










Research Article

Assessment of postharvest handling practices of green leafy vegetables and its challenges among holders in Ilorin, Nigeria.

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Abstract

Consuming green leafy vegetables contributes immensely to the diet of humans due to the presence of bioactive compounds that are essential for good health. Therefore, its marketing is crucial for the sustainability of the whole value chain. The study was conducted to evaluate the postharvest handling practices of vegetable handlers in Ilorin and environs in order to assess the challenges and their level of awareness of NSPRI technologies for green leafy vegetables. A total of 30 respondents were purposely selected from five locations (150 respondents) considered to be major clusters around the Ilorin metropolis. Structured questionnaires on relevant issues that directly addressed the study objectives were administered to respondents for data collection, their responses were analysed through the use of descriptive statistics of averages and percentages. Results showed that 48% of respondents were within their active productive years (26–45), 90% were female, and 83% were married while 56% had no formal education. The average annual income of respondents was ₦243,333.00 and majority (41%) were from the Ilorin-West Local Government Area. Technologies known and/or adopted include; vegetable bunching, baskets and sheds. Challenges faced during postharvest handling of green leafy vegetables include; wilting, discolouration and average storage time of only 25h. Although, a high level of awareness (70%) was recorded among holders, nevertheless, there was the low level of adoption (less than 40%) of postharvest technologies among them. Factors responsible for low adoption include; cost, technical know-how and ease of use.

1. Introduction

The term green leafy vegetables or leafy green refers to all those plants, cultivated or wild, whose leaves are edible. This classification is used in dietetics to encompass a whole series of plant foods that share botanical and nutritional characteristics slightly different from those of other vegetables, roots and edible tubers. The leaves may sometimes accompany by tender petioles and shoots which may come from a

very wide variety of plants, but share a great deal in nutrition and other characteristics. In Nigeria, vegetables are supplementary food side dishes (raw) or soup with condiments and other main staple dishes [1]. Some common leafy vegetables are *Amanrathus viridis* (spinach/tete.), *Corchorus olitoris* (Ewedu), *Veronia amyadalina* (Bitter leaf/ewuro), *Talinum triangulare* (water leaf/gbure), *Telfaria occidentalis*

(fluted pumpkin/Ugu) and *Celosia argentea* (shokoyokoto).

All leafy vegetables can be categorized as functional foods that possess good nutritional contents vital for growth, health and good skin [2, 3]. Some health benefits include reduced risks of; obesity, heart disease, high blood pressure, cancer and mental decline [4-6]. Other attributes of green leafy vegetables include; low calories, huge fibre, low fat and protein contents, rich in vitamins A, B, C, E, and K, potassium, magnesium and calcium [7]. They are the richest known food in vitamin K and foliates (vitamin B9), and they contain lots of antioxidants: such as chlorophyll, beta-carotene, lipoic acid with depurative and diuretic properties, quercetin, resveratrol or rutin [8]. These are active substances that are beneficial for health, and are not found in products of animal origin [9].

However, leafy green vegetables are prone to huge postharvest losses because they are highly perishable due to their high moisture content of about 65–95% [10, 11]. According to Elemasho *et al.* [12], the primary cause of postharvest food losses is mostly neglected, this includes a lack of awareness of food losses and ways to prevent and reduce them. Other causes of postharvest losses of leafy green vegetables include physiological deterioration, mechanical damage, diseases, and pest infestation [10]. Fresh fruits and vegetables are wasted throughout the food supply chains, from initial agricultural production down to final household consumption [13]. It is very difficult to ascertain accurate data on postharvest losses of leafy vegetables [13, 14]. Nevertheless, many authors have ascribed different values of postharvest losses of fruits and vegetables in general and some for leafy vegetables in particular. For instance; Kitinoja *et al.* [15] posited that losses of highly perishable leafy vegetables have been measured to be as high as 70–80% in West Africa including Nigeria. Idris-Adeniyi *et al.* [16] reported that marketers in Nigeria suffer a lot because of the marketing techniques they employ which are resulted in high postharvest losses of up to 70% while other African countries experienced postharvest losses as high as above 50%. Gebru and Belew [13] have also reported postharvest loss of fruits and vegetables in other parts of the world as; Europe and Russia (56%), North America & Oceania

(66%), Industrialized Asia (43%), Sub-Saharan Africa (66%), Latin America (72%), United States (31%) and Ethiopia (50%).

The common sights of vegetable handlings in the markets in Nigeria include; open bulk packaging in vehicles or packaging in polypropylene bags, mosquito nets and stacking in vehicles for transportation, marketing and home storage [17]. This practice has added to the problems of postharvest losses considerably in the country. To achieve meaningful results in postharvest losses reduction in Nigeria, there should be increased adoption of appropriate technologies that are adequate, available, affordable and easily adaptable to the farmers [18].

The Nigerian Stored Products Research Institute (NSPRI) has developed some technologies for the effective handling of leafy vegetables which include; Vegetable Baskets (VBs) for harvesting, handling and transportation of leafy vegetables and Vegetable Sheds for on-farm handling of vegetables. These technologies are forms of Evaporative Cooling System (ECS) or control atmosphere storage which majorly relate to the environmental conditions of the storage area [19]. The VBs as developed can preserve some vegetables for between 5–7 days [20].

Adequate awareness of any given innovation or technology is a key to the success of adoption and utilization of the technology [21]. Awareness of these technologies for leafy vegetables and others has been created severally by NSPRI through exhibitions, adopted villages and schools [12]. Nonetheless, the rate of adoption of VB among holders in Ilorin is still very low. This study is an attempt to investigate the handling practices of leafy vegetable handlers in Ilorin and its environs to; (i) enumerate causes of postharvest losses of leafy vegetables (ii) identify some constraints faced by leafy vegetable handlers and (iii) determine the level of awareness and/or adoption rate of NSPRI postharvest technologies in the study area.

2. Materials and methods

2.1 Study area

The study was carried out in Ilorin metropolis and environ [comprises of four Local Government Areas (LGAs) which are; Asa, Ilorin-East, Ilorin-South and Ilorin-West]. Ilorin is the Kwara State capital city

(North-Central Nigeria) located within latitude 8°33'N and longitude 4°33'E. The city is within the tropical savannah climate (Köppen climate classification) with annual rainfall of 990.3–1,310 mm (39–52 in), maximum temperatures ranging between 33–37°C (91.4–98.6°F) with the hottest month being March while the relative humidity (RH) ranges between 29–70.2% from month to month [22].

2.2 Sampling procedure

Leafy vegetable sellers and/or holders in the study area constituted the population for data collection in this study with a three-stage sampling procedure [21, 23]. The first stage involved a purposive selection of four (4) LGAs in Kwara State (Asa, Ilorin-East, Ilorin-South and Ilorin-West LGAs). The second stage involved purposive selection of five locations (Lasoju, Kodi, Mandate, Ipata and Yoruba Road) comprising farm settlements, vegetable clusters and markets where varieties of green leafy vegetables are commonly sold within these four LGAs. The third stage consists of a random selection of 30 respondents from each location to make a total of 150.

2.3 Data collection, treatment and presentation

Data were collected from the respondents through the use of the structured questionnaire. It contained relevant questions based on the objectives of the study. Descriptive statistics (such as frequency, percentage and mean) were used in analyses of data. Results were represented in tables and charts for clarity and understanding.

3. Results and discussion

3.1 Socio-economic characteristics of leafy vegetable handlers in Ilorin

The socio-economic characteristics of respondents in the survey of green leafy vegetable handlers in Ilorin environ is as presented (Table 1). Factors examined included; gender, age, marital status, household size, educational level, years of experience, annual income, location and membership of traders' association [24]. The results showed that the age range of the majority (29.3%) of green leafy vegetable handlers in the study area fell within 26-35 years while another 19.3% of respondents had an age range between 36-45 years. This implies that about 48% of respondents are still active and within their productive years. This was in line with the report of Elemasho *et al.* [12] which stated

that the majority of fluted pumpkin leaf sellers in Obio-Akpor L.G.A of Rivers State fell within the active age of 36-45 years. It has been shown that age is an important factor in the study of individuals because it reflects the physical strength to perform a task and the psychological disposition for imbibing behavioural change or otherwise [21].

Further, the gender distribution of the respondents showed that the majority (90%) were females while less than 10% were males. This indicated that postharvest activities of green leafy vegetables in the study area were affected by gender in which case females were involved more than their male counterparts. This agreed with the findings of Adejo [25], who stated that postharvest activities in Nigeria are based on the division of labour where women are seen to be more involved than men. Not only that, some cultural beliefs also had it that only certain genders can participate in some business activities. Similar results have been reported by researchers among leafy vegetable handlers in other locations in Nigeria where the majority of sellers were females [26, 12]. The marital status and household size of respondents were also studied. It indicated that the majority (83.3%) were married with a large household size of 6-10 (60.7%). This might probably be due to the fact that married people tend to have more social responsibilities than single ones. This assumption was also submitted by Elemasho *et al.* [12] Another fact to support this was given by Otene *et al.* [26] that, green leafy vegetable farming activities required less energy, therefore, women find it easier to cultivate them more than other crops.

In the educational strata of the study population, the results showed that the majority (56%) had no formal education. This figure constitutes more than half of the study population. This might probably be pointing to the fact that selling green leafy vegetables does not require any special skills. However, the educational level of individuals can affect his/her perception of new or modern postharvest technologies due to numerous factors. To support this assumption, Dire *et al.* [21] stated that; education has been identified as an enhancer of agricultural and other productive activities because it is a factor that broadens the mental horizon, influences the totality of the mind and predisposes individuals to new ideas.

Table 1. Distribution of respondents according to socio-economic characteristics (N=150)

Socio-Economic Characteristics	Frequency	Percentage	Mean	Socio-Economic Characteristics	Frequency	Percentage	Mean
Gender				Artisan	7	4.7	
Male	14	9.3		Civil servant	2	1.3	
Female	135	90.0		Total	150	100.0	
No response	1	0.7		Years of experience			
Total	150	100.0		1-5	26	17.3	
Age (Year)				6-10	29	19.3	
15-25	19	12.7		11-15	24	16.0	14
26-35	44	29.3		16-20	27	18.0	
36-45	29	19.3	41	21 & above	47	28.0	
46-55	29	19.3		No response	2	1.3	
56-65	29	19.3		Total	150	100.0	
Total	150	100.0		Annual earnings (₦)			
Marital status				Below 100,000	5	3.3	
Single	14	9.3		100,000 – 200,000	69	46.0	
Married	125	83.3		200,001 – 300,000	21	14.0	243,333
Widowed	11	7.3		300,001 – 400,000	15	10.0	
Total	150	100.0		400,001 – 500,000	20	13.4	
Household size				500,001 and above	5	3.3	
1-5	47	31.3		No response	15	10.0	
6-10	91	60.7	7	Total	150	100.0	
11 & above	9	6.0		LGA			
Total	150	100.0		Asa	58	38.7	
Educational level				Ilorin-East	6	4.0	
No formal education	84	56.0		Ilorin-South	21	14.0	
Primary	30	20.0		Ilorin-West	62	41.3	
Secondary	34	22.7		No response	3	2.0	
Tertiary	2	1.3		Total	150	100.0	
Total	150	100.0		Do you belong to any association?			
Primary occupation				Yes	80	53.3	
Farmer	63	42.0		No	70	46.7	
Trader	69	46.0		Total	150	100.0	
Farmer & trader	9	6.0					

Source: Field Survey, 2022

The occupational distribution of respondents showed that the majority (46%) engaged in vegetable trading as their primary occupation, 42% of respondents were farmers, 6% were farmers and traders at the same time, 4.7% were artisans while 1.3% were civil servants but engage in green vegetable business on a part-time basis. Years of experience in vegetable selling (Table 1) showed that the majority (28%) had been doing the business for the past 20 years and above. This means that they are well experienced in selling of green leafy vegetables. According to Elemasho *et al.* [12], good

experience in business would mean that they were well familiar with it and that they must have been faced with many challenges in the past which would motivate them to make enquiry in order to find solutions to those problems. The annual income of respondents was also computed (Table 1). It showed that the majority (46%) of them earned between one hundred thousand (₦100,000.00) to two hundred thousand naira (₦200,000.00) annually.

Further, the average annual income of the study population was shown to be two hundred and forty-

three thousand, three hundred and thirty-three naira only (₦243,333.00). This explained why respondents were so enthusiastic about the business because they find their livelihood through the activity of vegetable selling, some attested they have acquired their own houses and trained all their children as well.

The location of the respondents is also presented in Table 1. It showed that the majority (41.3%) came from Ilorin-West Local Government Area followed by the Asa Local Government Area (38.7%). These two LGAs comprise 80% of the respondents, this might probably be due to their proximity to River Asa where people had an opportunity to practice dry season farming through irrigation. It has been shown in literature that the Asa River in the Ilorin, Kwara State has become a major river of economic, agricultural and environmental significance [27].

The distribution of respondents according to their membership of association (Table 1) indicated that the majority (53.3%) belong to various trader associations while 46.7% of the respondents do not belong to any association. This was unlike in the case of a report published by Elemasho *et al.* [12] where all the fluted pumpkin leaves sellers in Obiarkpo L.G.A. in Rivers State did not belong to any association. Although, being a member of traders' association might not significantly affect an individual's success in the business of selling green leafy vegetables, but some published research works have shown the importance of belonging to such association. According to Elemasho *et al.* [12], being a member of association could help in accessing vital information, benefits like loan facilities innovations from Government Agencies and Non-Governmental Organization (NGO). The association could also in some cases serve as a regulatory body regarding their trading activities.

3.2 Challenges of postharvest handling and storage of leafy vegetables

The distribution of respondents according to postharvest handlings and storage of leafy vegetables is shown in Table 2. The results showed that the majority (62%) of respondents harvest their leafy vegetables in the morning time while others harvest at various times of the day. It has been shown that the early hours of the day or cool time in the evening is the best time to harvest fruits and vegetables. It is also important to know that the time of harvesting can

affect the shelf-life of fruits and vegetables to a large extent [28, 17]. Further, Table 2 showed that the majority (82.6%) of respondents do sorting after harvesting, and only 12% of them do not sort at all. Sorting can affect shelf-life to a great extent especially when spoilage has started from the field. The types of treatment given to harvested leafy vegetables, the type of transportation used in bringing leafy vegetables to the markets, the mode of transportation (opened or closed), mode of storage treatments given to leafy vegetables before selling, the duration of storage, the effectiveness of storage, indices of measurement of effectiveness, challenges encountered during storage, awareness/adoption of NSPRI technologies and types of postharvest processing were all computed.

There were many types of transportation used by vegetable sellers which include; bus or taxi, motorcycle, tricycle and manual methods. Although, a majority (50%) used the open method or mode of transportation, 44% of respondents still used the closed method which has a great disadvantage. The closed method could give rise to heat build-up in the system which would lead to rapid deterioration of the produce according to Adekalu *et al.* [29]. The average storage duration of the studied population was found to be 25 h. This is short and a lot still needs to be done in this aspect. If more stakeholders would adopt NSPRI technologies most especially the vegetable baskets which have been used for holding *Amarantus viridis* for 96h (4 days) and *Telfaria occidentalis* H. for 144h (6 days) [29]. The challenges experienced during storage include; wilting and colour change. These challenges could adequately be taken care of by the use of these simple technologies that are available. According to Gebru and Belew [13], poor conservation of leafy vegetables might result into low qualities including; loss of nutrients, colour, deterioration and outright rejection by the consumers which implies loss of income. It also has negative impacts on the environment because of the energy, biodiversity, greenhouse gases, water, soil and other resources embedded in food that no one consumes. Also, there were reported cases of numerous foodborne disease outbreaks caused by consumption of fresh vegetables contaminated by microorganisms due to spoilage which has resulted in various illnesses,

Table 2. Challenges of postharvest handling and storage of leafy vegetables (N=150)

Handling	Frequency	Percentage	Handling	Frequency	Percentage	Mean
Time of harvest			Do you store?			
Morning	93	62.0	Yes	34	22.7	
Afternoon	6	4.0	No	110	73.3	
Evening	2	1.3	No response	6	4.0	
Anytime	45	30.0	Total	150	100.0	
No response	4	2.7	If yes, how?			
Total	150	100.0	Bunching	12	8.0	
Do you sort?			Under shed	12	8.0	
Yes	124	82.6	Wetting	10	6.7	
No	18	12.0	No response	116	76.5	
No response	8	5.4	Total	150	100.0	
Total	150	100.0	How long do you store?			
Treatment measures			12-24 h	12	8.0	
No treatment	76	50.7	25-36 h	6	4.0	25 h
Pre-cooling	12	8.0	37-48 h	3	2.0	
Wetting	53	35.3	No response	129	86.0	
Chemicals	3	2.0	Total	150	100.0	
Others	1	0.7	Is your storage effective?			
No response	5	3.3	Yes	13	8.7	
Total	150	100.0	No	8	5.3	
Mode of transportation			No response	129	89.0	
Motor cycle	32	21.3	Total	150	100.0	
Tricycle	42	28.0	If yes, how do you know?			
Taxi/bus	49	32.7	Freshness	10	6.7	
Manual	4	2.7	Colour	3	2.0	
Others	18	12.0	No response	137	91.3	
No response	5	3.3	Total	150	100	
Total	150	100.0	Challenge during storage			
Type of transportation			Wilting	69	46.0	
Open method	76	50.6	Colour change	21	14.0	
Close method	66	44.0	No response	60	40.0	
No response	8	5.4	Total	150	100.0	
Total	150	100.0	When do you experience high spoilage			
Packaging materials during transportation			Raining season	70	46.7	
Raffia basket	4	2.7	Hot season	69	46.0	
Polypropylene sack	131	89.3	No response	11	7.3	
Jute bag	1	0.7	Total	150	100.0	
Vegetable basket	7	4.7	Do you engage in postharvest processing?			
Trays	1	0.7	Yes	10	6.7	
No response	6	4.0	No	130	86.6	
Total	150	100.0	No response	10	6.7	
			Total	150	100.0	

Source: Field survey 2022.

hospitalizations, deaths, and even food recalls in some countries [30]. Further, some respondents experienced these challenges more in the rainy

seasons while others experienced the challenges more in the dry seasons. These disparities might probably be due to the different varieties of green leafy

vegetables they were selling. The study revealed that a very low proportion (7%) of the population under study engaged in postharvest processing. This has to be improved upon in order to curb losses.

3.3 Level of awareness/adoption of NSPRI postharvest technologies for green leafy vegetables

The distribution of respondents according to their level of awareness and/or adoption of NSPRI technologies is as shown (Fig. 1).

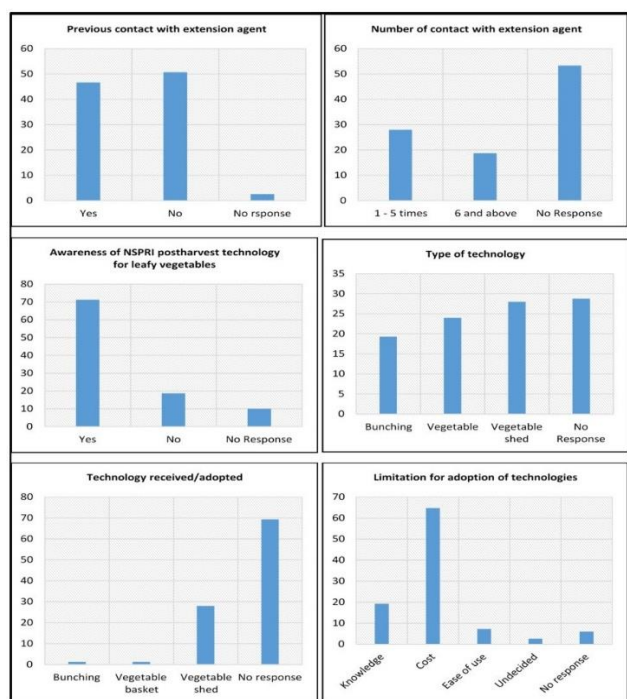


Figure 1. Level of awareness and adoption of NSPRI technologies by the respondents (Source: 2022 Field Survey).

These include; contact with extension agents, awareness of NSPRI postharvest technologies for green leafy vegetables, rates of adoption of postharvest technologies and the constraints for adopting these technologies. The results showed that the majority (about 51%) has no contact with any extension agents, this represents more than half of the population in the study. Although, more than 70% of the respondents were aware of NSPRI postharvest technologies for green leafy vegetables, only a few have adopted them. The technologies adopted include; bunching (1.3%), vegetable baskets (1.3%) and vegetable sheds (28%). These results have shown clearly that the adoption rate of NSPRI technologies for leafy vegetables was low in the study area. These findings agreed with the report of Adebayo *et al.* [24] that there is positive relationship between contact

with extension agents and the rate of adoption. The constraints faced by respondents include; cost (64.7%), technical know-how (19.3%) and ease of use (7.3%).

3.4 Sources of information on postharvest technologies

The distribution of respondents according to sources of information on postharvest technology is as shown (Table 3).

Table 3. Distribution of respondent according to their sources of information on postharvest technology

Sources of information	Frequency	Percentage
Mass media		
Radio	34	22.7
Television	4	2.7
No response	112	74.6
Total	150	100.0
Interpersonal		
Extension agent	13	8.7
Farmer to farmer	38	25.3
Research institute	6	4.0
No response	93	62.0
Total	150	100.0
Preferred sources of information		
Radio	3	2.0
Television	3	2.0
Internet	2	1.3
Research institute	19	12.7
Extension agent	10	6.7
Farmer to farmer	41	27.3
No response	72	48.0
Total	150	100.0

Source: 2022 Field Survey.

Two major sources of information were listed; mass media and interpersonal mode. The results showed that, the majority (25%) of respondents sourced their information through farmer-to-farmer means (interpersonal) and 27% of them categorically stated they preferred farmer-to-farmer as a source of their information. The reasons for this choice may not be far fetch, it is cheap, easy to adopt and can spread in good time in a particular location. However, this method is not without some limitations, as some individuals may like to hoard information so that it will not get to others.

4. Conclusions

The study has shown that indigenous methods of packaging and transportation of leafy vegetables are still in operation among holders in the locations

visited. Awareness of modern technologies developed by the Nigerian Stored Products Research Institute (NSPRI) for improved handling, transportation and shelf life extension of green leafy vegetables were high among the respondents but are not popularly used in the study area. Prominent among the constraints for lack of adoption of the technologies was cost or finance. Whereas the cost of these items may not be unaffordable for the users, we recommend that more education should be provided to enlighten them about these technologies. The institute should also make some of these materials available to users at no cost or being subsidized for popularization.

Authors' contributions

“Conceptualization, Bamishaiye, E.I.; Methodology, Owojaiye, O.B.; Validation, Bamishaiye, E.I. and Akande, S.A.; Investigation, Fashanu, T.A and Lawal, I.O; Data Curation, Aina, O.B; Writing – Original Draft Preparation, Akande, S.A; Writing – Review & Editing, Onyegbula A.F; Visualization, Ajani A.O;”

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Availability of data and materials

All data will be made available on request according to the journal policy

Conflicts of interest

The authors declare no conflict of interest in this work.

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