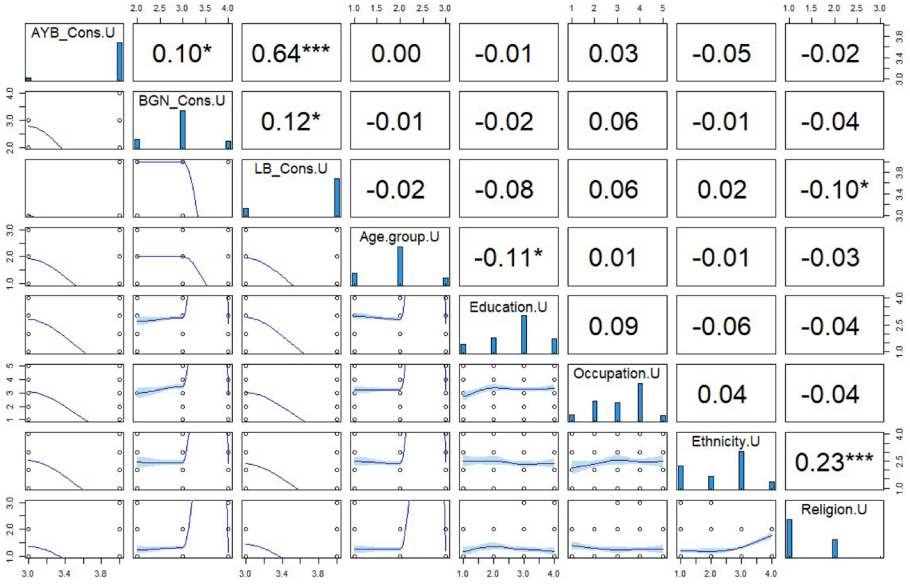

Fig. 6 Relationship between the consumption rates of selected utilized legumes

Table 4 Path coefficient analysis showing the influence of socio-demographic factors on consumption AYB, BGN and LB in selected urban areas of Niger state

Socio-demographic factors	Estimate	S.E	*P*-Value
AYB-Cons.U			
Age group	0.00	0.02	0.99
Education	-0.01	0.02	0.63
Occupation	0.01	0.01	0.56
Ethnicity	-0.02	0.01	0.30
Religion	0.00	0.03	0.93
BGN-Cons.U			
Age group	-0.00	0.05	0.84
Education	-0.01	0.03	0.88
Occupation	0.00	0.03	1.00
Ethnicity	0.00	0.03	0.98
Religion	-0.05	0.06	0.41
LB-Cons.U			
Age group	-0.03	0.03	0.44
Education	-0.04	0.02	0.05
Occupation	0.02	0.02	0.17
Ethnicity	0.01	0.02	0.66
Religion	-0.08	0.04	0.04

SE (Standard error) = 0.02, 95% CI − 0.079 to − 0.001; $p = 0.05$), and religion showed a similarly small negative association (B = − 0.08, SE = 0.04, 95% CI − 0.158 to − 0.002; $p = 0.04$). These estimates indicate that, while statistically marginal, higher education and religion are associated with slightly lower LB consumption.

4 Discussion

4.1 Socio-demographic characteristics of rural and urban households

The present findings indicate uneven awareness and irregular consumption of the three selected underutilized legumes among women in Niger State. In line with prior work on rural–urban disparities in Nigeria, the socio-demographic profile observed here that rural women being younger with lower formal education and higher participation in farming and fishing and urban women being older with greater engagement in wage work and trading helps explain differences in adoption capacity of these legumes [39, 40]. Lower educational attainment can limit access to information about improved processing methods, whereas time constraints associated with urban wage employment make long boiling times particularly prohibitive. Religious and ethnic composition further conditions food-choice norms and receptivity to new or re-introduced legumes, consistent with earlier studies on diet and faith-linked practices in West Africa [41–43].

4.2 Awareness, consumption pattern, and reasons for consumption of selected underutilized legumes

In general, awareness of the three legumes is lower in urban settings than in rural communities, underscoring the continuing role of traditional knowledge and rural market exposure in shaping recognition and use. BGN is more widely known among women in both rural and urban samples, reflecting its established role in dietary diversity and its versatile preparations [44–46].By contrast, AYB remains least familiar in urban areas, consistent with its status as an 'orphan crop' [47] whereas LB awareness is comparatively higher among rural participants. These patterns are consistent with regional evidence

showing Northern Nigerian data documenting common LB dishes in household diets [48].

The main obstacles are perceptions of difficult preparation and concerns about antinutritional compounds. Practically, the hard-to-cook (HTC) trait lengthens boiling time and increases fuel use [49–51]. Recent work in Ghana shows that simply soaking BGN in alkaline brine can improve HTC [52]. Together, these points highlight the need for value-chain improvement such as pre-processing and targeted nutrition education to lower adoption barriers for underutilized legumes [53, 54]. Among the three underutilized legumes assessed, respondents most preferred boiling, aligning with findings from Ghana and Zimbabwe where boiling is the dominant preparation method [55, 56].

Observed disparities in awareness underscore the need for legume-specific promotion and targeted value-chain interventions. To raise AYB visibility among urban consumers, priorities include focused extension, recipe standardization, and consumer nutrition education that emphasizes convenience and taste [57]. Consistent with evidence of local acceptance, promoting LB uptake through vendor training, market incentives and integration into institutional feeding [58, 59].The continued barriers in Niger State likely reflect weak local pre-processing capacity, constrained affordability of pressure cookers/clean stoves, and prevailing energy prices [60] With Nigeria similar to much of Sub-Saharan Africa still lagging on clean-cooking access, extended boiling times disproportionately influence household choices [61, 62].

4.3 Consumption patterns of underutilized legumes and their sociodemographic drivers

We found that the selected Underutilized legume consumption patterns in Niger State align with broader regional trends while also reflecting local determinants. BGN consumption appears to be largely unaffected by any social demographic variables, while in rural contexts, it varies according to religious affiliation. In the selected urban settlements, the age group, education level, occupation, ethnicity, or religion of the respondents does not explain the consumption of AYB. However, LB consumption is influenced by Education and Religion. Specifically, implying that certain religious groups consume much lower than others do. Age Group, Occupation, and Ethnicity influence the consumption of LB. The effect of Ethnicity is the most powerful predictor, followed by Age Group with both as negative influencers while Occupation was a positive influencer [63, 64]. This similar observation have been report in Malawi, and some other part of Nigeria where religion, education, ethnicity and other cultural belief influenced underutilized legume consumption [65, 66].Consequently, the evidence underscores the urgent need for targeted outreach through schools and institutions, demand-driven initiatives should be complemented by shared pre-processing facilities, micro-processing hubs, and quick-cooking options to increase intake of these selected legumes.

This study limitation includes, the seasonality of these selected legumes were not captured, yet availability and use of these legumes vary across seasons and Secondly consumption was self-reported, introducing recall and social-desirability bias. Thus, Future work should employ multi-site longitudinal designs, integrate market and energy variables.

5 Conclusions

The study shows that women's awareness and use of underutilized legumes in Niger State are uneven: BGN is widely recognized and accepted; AYB remains least familiar most especially in urban areas and LB is moderately accepted. Barriers are largely practical and structural, including long cooking times, concerns about antinutritional factors, and limited pre-processing and market availability at some period of the year. Sociodemographic effects were modest overall; in rural areas religion strongly shaped BGN use, while for LB, age, occupation, and ethnicity were influential, with ethnicity exerting the largest negative effect. To increase intake, relevant authorities should pair nutrition education with hands-on, timesaving preparation training delivered through extension and primary health platforms; support micro-processing hubs to supply dehulled or pre-cooked products; integrate these legumes into school feeding and institutional procurement; and use BGN as a "gateway" to introduce acceptable recipes featuring AYB and LB. Improving access to fast -cooking technologies and targeted market promotion through women's groups, faith-based organizations, and urban retailers would further reduce adoption barriers. This coordinated approach can enhance dietary diversity and micronutrient intake, strengthen a climate-resilient food system, and improve nutrition for women and children in Niger State.

Abbreviations

AYB African Yam Bean also refers to as *Sphenostylis stenocarpa*
BGN Bambara groundnuts also known as *Vigna subterranea*
LB Lima beans also the same as Phaseolus lunatus

Acknowledgements

We will like appreciate the staff of the Department of Human Nutrition and Dietetics, University of Ibadan, Local Government chairpersons of the 12 LGAs visited, the field teams, for their support in ensuring the success of this project and all survey participants for their time.

Author contributions

F.A.U, M.T.A, and O.T.A. designed the research; O.A.O, D.M.C., and F.A.U contributed to the study protocol; and were all actively involved in data collection and analysis, F.A.U drafted the manuscript and all authors read and reviewed the manuscript.

Funding

The International Institute of Tropical Agriculture (IITA) Graduate Research Fellowship Programme supported this research.

Data availability

The datasets generated during the current study are available in the Figshare repository 10.6084/m9.figshare.29420936.

Declarations

Ethics approval and consent to participate

The study protocol was reviewed and approved by the Joint University of Ibadan/University College Hospital (UI/UCH) Ethics Review Committee (Ref: UI/EC/21/0747). The research adhered to ICH–Good Clinical Practice (GCP), the Declaration of Helsinki, and the National Code of Health Research Ethics. A letter of introduction was issued by the Department of Human Nutrition and Dietetics, University of Ibadan. All participants provided written informed consent prior to enrollment. Participation was voluntary, and confidentiality/anonymity were ensured throughout data collection and reporting.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 8 August 2025 / Accepted: 21 November 2025
Published online: 28 November 2025

References

1. Steyn NP, Walker ARP. Nutritional status and food security in Sub-Saharan africa: predictions for 2020. Asia Pac J Clin Nutr. 2000;9(1):1–6. https://doi.org/10.1046/j.1440-6047.2000.00138.x.
2. Giancola A, Hauerslev M, Ndinda C, Farmer M, Musah L, Msengi G, Bhutta Z. Addressing the double-burden of malnutrition among children and adolescents in sub-Saharan Africa. J Glob Health Rep. 2022;6:e2022033. https://doi.org/10.29392/001c.36904.
3. Ogwu MC, Izah SC, Ntuli NR, Odubo TC. Food security complexities in the global south. In: Food Security and Safety: African Perspectives. Singapore: Springer Nature; 2024. In Food Safety and Quality in the Global South, pp. 3–33. https://doi.org/10.1007/978-981-97-2428-4_1
4. Mekonnen DA, Trijsburg L, Achterbosch T, Brouwer ID, Kennedy G, Linderhof V, et al. Food consumption patterns, nutrient adequacy, and the food systems in Nigeria. Agric Food Econ. 2021;9(1):16. https://doi.org/10.1186/s40100-021-00188-2.
5. Casari S, Di Paola M, Banci E, Diallo S, Scarallo L, Renzi S, et al. Changing dietary habits: the impact of urbanization and rising socio-economic status in families from Burkina Faso in Sub-Saharan Africa. Nutrients. 2022;14(9):1782. https://doi.org/10.3390/nu14091782.
6. Vermeulen SJ, Park T, Khoury CK, Bene C. Changing diets and the transformation of the global food system. Ann N Y Acad Sci. 2020;1478(1):3–17. https://doi.org/10.1111/nyas.14446.
7. Scalvedi ML, Gennaro L, Saba A, Rossi L. Relationship between nutrition knowledge and dietary intake: an assessment among a sample of Italian adults. Front Nutr. 2021;8:714493. https://doi.org/10.3389/fnut.2021.714493.
8. Popoola JO, Ojuederie OB, Aworunse OS, Adelekan A, Oyelakin AS, Oyesola OL, et al. Nutritional, functional, and bioactive properties of African underutilized legumes. Front Plant Sci. 2023;14:1105364. https://doi.org/10.3389/fpls.2023.1105364.
9. Ojuederie OB, Popoola JO, Aremu C, Babalola OOB. Harnessing the hidden treasures in African AYB bean (Sphenostylis stenocarpa), an underutilized grain legume with food security potentials. Food security and safety: African perspectives. Singapore: Springer; 2021. pp. 1–20. https://doi.org/10.1007/978-3-030-50672-8_1.
10. Baiyeri SO, Uguru MI, Ogbonna PE, Samuel-Baiyeri CCA, Okechukwu R, Kumaga FK. Evaluation of the nutritional composition of the seeds of some selected African AYB bean (Sphenostylis stenocarpa) accessions. Agro-Science. 2018;17(2):37–44. https://doi.org/10.4314/as.v17i2.5.
11. Lungaho M, Ikhajiagbe B, Ojuederie OB, Odozi EB, Mshelbula BP, Onawo LO, et al. From discard to resource: unlocking the environmental and nutritional value of BGN waste. Front Sustain Food Syst. 2025;9:1684699. https://doi.org/10.3389/fsufs.2025.1684699.
12. Adewale BD, Konyeme TE, Fayose FT, Odetoye AA, Popoola JO, Ojuederie BO, et al. Botanical and economic significance of African AYB bean and its relatives. Integrated improvement of food legumes. Cham: Springer Nature Switzerland; 2025. pp. 299–325. https://doi.org/10.1007/978-3-031-82629-0_12.
13. Gavilan-Figari IM, Inga M, Betalleluz-Pallardel I, Espinoza de Arenas LM, Comettant-Rabanal R. Andean LB bean ecology and its potential contribution to food security. Legume Sci. 2024;6(2):e225. https://doi.org/10.1002/leg3.225.
14. Chongtham SK, Devi EL, Samantara K, Yasin JK, Wani SH, Mukherjee S, et al. Orphan legumes: Harnessing their potential for food, nutritional and health security through genetic approaches. Planta. 2022;256(2):24. https://doi.org/10.1007/s00425-022-03923-1.
15. Nnamani CV, Ajayi SA, Oselebe HO, Atkinson CJ, Igboabuchi AN, Ezigbo EC. Sphenostylis stenocarpa prerequisite for conservation and sustainability. Plants. 2017;6(3):30. https://doi.org/10.3390/plants6030030.
16. Halimi RA, Barkla BJ, Mayes S, King GJ. The potential of the underutilized pulse BGN. J Food Compos Anal. 2019;77:47–59. https://doi.org/10.1016/j.jfca.2018.12.008.
17. Mubaiwa J, Fogliano V, Chidewe C, Linnemann AR. Influence of alkaline salt cooking… BGN. LWT. 2019; 107:49–55. https://doi.org/10.1016/j.lwt.2019.02.067
18. Nyau V, Prakash S, Rodrigues J, Farrant J. Domestic cooking effects on BGNs and common bean. J Food Res. 2017;6(2):24. https://doi.org/10.5539/jfr.v6n2p24.
19. Adegboyega TT, Abberton MT, AbdelGadir AH, Dianda M, Maziya-Dixon B, Oyatomi OA, et al. Evaluation of nutritional and anti-nutritional properties of African AYB bean seeds. J Food Qual. 2020;2020(6569420). https://doi.org/10.1155/2020/6569420.
20. Ibrahim MA, Serem JC, Abdullahi AD, et al. Bioactive peptides from African AYB and Taro reveal antidiabetic effects. Int J Pept Res Ther. 2023;29:46. https://doi.org/10.1007/s10989-023-10518-1.
21. Edem UL, Osuagwu AN, Edu NE, Phillip JO, Nelson AY, Emeagi LI, et al. Genetic potential and phytochemical diversity of African AYB bean. Trop J Phytochem Pharm Sci. 2025;4(1):9–15.
22. Adebo JA. A review on the potential food application of LB beans. Appl Sci. 2023;13(3):1996. https://doi.org/10.3390/app13031996.
23. Xuan L, Yadav R, Siddique KHM. Neglected and underutilized crop species: the key to improving dietary diversity and fighting hunger and malnutrition in Asia and the Pacific. Front Nutr. 2020;7:593711. https://doi.org/10.3389/fnut.2020.593711.
24. Oluwole OB, Nwachukwu-Nicholas-Okpara V, Elemo G, Adeyoju O, Ibekwe D, Adegboyega MO. Medicinal uses Bambara beans and pigeon pea. Glob J Epidemiol Public Health. 2021;6:41–50. https://doi.org/10.12974/2313-0946.2021.06.01.3.
25. Okafor JNC, Jideani VA, Meyer M, Le Roes-Hill M. Bioactive components in Bambara groundnut. Heliyon. 2022;8(3):e09145. https://doi.org/10.1016/j.heliyon.2022.e09145.
26. Mayes S, Ho WK, Chai HH, Gao X, Kundy AC, Mateva KI, Zahrulakmal M, Hahiree MK, Kendabie P, Licea LC, Massawe F. Bambara groundnut: an exemplar underutilized legume for resilience under climate change. Planta. 2019;250(3):803–20. https://doi.org/10.1007/s00425-019-03191-6.
27. Mijena DF, Alamerew S, Assefa K, Nigusse M. Indigenous and underutilized crops … Anchote.Ethiop J Crop Sci. 2024; 12(2):15–38.
28. Mustafa MA, Mabhaudhi T, Massawe F. Building a resilient and sustainable food system… Glob Food Security. 2021; 28:100477. https://doi.org/10.1016/j.gfs.2020.100477.
29. Odeku OA, Ogunniyi QA, Ogbole OO, Fettke J. Forgotten gems: underutilized legumes. Plants. 2024;13(9):1208. https://doi.org/10.3390/plants13091208.
30. Paliwal R, Adegboyega TT, Abberton M, Faloye B, Oyatomi O. Potential of genomics for the improvement of underutilized legumes in sub-Saharan Africa. Legume Sci. 2021;3(3):e69. https://doi.org/10.1002/leg3.69.

31. Akintayo OA, Karim OR, Balogun MA, Kolawole FL, Salami KO. Limitations to BGN utilization. Food and potential industrial applications of BGN. Springer; 2021. pp. 61–84. https://doi.org/10.1007/978-3-030-73920-1_5.
32. Shitta NS, Edemodu AC, Abtew WG, Tesfaye AA. A review on the cooking attributes of African AYB bean. IntechOpen; 2021. https://doi.org/10.5772/intechopen.99674
33. Savari M, Sheykhi H, Amghani MS. Role of educational channels in motivating rural women to improve household food security. One Health. 2020;10:100150. https://doi.org/10.1016/j.onehlt.2020.100150.
34. Mena B, Sîrbu A, Eze CC. Global consumer perception towards healthy foods. Consumer perceptions and food. Elsevier; 2024. pp. 605–23. https://doi.org/10.1007/978-981-97-7870-6_29.
35. Sallawu H, Tanko L, Coker AA, Sadiq MSS. Livelihood and income diversification among rural farm households in Niger State, Nigeria. Asian J Agric Ext Econ Sociol. 2016;11(4):1–11. https://doi.org/10.9734/AJAEES/2016/26010.
36. Ene-Obong HN, Alozie Y, Abubakar S, Aburime L, Leshi OO. Update of the nutrition situation in Nigeria. North Afr J Food Nutr Res. 2020;4(9):S63–74. https://doi.org/10.51745/najfnr.4.9.S63-S74.
37. Jung SH. Stratified fisher's exact test and its sample size calculation. Biom J. 2014;56(1):129–40. https://doi.org/10.1002/bimj.201300048.
38. Rosseel Y, Lavaan. An R package for structural equation modeling. J Stat Softw. 2012;48. https://doi.org/10.18637/jss.v048.i02.
39. Ikonne O. Internal migration and urbanization in Nigeria. Int Social Sci Educ J. 2025;3(1):25–33.
40. Agada MO, Igbokwe EM. Dietary diversity of rural households in North central Nigeria. Eur J Nutr Food Saf. 2015;5(3):150–5.
41. Nworgu BG, Nworgu LN. Urban–rural disparities in achievement at the basic education level: the plight of the rural child in a developing country. J Dev Ctry Stud. 2013;3(14):128–39.
42. Oladokun Y, Olubunmi A. Female education and employment in Nigeria. Mujer Andina. 2024;2(2):179–93.
43. Okeke BC. Literacy/numeracy and vocational training among rural women in Nigeria. Int J Lifelong Educ. 2004;23(3):287–99.
44. Mubaiwa J, Fogliano V, Chidewe C, Bakker EJ, Linnemann AR. Utilization of Bambara groundnut (*Vigna subterranea (L.) Verdc.*) for sustainable food and nutrition security in semi-arid regions of Zimbabwe. PLoS ONE. 2018;13(10):e0204817. https://doi.org/10.1371/journal.pone.0204817.
45. Davidson GI, Nnamani PO, Obiegbuna JE. Nutritional composition and glycaemic index of standardized Bambara-nut, corn and AYB-based dishes. Pak J Nutr. 2019;18:677–85. https://doi.org/10.3923/pjn.2019.677.685.
46. Jahanshiri E, Goh EV, Wimalasiri EM, Tengku Mohd Suhairi TASA, Nizar NMM, Mohd Sinin SS. The potential of Bambara groundnut: analysis for the people's Republic of China. Food Energy Secur. 2022;11(2):e358. https://doi.org/10.1002/fes3.358.
47. Adewale DB, Abberton MT. African AYB bean (Sphenostylis stenocarpa). Potential pulses: genetic and genomic resources. Wallingford: CABI; 2024. pp. 14–38. https://doi.org/10.1079/9781800624658.0002.
48. Owolabi OA, Dankat CB, Okolo I, Anigo KM. Proximate, antinutrient and mineral composition of commonly consumed foods from Lima beans. Int J Adv Sci Res Eng. 2020;6(6):40–5. https://doi.org/10.31695/IJASRE.2020.33823.
49. Tan XL, Azam-Ali S, Goh EV, Mustafa M, Chai HH, Ho WK, et al. Bambara groundnut: an underutilized leguminous crop for global food security and nutrition. Front Nutr. 2020;7:601496. https://doi.org/10.3389/fnut.2020.601496.
50. Sofi PA, Mir RR, Zargar SM, Rani S, Fatima S, Shafi S, et al. What makes the beans (Phaseolus vulgaris L.) soft: insights into the delayed cooking and hard to cook trait. Proc Indian Natl Sci Acad. 2022;88(2):142–59. https://doi.org/10.1007/s43538-022-00075-4.
51. Venketeish N, Govindarajan N, Pandiselvam R, Mousavi Khaneghah A. Unlocking the potential of underutilized legumes. Nutritional benefits, anti-nutritional challenges, and mitigation strategies. J Food Meas Character. 2024;18(11):9588–602.
52. Diedericks CF, Venema P, Mubaiwa J, Jideani VA, van der Linden E. Effect of processing on the microstructure and composition of Bambara groundnut (Vigna subterranea (L.) Verdc.) Seeds, flour and protein isolates. Food Hydrocolloids. 2020;108:106031. https://doi.org/10.1016/j.foodhyd.2020.106031.
53. Raneri JE, Padulosi S, Meldrum J, King OI. Promoting neglected and underutilized species to boost nutrition in LMICs. 2019.
54. Mogopodi D, Mogotsi KK, Kwaambwa HM, Raditloko S, Tanyala G. Improving food security in Africa through sustainable utilization of selected climate smart emerging crops: A case of Botswana and Namibia. In Food security and safety volume 2: African Perspectives. 2022:17 (pp. 329–61). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-09614-3_15
55. Kaur S, Kaur G, Kumari A, Ghosh A, Singh G, Bhardwaj R. Resurrecting forgotten crops: food-based products from potential underutilized crops—a path to nutritional security and diversity. Future Foods. 2025;11:100585. https://doi.org/10.1016/j.fufo.2025.100585.
56. Oyeyinka AT, Pillay K, Tesfaye S, Siwela M. Physical, nutritional and antioxidant properties of Zimbabwean Bambara groundnut and effects of processing methods on their chemical properties. Int J Food Sci Technol. 2017;52(10):2238–47. https://doi.org/10.1111/ijfs.13503.
57. Omotayo AO, Omotoso AB, Asong JA. Leveraging africa's underutilized crops to combat climate, water scarcity, and food insecurity in South Africa. Sci Rep. 2025;15:19404. https://doi.org/10.1038/s41598-025-03853-4.
58. Farinde EO, Oyedokun MO, Fasoyiro SB, Adebayo AK. Sensory evaluation and acceptability of selected LB bean products at Erin-Oke. J Underutilized Legumes. 2020;2(1):7–14.
59. Temegne CN, Gavilan Figari IM, Tsoata E, Agendia AP, Ngome FA. LB bean (Phaseolus lunatus L). Potential pulses: genetic and genomic resources. Wallingford: CABI; 2024. pp. 132–58. https://doi.org/10.1079/9781800624658.0008.
60. Adelaja AO. Barriers to National renewable energy policy adoption: insights from Nigeria. Energy Strategy Rev. 2020;30:100519. https://doi.org/10.1016/j.esr.2020.100519.
61. IEA; IRENA; United Nations Statistics Division. WHO. Tracking SDG7: the energy progress report 2024. World Bank; 2024.
62. Yetano Roche M, Slater J, Malley C, Sesan T, Eleri EO. Towards clean cooking energy for all in nigeria: pathways and impacts. Energy Strategy Rev. 2024;53:101366. https://doi.org/10.1016/j.esr.2024.101366.
63. Ofosu IW, Ellis WO, Nsiah K, Oduro IN. Neglected and underutilized legumes: exposure assessment, cooking/eating habits, and consumer characteristics. J Food Secur. 2017;5(5):169–75. https://doi.org/10.12691/jfs-5-5-3.
64. Forsythe L, Nyamanda M, Mbachi Mwangwela A, Bennett B. Beliefs, taboos and minor crop value chains: the case of Bambara groundnut in Malawi. Food Cult Soc. 2015;18(3):501–17. https://doi.org/10.1080/15528014.2015.1043112.

65. Tanimonure VA, Awoleye TG, Fatokimi EO. Exploring the potentials of underutilized Indigenous legume for nutritional welfare of rural households in Oyo State, Nigeria. Food Hum. 2023;1:1331–7. https://doi.org/10.1016/j.foohum.2023.09.029.
66. Agyekum PB, Dombrowski J, Lutterodt HE, Ofosu IW. Consumption patterns and usage of selected underutilized legumes in a Ghanaian community. Legume Sci. 2023;5(4):e202. https://doi.org/10.1002/leg3.202.

Publisher's note