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Fruit Ripening Methods and Knowledge of Health Effect of Use of Calcium Carbide in Ripening Fruits among Fruit Sellers in Uyo, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Eating of fruits prevent several diseases in man but unhealthy ripening methods are reported in many countries. This study aimed at determining the various fruit ripening methods and knowledge of the health effects associated with the use of calcium carbide as an artificial ripening agent by fruit sellers.
Study Design: A descriptive cross sectional design was used.
Place and Duration of Study: The study was carried out in the 3 major markets in Uyo capital city territory, Akwa Ibom State, Nigeria between April and June, 2021.
Methodology: One hundred and ninety nine fruit sellers [19 (9.5%) men, 180 (90.5%) women] between the ages of 18-67 years were recruited through systematic random sampling. Data on methods of fruit ripening known, ever used and mainly used and knowledge of adverse health effects of use of calcium carbide as fruit ripening agent were collected using a semi-structured questionnaire and analyzed with STATA at a level of statistical significance of P<0.05.

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Results: Common fruit ripening methods known were natural ripening199 (100%), packaging in polyethylene bags 178 (89.5%) and use of calcium carbide 155 (77.9%). Main methods currently used to ripen fruits were natural ripening 125 (62.8%), packaging in polyethylene bags 45(22.6%) and use of calcium carbide 8(4.0%). Fifty four (27.1%) and 43(21.6%) knew that use of calcium carbide for fruit ripening is associated with cough and chest tightness in traders and cancers in consumers respectively. Poor knowledge of adverse health effect of use of calcium carbide in ripening fruits was reported in 147(73.9%) respondents. No significant association between socio-demographic characteristics of respondents and knowledge of use of calcium carbide in fruit ripening was observed (P>0.05)

Conclusion: Use of unhealthy methods of fruit ripening and poor knowledge of health effects of use of calcium carbide in ripening fruits was observed. Intense education of traders on healthy methods of fruit ripening is needed.

Keywords: Fruit sellers; calcium carbide; fruit ripening; Uyo.

1. INTRODUCTION

Fruits are the natural staple food of humans and contain considerable amount of essential nutrients in large proportion that prevent diseases and keeps a person energetic throughout his life [1].Fruit consumption decreases the risk of several diseases including atherosclerosis, heart and brain disorders and different types of cancer [2]. Their content of antioxidants, vitamins, minerals, dietary fiber and health benefits are attractive factors in consumer preferences [3].

Ripening of fruit is a natural process in which the fruit undergoes various chemical changes and gradually become sweet, flavored, colored, gets soft and become palatable [4]. Ethylene is the plant hormone that triggers fruit ripening and senescence of vegetative tissues and has been reported that if applied exogenously, helps fruit ripening [5,6]. Ethylene is also produced in response to stress, such as wounding, very low and very high temperatures, flooding or drought, treatments with other hormones, heavy metals, and attack by pathogens [7]. At various stages of fruit production especially during harsh transportation conditions, parts of naturally ripened fruits could be damaged causing great economic loss for the fruit sellers. To minimize the loss and to meet increasing fruit demands even during off seasons, fruits at mature green unripe stage are sometimes collected by fruit sellers and artificially ripened before selling to the consumers [8,9].

Ripening agents are substances, which hasten the ripening process and include ethylene gas, ethephon, ethylene glycol, Ethrel and calcium carbide,CaC_2 [10]. However, the only safe and worldwide-accepted method is using ethylene for ripening when done under controlled temperature and relative humidity conditions. Thus, unripe fruit are exposed to an exogenous source of ethylene gas which stimulates natural ripening until the fruit itself starts producing ethylene in large quantities [11]. However, ethylene ripening agents are relatively expensive [12]. Therefore, low-cost chemicals such as calcium carbide, ethylene glycol, and ethephon are commonly used to artificially trigger fruit ripening in many developing countries [12,13]. A small quantity of calcium carbide is usually wrapped in a paper packet and kept near a pile or box of fruits. Acetylene gas, an analogue of ethylene which hastens the ripening process is produced when the calcium carbide reacts with moisture in fruits.

The use of calcium carbide is associated with a lot of adverse health effects in humans [10], and on the fruits. It contains traces of arsenic and phosphorus hydride, which are hazardous to human health if ingested and the gases emitted respectively contain arsine and phosphine gas which are carcinogenic [14]. Children are reported to be born with congenital abnormalities when pregnant women consumed fruit ripened with carbide [15]. Its alkaline nature irritates the mucosal tissue in the abdominal region [16]. Cases of stomach upset after eating carbide ripened mangoes have been reported [17]. The hypoxia inducing effects of arsenic in calcium carbide cause nervous system disorders in consumers of such fruits in addition to skin ulcers and heart related health issues [18,19]. Furthermore, fruits ripened with CaC_2 are overly soft, less tasty and have a shorter shelf-life [17]. Such fruits would present a yellow outer skin, but the tissue inside is unripe or itself remains green and raw [14]. Considering these facts, the use of calcium carbide as a fruit-ripening agent has been banned in some countries [20].

In areas of high prevalence of artificial fruit ripening, farmers/traders of these fruits have a little knowledge about artificial ripening and the harm of using such chemicals [15]. So far, there has been no published studies on materials used for ripening of fruits by fruit sellers and their knowledge of the health effects of use of calcium carbide in fruit ripening in Uyo capital city territory, hence the need for this study. Findings would help document fruit ripening methods used and will serve as baseline to assess the impacts of subsequent interventions amongst them. This study, therefore, aims to identify the methods used in fruit ripening, and the knowledge of the health effects of use of calcium carbide in ripening of fruit among sellers in major markets in Uyo capital city territory.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in Uyo capital city territory, in Akwa Ibom state which is in the south-south geopolitical zone of Nigeria. The state with Uyo as its capital, has 31 Local Government Areas (LGAs), 3 senatorial districts and a 2018 projected population of 5,737,270 [21]. Uyo capital city territory consists of Uyo, the state capital and 8 surrounding LGAs including Ibiono Ibom, Nsit Atai, Nsit Ibom,Nsit Ubium, Ibesikpo Asutan, Uruan,Etinan and Itu [22]. There are 3 major markets in the capital city territory namely: Urua Akpan Andem, Urua Itam and Urua Kpokpo.

2.2 Study Design and study Population

This was a descriptive cross sectional study among fruit sellers in Uyo capital city territory conducted between April and June,2021.

Inclusion and exclusion criteria: Those included were respondents who had been in the business for at least 6 months and were available during our visits for the study. Traders who were less than 18 years or children selling fruits for their parents who may not know how the fruits are ripened were excluded.

2.3 Sample Size

A minimum sample size of 292 was determined using the Cochran Formula [23] for cross sectional studies $n=Z^2pq/d^2$. The prevalence, p, being the prevalence of fruit sellers with good level of knowledge of adverse effects of use of calcium carbide in fruit ripening was obtained from a similar study in Malaysia [24], z=1.96 and d is sampling error of 0.05.The sample size was however, increased to 321 after adding a 10% attrition rate. A census of fruit sellers in the 3 major markets gave 450 fruit sellers as follows: Urua Itam 180; Urua kpo kpo 120 and Urua Akpan Andem with 150 fruit sellers respectively.

An adjusted sample size formula, a=n/1+n/N for populations less than 10,000 was used where a=adjusted sample size, n = calculated sample size (i.e 321),N = Total population of the target population (450) to give a minimum sample size of 187. Proportional allocation was used to determine the number of fruit traders each market contributed to the minimum sample size as follows: minimum sample size/total number of traders from the 3 markets to give 187/450=0.416.The number of fruit sellers from each market was multiplied by this (0.416) to obtain the minimum number to be recruited from each market. Thus the numbers of fruit sellers proportionally recruited from each market were as follows: Urua Itam 75; Urua Akpan Andem 62 and Urua kpo kpo with 50 giving a total of 187. However,199 respondents were recruited.

2.4 Sampling Technique

The traders in each market were numbered according to their sitting position. The first respondent from each market was determined using simple random sampling method. Thereafter, subsequent respondents were recruited using the systematic sampling of alternate consenting fruit sellers. Data collection lasted for 6 days as each market was visited twice.

2.5 Data Collection and Study Instrument

The study instrument used was a semi-structured interviewer administered questionnaire developed according to the objectives of this study. It was pretested among 15 fruit sellers opposite the University of Uyo teaching hospital, Abak road,Uyo which was not used for the study Statements in the questionnaire that were ambiguous were rephrased before the final application of the tool at the selected markets. The instrument had 3 sections and obtained socio-demographic characteristics, methods of fruit ripening known and used by respondents and knowledge of health implications of use of calcium carbide in fruit ripening. Seven research assistants who were final year medical students

and previously trained on the objectives and methodology of the study were recruited for data collection. The section assessing knowledge had 14 questions. The score obtainable for every correct response per question was one (1) point and zero (0) point for a wrong response giving a maximum score per respondent of 14 and a minimum of 0. Scores of between 0-7 and 8-14 were categorized as poor and good levels of knowledge respectively.

2.6 Data Analysis

Data obtained was analyzed using Stata statistical software version 13.0. Categorical data were summarized with frequency and percentages while quantitative data were summarized using appropriate measures of central tendencies (mean and standard deviation for normally distributed data or median and Inter-quartile range for skewed data). Association between selected variables and level of knowledge of the health effects of use of calcium carbide for fruit ripening was determined using Chi square test (or Fisher exact test) at a significant level of $P<0.05$

3. RESULTS AND DISCUSSION

3.1 Socio-Demographic and Occupational Characteristics of Respondents

A total of 199 respondents participated in the study, 65 (32.7%), 57 (28.6%) and 77 (38.7%) from Urua Akpan Andem, Urua Kpo Kpo and Urua Itam respectively. The mean age of respondents was 35.5+/-11.4 years and 106 (53.3%) were less than the mean age. Most respondents were females 180 (90.5%), 97(48.7%) completed their secondary education, 190 (95.5%) were Christians and 115(57.8%) were married. Majority 188 (94.5%) were indigenes and 101(50.7%) had spent at least 5 years in the business. Some 106 (53.3%) resided in the urban area, 52 (26.1%) received some form of training on food ripening and thirty (57.7%) of these were trained by their mothers (Table 1).

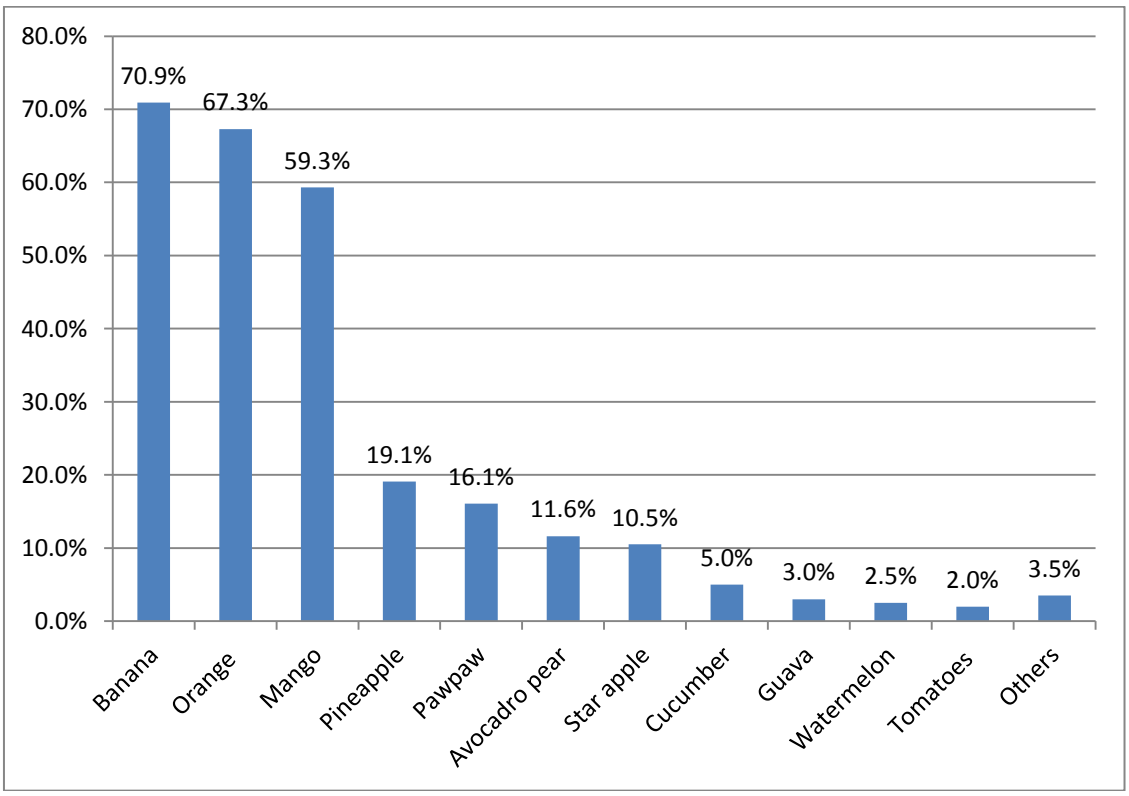

Fig. 1. Types of fruits sold by respondents

Table 1. Socio-demographic characteristics and occupational history of respondents (n=199)

Variable	Frequency	Percent
Major Markets		
Akpan Andem	65	32.7
Kpokpo	57	28.6
Itam	77	38.7
Age (in years)		
Less than 35 years	106	53.3
35 years and above	93	46.7
Age (Mean+/-SD)	35.54+/-11.39	
Sex		
Male	19	9.5
Female	180	90.5
Educational Level		
No formal education	30	15.1
Primary secondary	56	28.1
Secondary	97	48.7
Tertiary	16	8.0
Religion		
Christianity	190	95.5
Islam	8	4.0
Traditional worshipper	1	0.5
Marital status		
Single	69	34.7
Married	115	57.8
Divorced/separated	8	4.0
Widowed	7	3.5
Tribe		
Indigenes (Ibibio, Annang, Oron)	188	94.5
Non Indigenes(Igbo/Hausa)	11	5.5
Years in business		
< 5	98	49.3
5 and above	101	50.7
Median (IQR)	5 (2-7)	
Residence		
Urban	106	53.3
Rural	93	46.7
Training on food ripening		
Yes	52	26.1
No	147	73.9
Trained by who (n=52)		
Mother	30	57.7
Aunty	8	15.4
Sister	5	9.6
Others	9	17.3

IQR=Interquartile range

3.2 Types of Fruits sold by Respondents

The top three fruits sold by respondents were banana (70.9%), orange (67.3%) and mango (59.3%). Cucumber (5.0%), Guava (3.0%), watermelon (2.5%), tomatoes (2.0%) and other fruits were also sold (Fig. 1).

3.3 Fruits Ripening Agents Known, Ever Used and Mainly Used by Respondents

All respondents (100%) knew natural ripening of fruits. Apart from this, the top 5 other methods known by respondents for ripening of fruits were

packaging in polyethylene (nylon) bags 178 (89.5%), use of calcium carbide 155 (77.9%), heating in the sun 59 (29.7%), use of other fruits 51 (25.6%) and use of ash 42 (21.1%). Pouring detergent water on fruits 4 (2.0%) and use of blue stones 4 (2.0%) were other methods reported. Apart from natural ripening, the top 3 methods ever used by respondents to ripen fruits include wrapping in nylon bag 124 (62.3%), use of calcium carbide 50 (25.1%) and use of other fruits 26 (13.1%). The majority of respondents 125 (62.8%) majorly used natural ripening process to ripen their fruits for sale. Wrapping in nylon bags was the next major ripening method used by respondents 45 (22.6%) while 8 (4.02%) majorly use calcium carbide (Tables 2a and 2b).

3.4 Knowledge of the Health Effects of Use of Calcium Carbide in Ripening of Fruits

Fifty four (27.1%) and 73 (36.7%) knew that use of calcium carbide to ripen fruits can cause cough /chest tightness and stomach upset respectively in the traders. Headaches 39 (19.6%), skin damage 44 (22.1%) and frequent thirst 27 (13.6%) was known by respondents to occur in traders who use calcium carbide to ripen fruits. Forty three (21.6%) respondents knew that use of calcium carbide to ripen fruits can cause cancers in consumers while that its use can make the fruit to be overly soft was known by 105 (52.8%) respondents. Many 120 (60.3%) knew that use of calcium carbide to ripen fruits can make fruits not to be as tasty as naturally ripened fruits and 107 (53.8%) knew that its use can make outer surface of fruits appear ripe while the inside remains green and raw. One hundred and five (52.8%) knew that fruits ripened with calcium carbide do not last long before getting spoilt compared to naturally ripened fruits and 81 (40.7%) knew that fruits ripened with it do have dots and patches on their surface after a few days. Few 52 (26.1%) knew that its use to ripen fruits can pollute the environment.

3.5 Knowledge of Health Effects of Use of Calcium Carbide in Ripening of Fruits

One hundred and forty seven (73.9%) had poor knowledge of the health effects of use of calcium carbide in fruit ripening (Fig. 2).

3.6 Relationship between Selected Characteristics of Respondents and Knowledge of Health Effects of Fruit Ripening with Calcium Carbide

There was no association between age, sex of respondents and knowledge of health effects of use of calcium carbide in fruit ripening (*P*=0.38 and Fishers exact =0.17 respectively). Level of education, religion and marital status of respondents had no significant association with their knowledge of health effects of use of calcium carbide in fruit ripening (Fishers exact=0.14,*P*=0.26 and 0.99 respectively). The residence and number of years of practice of fruit vendors was not significantly associated with their knowledge of health effects of use of calcium carbide in fruit ripening (*P*=0.58 and 0.07 respectively) (Table 4).

Table 2a. Substances known for fruit ripening by respondents

Variables	Frequency	Percent %
***Substances known to be used for fruit ripening**		
Natural ripening	199	100.0
Packaging in polyethylene (nylon) bags	178	89.45
Calcium carbide (carbide)	155	77.89
Heating in the sun	59	29.65
Use other fruits	51	25.63
Use of ash	42	21.11
Boil in hot water	33	16.58
Use of ethanol	**17**	8.04
Use of potash	8	4.02
Pour water on it	14	7.04
Pour warm water on it	4	2.01
Wrap in dry leaves	3	1.51
Pour detergent water on it	4	2.01
Use of blue stone	4	2.01
Use of saccharine water for oranges	2	1.00
Keep in cold dry place	5	2.51

Table 2b. Substances ever used and mainly used by respondents in ripening fruits

Variables	Frequency	Percent
***Substances ever used by respondents to ripen fruits**		
Wrap in polyethylene Bags	124	62.31
Calcium carbide	50	25.13
Use of other fruits	26	13.07
Use of ash	17	8.54
Sun heating	15	7.54
Boil in hot water	6	3.02
Use of torch light battery	2	1.00
Use of salt water	5	2.51
Pour water on it	12	6.03
Use of detergent water	2	1.00
Wrap with leaves	3	1.51
Place in cold room	3	1.51
Use of saccharine water	1	0.50
Main Fruit Ripening method		
Natural ripening	125	62.81
Packaging in polyethylene Bags	45	22.61
Calcium carbide	8	4.02
Pour water on it	7	3.52
Use of other fruits	6	3.02
Cover with leaves	2	1.00
Use of salt water	2	1.00
Use of ash	1	0.50
Heating in the sun	1	0.50
Use of torch light battery	1	0.50
Use of warm water	1	0.50

**Multiple responses allowed*

Table 3. Knowledge of the health effects of use of calcium carbide in ripening of fruits by respondents

Variables	Yes n(%)	No n(%)	Don't Know n(%)
Use of calcium carbide to ripen fruits can cause cough and chest tightness in the trader who use it.	54 (27.1)	22 (11.1)	123 (61.8)
Use of calcium carbide to ripen fruits can cause stomach upset in the traders who use it.	73 (36.7)	22 (11.1)	104 (52.3)
Use of calcium carbide to ripen fruits can cause headache in traders who use it.	39 (19.6)	27 (13.6)	133 (66.8)
Use of calcium carbide to ripen fruits can cause skin damage in traders who use it.	44 (22.1)	27 (13.6)	128 (64.3)
Use of calcium carbide to ripen fruit can cause frequent thirsts in traders who use it.	27 (13.6)	31 (15.6)	141 (70.8)
Calcium carbide fumes can be inhaled by traders during fruit ripening.	67 (33.7)	28(14.1)	104 (52.3)
Calcium carbide can be ingested by traders during the process of fruit ripening.	34 (17.1)	38 (19.1)	127 (63.8)
Use of calcium carbide to ripen fruit may cause cancers in consumers of such fruits.	43 (21.6)	20 (10.1)	136 (68.3)
Use of calcium carbide to ripen fruit can make the fruit to be overly soft.	105 (52.8)	14 (7.0)	80 (40.2)
Fruits ripened with calcium carbide may not be as tasty as naturally ripened fruits.	120 (60.3)	16 (8.0)	63 (31.7)

Variables	Yes n(%)	No n(%)	Don't Know n(%)
Use of calcium carbide to ripen fruits can make the outer surface appear ripen and attractive while the inside remains green and raw.	107 (53.8)	23 (11.6)	69 (34.7)
Fruits ripened with calcium carbide do not last long before getting spoilt compared to naturally ripened fruits.	105 (52.8)	18 (9.0)	76 (38.2)
Fruits ripened with calcium carbide have dots and patches on their surface after a few days.	81 (40.7)	33 (16.6)	85 (42.7)
The calcium carbide used in ripening fruits can cause pollution of the environment.	52 (26.1)	9 (4.5)	138 (69.4)
Total knowledge score (Median; IQR) 5(0-8)			

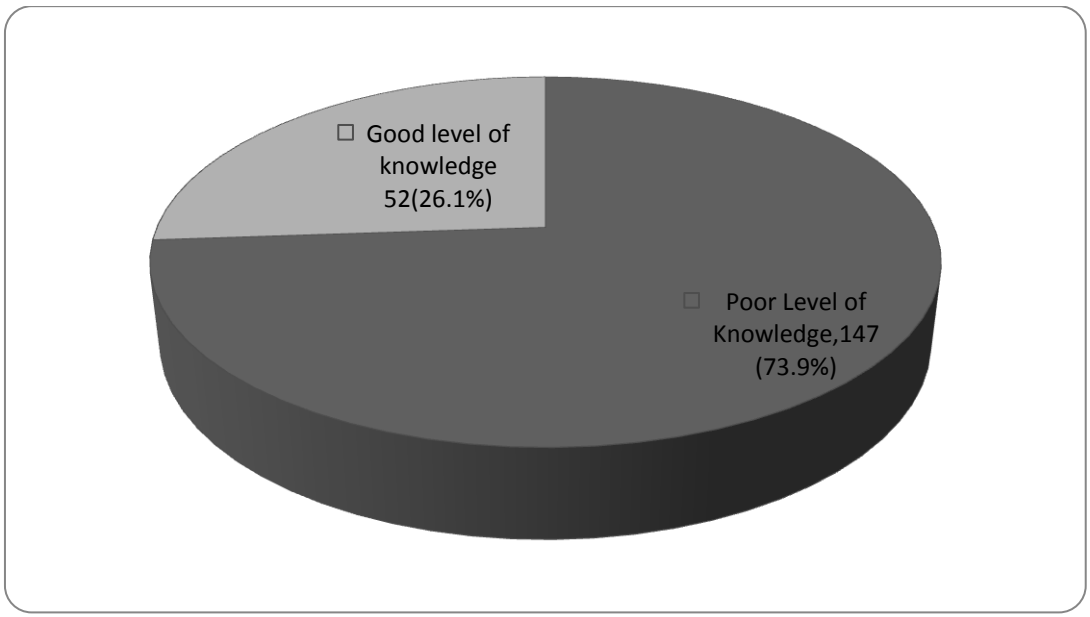

Fig. 2. Respondents' level of Knowledge of health effects of use of calcium carbide to ripen fruit

Table 4. Association between selected factors and knowledge of health effects of use of carbide in fruit ripening by fruit sellers in Uyo Markets

Variables	Level of Knowledge of Health Effects of use of carbide		Total	Statistical test and P values
	Poor	Good		
Age group				
Less than 35	81 (55.1)	25 (48.1)	106 (53.3)	χ^2=0.76
35 and above	66 (44.9)	27 (51.9)	93 (46.7)	*P*=0.38
Sex				
Male	17 (11.6)	2 (3.8)	19 (9.6)	Fishers
Female	130 (88.4)	50 (96.2)	180 (90.4)	exact=0.17
Educational Level				
No formal education	27 (18.4)	3 (5.8)	30 (15.1)	Fishers
Primary secondary	41 (27.9)	15 (28.9)	56 (28.1)	exact =0.14
Secondary	68 (46.3)	29 (55.8)	97 (48.7)	
Tertiary	11 (7.5)	5 (9.6)	16 (8.0)	
Religion				Fishers
Christianity	140 (95.2)	50 (96.2)	190 (95.5)	exact=0.26
Islam	7 (4.8)	1 (1.9)	8 (4.0)	
Traditional worship	0 (0.0)	1 (1.9)	1 (0.5)	

Variables	Level of Knowledge of Health Effects of use of carbide		Total	Statistical test and P values
	Poor	Good		
Marital status				Fishers
Single	52 (35.4)	17 (32.7)	69 (34.7)	exact=0.99
Married	84 (57.1)	31 (59.6)	115 (57.8)	
Divorces/separated	6 (4.1)	2 (3.9)	8 (4.0)	
Widowed	5 (3.4)	2 (3.9)	7 (3.5)	
Years of practice				χ^2=3.27
Less than 4	78 (53.1)	20 (38.5)	98 (49.3)	*P*= .07
5 and above	69 (46.9)	32 (61.5)	101 (50.7)	
Residence				χ^2=0.30
Urban	80 (54.4)	26 (50.0)	106 (53.3)	*P*=.58
Rural	67 (45.6)	26 (50.0)	93 (46.7)	

3.7 Discussion

Fruit sellers use various materials to ripen fruits that may lead to various health consequences in the traders, consumers and environment. The young age of fruit sellers in this study differed from older respondents in a Malaysian and another Nigerian study [24,25] while the female preponderance of the respondents agrees with findings in a similar study in Ilorin, Nigeria [25]. This is due to the socio-cultural setting prevalent in the Southern part of Nigeria, where the fruit markets are dominated by females. There was a higher rate of completion of secondary education in this study compared to the Ilorin study [25].

All respondents knew the natural ripening of fruits. Many knew packaging of fruits in polyethylene bags and use of calcium carbide as methods of artificial fruit ripening. Over a half of the respondents had ever made use of packaging in polyethylene bags while a quarter of the respondents had ever made use of calcium carbide. About 4% of our respondents currently/mainly use calcium carbide in ripening fruits in this study. The Ilorin study reported the use of nylon bags by fewer respondents and only 1 respondent admitted using calcium carbide [25]. Though our study had a higher proportion using calcium carbide currently to ripen fruits than the Ilorin study, an Indian survey revealed that almost all (99%) mangoes consumed there were artificially ripened by calcium carbide [26]. There is a possibility that more of them that had ever used calcium carbide in ripening fruits may adopt it as their major method of fruit ripening as it is known to be cheap and readily available [10,12,13,24,26].

Wrapping fruits in polyethylene bags, sun heating, storing in cold rooms and pouring water on fruits to ripen was reported in our study as methods ever used and majorly used to ripen fruits artificially . These actions probably triggers fruit ripening by increasing or reducing temperature of fruits, conditions reported to induce ethylene that cause fruits to ripen [7]. Use of ashes to ripen fruit was also reported in this study. Ashes are known to contain inorganic salts such as sodium, potassium and calcium salts, other trace minerals and unique molecules [27] which stimulate fruits ripening when rubbed on fruits [27,28,29,30]. Use of other fruits ,sun heating and use of old torch light batteries reported in this study for fruit ripening had also been previously reported [18,28,29,31]. Spoilt torch light batteries some of which are dry cells contain zinc/lead cathodes and anodes and others made up of lead in sulphuric acid solutions. Rubbing these chemicals on fruit, triggers fruit ripening through the stimulation of endogenous ethylene [28,29]. Traders probably use these methods of fruit ripening to meet the increasing demands for fruits both in and out of season without having much knowledge of the health implications of their actions.

There are various health implications associated with use of calcium carbide in fruit ripening. In a previous study, 7.5%, 1.5%, 0.5%, 2% and 0.5% of their respondents knew that the use of calcium carbide for fruit ripening causes cough, chest tightness, skin damage, frequent thirst and headache respectively [24]. The findings of this present study showed higher proportions of respondents with good knowledge of health implications of this practice. Symptoms mentioned that could results from its use in fruit ripening by our respondents included cough and chest tightness (27.1%), stomach upset (36.7%), headaches (19.6%), skin damage (22.1%) and frequent thirst (13.6%). Cancers in consumers of fruits ripened with calcium carbide was known by 21.6% of our respondents. The higher level of

education of our respondents may account for this better level of awareness.

Many of our respondents knew that use of calcium carbide in fruit ripening can make fruits less tasty and even make outer surface of fruits appear ripe while the inside remains green and raw. Most respondents in this study also knew that its use reduces the shelf life of fruits compared to naturally ripened fruits and such fruits do have dots and patches on their surface after a few days. This is similar to findings in a Bangladesh study that showed reduced flavor, taste, altered colour and shorter shelf life [12], uniform attractive surface colour but poor flavor and the inside remaining unripe [32] in fruits ripened with calcium carbide was also previously reported.

Few fruit sellers in our study knew that its use to ripen fruits can pollute the environment. Similar studies did not assess the effects of calcium carbide used by the fruit sellers on the environment. Spent carbide (carbide waste) composed mainly of calcium and less of magnesium compound and impurities from silica, aluminium and iron is disposed into the environment without adequate treatment. When disposed into the soil, it leads to nutrient enrichment and the accumulation of toxic compounds in biomass and sediments leading to death of soil living organisms [33,34]. A reduction in the growth and yield of maize, groundnut and okra in carbide waste polluted soil especially at high concentration is also reported [35,36].

This study shows that the majority of the respondents had overall poor level of knowledge of the health implication of the use of calcium carbide in fruit ripening as similarly reported in the Malaysian study [24]. Though more of the older respondents had good level of knowledge of health effects of use of carbide in fruit ripening than the younger ones, this association was not statistically significant. In addition, the sex, marital status, duration of selling fruits and residential area of fruit sellers had no significant association with the level of knowledge. This is similar to findings in a Malaysian study [24].

4. CONCLUSION

Various unsafe methods of fruit ripening were reported by fruit sellers in Uyo capital city territory ripening in Uyo capital city territory. There was poor knowledge of the adverse health effects of the use of calcium carbide in fruit ripening amongst them. It is recommended that health education be carried out for fruit sellers and consumers on safer methods of fruits ripening in Uyo metropolis. There should be increased involvement of government through legislations, and regulatory bodies saddled with the responsibility of training and monitoring the activities of fruit sellers on methods used in fruit ripening to ensure fruit hygiene and safety in the state. Establishment of fruit research centers where research and innovations of better fruit ripening methods can be made possible is needed.

DISCLAIMER

The products used for this research are commonly and predominantly used products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

Informed consent was obtained from the respondents. The purpose and voluntary nature of the study was explained to respondents. Participants were assured of absolute confidentiality of data obtained from them.

ETHICAL APPROVAL

Ethical approval was obtained from University of Uyo Teaching Hospital Institutional Health Review Ethical Committee (UUTH/AD//S/96/ VOLXX1/555).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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