

Knowledge of Artificial Fruit Ripening Among Consumers in Rivers State

Eze, Elizabeth E. M.Sc

Department of Human Kinetics and Health Education
Faculty of Education, University of Port Harcourt

Asogwa, Emmanuel. U. Ph.D

Department of Human Kinetics and Health Education
Faculty of Education, University of Port Harcourt

ABSTRACT

The study investigated the knowledge of artificial fruit ripening among consumers in Rivers State. The study adopted a descriptive cross-sectional survey design. Four research questions and three null hypotheses tested at .05 alpha level guided the study. The population for the study was 2,617,600 respondents in fruit markets in Rivers State. A sample size of 1,024 fruit consumers was drawn using multistage sampling procedure. Data were collected using a validated self-structured questionnaire titled "Knowledge of Artificial Fruit Ripening (KAFR)". Guttman Split-Half Coefficient of 0.881 was obtained using Pearson Product Moment Correlation in conjunction with Spearman Brown correction statistics. Data were analyzed using percentage, mean, standard deviation, Chi-square, z-test, and One way Analysis of Variance. It was found that consumers had moderate knowledge of artificial fruit ripening in Rivers State. Also, male consumers, those within 31-40 years and those with tertiary education had higher knowledge of artificial fruit ripening. More so, the study revealed significant difference in knowledge among consumers in Rivers State based on gender, age and level of education. Based on the findings, the study recommended among others that; community health workers in Rivers State should organize regular health education campaigns concerning the dangers of using chemicals for fruit ripening among consumers in Rivers State.

Keywords: Knowledge, Artificial Fruit Ripening, Consumers.

INTRODUCTION

Fruit is any structure that develops from a fertilized ovary, at the base of the flower and contains the seeds of the plant (Arya, Doke, Bhalerao, & Shinde, 2017). Fruits provide nourishment to the body and are best enjoyed when they are ripened. Fruit ripening is a physiological and natural process in which fruits go through various chemical changes and gradually become sweet, coloured, soft and palatable (Bouzayen, Latche, Nath & Pech, 2010; Prasanna, Prabha & Tharanathan, 2007). Though a natural process, fruit ripening can also be activated using various artificial fruit ripening agents. Natural ripening can be very slow, and many consumers are not ready to wait for the natural ripening process. Thus, over the years, various artificial methods have been used to ripen fruits to quicken the process and meet consumers' growing demands caused by increasing consciousness of the nutritional and health benefits of fruits.

The need for artificial ripening is often encountered when fruit vendors have to deal with transportation and distribution issues. After maturation, fruits are harvested, transported, and distributed. Transporting and distributing fruits from the farmers' orchard to the consumers' basket can take several days. During this time, naturally ripened fruits can become overripe and inedible. Some fruits if already ripened naturally cannot withstand harsh transportation conditions and can become damaged. The inedible and damaged fruits are discarded along the supply chain to meet quality and aesthetic standards set by consumers. This is an economic loss for the fruit-vendors and so to minimize the loss, fruits for commercial purposes are usually harvested unripe, transported, and then, artificially ripened at their site of retail in order to avoid spoilage (Akor & Mensa, 2018).

In recent times, fruits are artificially ripened using various chemicals to satisfy their extreme demand and overcome transportation damage. In different Western countries, selected ripening agents can be applied to ripen specific fruits under controlled conditions. Among the widely used artificial ripening agents, ethylene and methyl jasmonate are reported non-toxic for human consumption (Ur-Rahman, Chowdhury & Alam, 2008). It is interesting to note that developed countries like USA and UK allow using ethylene for postharvest ripening of selected fruits following specific dosing protocols not beyond tolerance limit. The commercial use of ethylene for fruit ripening is at a low concentration and simply initiates the respiratory climacteric.

However, ethylene is relatively expensive, scarce and requires high precautionary measures due to its explosive nature (Ur-Rahman, Chowdhury & Alam, 2008). Therefore, in developing countries like Bangladesh, India, Sri Lanka and Pakistan, low-cost chemicals such as calcium carbide, ethylene glycol and ethephon are reportedly used to trigger the ripening process (Siddiqui & Dhua, 2010; Ogundipe, 2018). Industrial grade calcium carbide (CaC_2) is the most common and widely used chemical for ripening of fruits, due to its low price and ready availability in local market. Upon application on fruits, calcium carbide meets moisture and releases acetylene gas, which has fruit ripening characteristics like ethylene (Ur-Rahman, Chowdhury & Alam, 2008). Industrial grade calcium carbide generally contains impurities of arsenic and phosphorus which pose several health problems (Igbinaduwa, Omotoso, Aikpitanyi & Uwaezuoke, 2018). Research has found that fruits that have been artificially ripened with calcium carbide contain high levels of heavy metals and other chemicals which get diffused into fruits, even those having hard peels, exposing public health to serious hazards such as cancer (Hossain, 2018; Igbinaduwa, Omotoso, Aikpitanyi & Uwaezuoke, 2018; Ogundipe, 2018). This is the reason its use is banned in most countries; but because of its cheap price and easy availability, it is still in use (Sinha, 2010; Hossain, 2018; Igbinaduwa, Omotoso, Aikpitanyi & Uwaezuoke, 2018; Ogundipe, 2018).

Recently, there is an upsurge in reported cases of carbide-ripened fruits in some countries including Nigeria (Oche, 2014; Opare, 2016). Although regulatory bodies exist to deal with food safety, there is still lack of specific regulations and technical support to control artificial fruit ripening in a good number of African countries (Stemming Dangers,' 2018; Islam, Mursalat, & Khan, 2016). In Nigeria, some of the fruits most affected by this practice include bananas, mangoes and plantains. The nutritional value of these fruits cannot be over-emphasized. It is noteworthy that high levels of arsenic and phosphorus, impurities found in calcium carbide have also been detected in fruits marketed in Benin City, Edo State (Igbinaduwa, Omotoso,

Aikpitanyi & Uwaezuoke, 2018). Inasmuch as fruits usually have short life spans, which requires action if we are to safeguard food and avoid financial loss, human health should be paramount in any decision that allows or disallows the use of these chemicals in food production.

Due to the prevalence of artificial fruit ripening in the country, consumers are expected to have adequate knowledge of artificial fruit ripening. Vendors indulge in artificial fruit ripening to meet the aesthetic standards of consumers as fruits that have been artificially ripened are very attractive (Akor & Mensa, 2018). This simply shows that consumers do not have adequate knowledge about the health implications of consuming such fruits and are only concerned about their attractiveness. Limited studies exist on knowledge of artificial fruit ripening among consumers in a populous country like Nigeria. It became appropriate therefore, to embark on the present study to ascertain the knowledge of artificial fruit ripening among consumers in Rivers State.

STATEMENT OF THE PROBLEM

Nowadays, fruits are artificially ripened using various hazardous chemicals. This is fast becoming a norm in Nigeria despite its harmful implications for health. Research has proven that calcium carbide, the most prevalent artificial ripening agent in developing countries is extremely detrimental to human health. With the growing rise of chemical contamination of fruits, it is little wonder that these days non-communicable diseases such as cancer and internal organs failure have become common in Nigeria and this could be partly attributed to increase in the consumption of fruits that have been contaminated with chemicals through processes such as artificial fruit ripening.

Presently, there are several fruit and vegetable markets in Rivers State. Considering the reported cases of enforced ripening of fruits with calcium carbide across Nigeria, it is undoubtedly that most of the fruits in these markets and other selling locations would be artificially ripened with calcium carbide to meet the increasing demands and maximize profits. It is based on these observations that the researchers decided to find out the knowledge of artificial fruit ripening among consumers in Rivers State, the most populated state in the Niger Delta Region of Nigeria, due to her capital-status and being home for gas and oil exploration in the region.

Research Questions

The following research questions guided the study.

1. What is the knowledge of artificial fruit ripening among consumers in Rivers State?
2. What is the knowledge of artificial fruit ripening among consumers in Rivers State based on gender?
3. What is the knowledge of artificial fruit ripening among consumers in Rivers State based on age?
4. What is the knowledge of artificial fruit ripening among consumers in Rivers State based on level of education?

Hypotheses

The following null hypotheses were postulated and tested at 0.05 level of significance.

1. There is no significant difference in knowledge towards artificial fruit ripening among consumers in Rivers State based on based on gender.
2. There is no significant difference in knowledge towards artificial fruit ripening among consumers in Rivers State based on based on age.
3. There is no significant difference in knowledge of artificial fruit ripening among consumers in Rivers State based on level of education.

METHODOLOGY

A cross-sectional descriptive survey research design was used for this study. The population of the study was 2,617,600 respondents, comprising all the fruit consumers in six selected metropolitan Local Government Areas (LGAs) with major fruit markets in Rivers East Senatorial District (National Population Commission (NPC) [Nigeria], 2016). A multi-stage sampling technique was used to obtain a sample size of one thousand and twenty-four (1,024) consumers of banana, mango, pawpaw and plantain from 25 communities in the six selected metropolitan LGAs.

A self-structured questionnaire titled Knowledge of Artificial Fruit Ripening (KAFR) was used for data collection. The instrument was divided into two sections. Section A consisted of items designed to obtain information on the demographic factors (gender, age, and level of education,) of the participants while Section B consisted of 25-items to assess respondents' knowledge of artificial ripening. 'True' or 'False' response options were used to elicit data on knowledge of artificial fruit ripening. The reliability of the instruments was established using split-half method. It yielded an index of 0.881 using Pearson Product Moment Correlation in conjunction with Spearman Brown correction statistics. Descriptive statistics of percentage, mean and standard deviation were used to analyse data for the research questions and the hypotheses were tested using Chi-square, z-test and One-Way Analysis of Variance (ANOVA) at .05 level of significance. Ashur's (1977) criteria as modified by Okafor (1997) was used as a guide for decision taking regarding their level of knowledge. A score of less than 20 percent given by the respondents for the correct option of the questionnaire was considered very low, 21-39 percent was considered low, 40-59 per cent was considered average, 60-80 percent was considered high, while 80 percent and above was considered very high.

RESULTS AND DISCUSSIONS

Research Question 1: What is the knowledge of artificial fruit ripening among consumers in Rivers State?

Table 1: Percentage rating on knowledge of artificial fruit ripening among consumers in Rivers State

S/n	Items	Consumers (n=1024)		
		True(%)	False(%)	Remark
1.	Most fruits sold in the market have been chemically induced to ripe. (True)	495(48.3)	529(51.7)	Average
2.	Fruits sold during off seasons are usually ripened with chemicals. (True)	518(50.6)	506(49.4)	Average
3.	Fruits ripened with chemicals are not uniformly ripened and attractive. (False)	673(65.7)	351(34.3)	Low
4.	Banana, mango, plantain and pawpaw are commonly ripened with chemicals such as carbide. (True)	571(55.8)	453(44.2)	Average
5.	Naturally ripened fruits are uniformly ripened and attractive. (False)	854(83.4)	170(16.6)	Very low
6.	Most fruits ripened with artificial ripeners such as carbide appear ripened but are actually raw inside and taste sour. (True)	811(79.2)	213(20.8)	High
7.	Fruit ripened with chemicals are usually soft and rot quickly. (True)	730(71.3)	294(28.7)	High
8.	Fruit-ripening chemicals do not reduce the nutritional qualities of fruits. (False)	418(40.8)	606(59.2)	Average
9.	Ripening fruits by subjecting them to smoke does not reduce the nutritional qualities of the fruits. (False)	247(24.1)	777(75.9)	High
10.	Different fruits require different fruit-ripening chemicals. (True)	385(37.6)	639(62.4)	Low
11.	Calcium carbide is the most available and widely used chemical for fruit ripening due to its cheap price. (True)	510(49.8)	514(50.2)	Average
12.	Fruits ripening chemicals cannot enter the flesh of the fruits. (False)	502(49.0)	522(51.0)	Average
13.	Eating fruits ripened with chemicals such as carbide can cause diarrhoea. (True)	620(60.5)	404(39.5)	High
14.	Eating fruits ripened with chemicals such as carbide can cause stomach cramps and vomiting. (True)	651(63.6)	373(36.4)	High
15.	Eating fruits ripened with high concentration of chemicals such as carbide can lead to liver disease and even liver cancer. (True)	543(53.0)	481(47.0)	Average
16.	Chest and abdominal burns could result from eating chemically ripened fruits. (True)	557(54.4)	467(55.6)	Average
17.	Eating fruits ripened with chemicals can lead to miscarriage or malformation of the unborn child. (True)	393(38.4)	631(61.6)	Low
18.	Ripening fruits with chemicals like carbide can cause serious health problems such as skin ulcers to the vendors. (True)	476(46.5)	548(53.5)	Average
19.	Those who ripen fruits with carbide are likely to inhale carbide gas and this can lead to respiratory disorders such as cough, catarrh and chest pain. (True)	640(62.5)	384(37.5)	High
20.	Ripening fruits through smoking can lead to inhalation of dangerous gases that affect the lungs causing diseases. (True)	734(71.7)	290(28.3)	High

21.	Other chemical ripening agents like, ethrel and ethylene glycol are considered less hazardous to health, but they must be used within recommended safe limits. (True)	422(41.2)	602(58.8)	Low
22.	Ethylene is the only safe and worldwide accepted chemical ripener for banana. (True)	272(26.6)	752(73.4)	Low
23.	Keeping unripe fruits together with certain fruits such as avocados or apple inside airtight bag causes fruits to ripen very fast. (True)	757(23.9)	267(26.1)	Low
24.	Mangoes can be ripened by dipping them in a pot of boiled water. (True)	823(80.4)	201(19.6)	Very High
25.	Bananas and plantains can be ripened by wrapping them in airtight paper bags or sacks. (True)	942(92.0)	82(8.0)	Very High
Average Percentage of correct answers		551(53.8)		Moderate
Average percentage of wrong answers		473(46.2)		

<20% = Very Low, 21-39% = Low, 40-59% = Average, 60-80% = High, 80 % and above = Very High

The data in table 1 showed the average score of 53.8% of correct answers to the options of the questionnaire, which showed that consumers in Rivers State had average knowledge of artificial fruit ripening.

Research Question 2: What is the knowledge of artificial fruit ripening among consumers in Rivers State based on gender?

Table 2: Knowledge of artificial fruit ripening among consumers in Rivers State based on gender

S/n	Items	Male (n=578)		Female (n=446)	
		True(%)	False(%)	True(%)	False(%)
1.	Most fruits sold in the market have been chemically induced to ripe. (True)	326(56.4%)	252(43.6%)	169(37.9%)	277(62.1%)
2.	Fruits sold during off seasons are usually ripened with chemicals. (True)	308(53.3%)	270(46.7%)	210(47.1%)	236(52.9%)
3.	Fruits ripened with chemicals are not uniformly ripened and attractive. (False)	405(70.1%)	173(29.9%)	268(60.1%)	178(39.9%)
4.	Banana, mango, plantain and pawpaw are commonly ripened with chemicals such as carbide. (True)	342(59.2%)	236(40.8%)	229(51.3%)	217(48.7%)

5.	Naturally ripened fruits are uniformly ripened and attractive. (False)	445(77.0%)	133(23.0%)	409(91.7%)	37(8.3%)
6.	Most fruits ripened with artificial ripeners such as carbide appear ripened but are actually raw inside and taste sour. (True)	484(83.7%)	94(16.3%)	327(73.3%)	119(26.7%)
7.	Fruit ripened with chemicals are usually soft and rot quickly. (True)	410(70.9%)	168(29.1%)	320(71.7%)	126(28.3%)
8.	Fruit-ripening chemicals do not reduce the nutritional qualities of fruits. (False)	216(37.4%)	362(62.6%)	202(45.3%)	244(54.7%)
9.	Ripening fruits by subjecting them to smoke does not reduce the nutritional qualities of the fruits. (False)	158(27.3%)	420(72.7%)	89(20.0%)	357(80.0%)
10.	Different fruits require different fruit-ripening chemicals. (True)	228(39.4%)	350(60.6%)	157(35.2%)	289(64.8%)
11.	Calcium carbide is the most available and widely used chemical for fruit ripening due to its cheap price. (True)	327(56.6%)	251(43.4%)	183(41.0%)	263(59.0%)
12.	Fruits ripening chemicals cannot enter the flesh of the fruits. (False)	309(53.5%)	269(46.5%)	193(43.3%)	253(56.7%)
13.	Eating fruits ripened with chemicals such as carbide can cause diarrhoea. (True)	367(63.5%)	211(36.5%)	253(56.7%)	193(43.3%)
14.	Eating fruits ripened with chemicals such as carbide can cause stomach cramps and vomiting. (True)	409(70.8%)	169(29.2%)	242(54.3%)	204(45.7%)
15.	Eating fruits ripened with high concentration of chemicals such as carbide can lead to liver	368(63.7%)	210(36.3%)	175(39.2%)	271(60.8%)

	disease and even liver cancer. (True)				
16.	Chest and abdominal burns could result from eating chemically ripened fruits. (True)	352(60.9%)	226(39.1%)	205(46.0%)	241(54.0%)
17.	Eating fruits ripened with chemicals can lead to miscarriage or malformation of the unborn child. (True)	279(48.3%)	299(51.7%)	114(25.6%)	332(74.4%)
18.	Ripening fruits with chemicals like carbide can cause serious health problems such as skin ulcers to the vendors. (True)	298(51.6%)	280(48.4%)	178(39.9%)	268(60.1%)
19.	Those who ripen fruits with carbide are likely to inhale carbide gas and this can lead to respiratory disorders such as cough, catarrh and chest pain. (True)	410(70.9%)	168(29.1%)	230(51.6%)	216(48.4%)
20.	Ripening fruits through smoking can lead to inhalation of dangerous gases that affect the lungs causing diseases. (True)	446(77.2%)	132(22.8%)	288(64.6%)	158(35.4%)
21.	Other chemical ripening agents like, ethrel and ethylene glycol are considered less hazardous to health, but they must be used within recommended safe limits. (True)	251(43.4%)	327(56.6%)	171(38.3%)	275(61.7%)
22.	Ethylene is the only safe and worldwide accepted chemical ripener for banana. (True)	171(29.6%)	407(70.4%)	101(22.6%)	345(77.4%)
23.	Keeping unripe fruits together with certain fruits such as avocados or apple inside airtight	409(70.8%)	169(29.2%)	348(78.0%)	98(22.0%)

	bag causes fruits to ripen very fast. (True)				
24.	Mangoes can be ripened by dipping them in a pot of boiled water. (True)	485(83.9%)	93(16.1%)	338(75.8%)	108(24.2%)
25.	Bananas and plantains can be ripened by wrapping them in airtight paper bags or sacks. (True)	522(90.3%)	56(9.7%)	420(94.2%)	26(5.8%)
Grand Percentage			236(40.8%)	229(51.3%)	217(48.7%)
		342(59.2%)			
<20% = Very Low, 21-39% = Low, 40-59% = Average, 60-80% = High, 80 % and above = Very High					

The data in table 2 showed the average score of 59.2% for male consumers and 51.3% of female consumers who got the correct answers to the items on the questionnaire showing both male and female consumers had average knowledge about artificial fruit ripening. However, the male consumers were slightly more knowledgeable than their female counterparts about artificial fruit ripening as indicated by their grand mean.

Research Question 3: What is the knowledge of artificial fruit ripening among consumers in Rivers State based on age?

Table 3: Knowledge of artificial fruit ripening among consumers in Rivers State based on age

S/n	Items	Less than 31 years (n=466)		31-40 yrs (n=279)		41-50yrs (n=201)		51 yrs & above (n=78)	
		TRUE (%)	FALSE (%)	TRUE (%)	FALSE (%)	TRUE (%)	FALSE (%)	TRUE (%)	FALSE (%)
1.	Most fruits sold in the market have been chemically induced to ripe. (True)	274(58.8)	192(41.2)	134(48.0)	145(52.0)	64(31.8)	137(68.2)	23(29.5)	55(70.5)
2.	Fruits sold during off seasons are usually ripened with chemicals. (True)	224(48.1)	242(51.9)	172(61.6)	107(38.4)	96(47.8)	105(52.2)	26(33.3)	52(66.7)
3.	Fruits ripened with chemicals are not uniformly ripened and attractive. (False)	265(56.9)	201(43.1)	191(68.5)	88(31.5)	163(81.1)	38(18.9)	54(69.2)	24(30.8)
4.	Banana, mango, plantain and pawpaw are commonly ripened with chemicals such as carbide. (True)	252(54.1)	214(45.9)	153(54.8)	126(45.2)	118(58.7)	83(41.3)	48(61.5)	30(38.5)
5.	Naturally ripened fruits are uniformly ripened and attractive. (False)	377(80.9)	89(19.1)	222(79.6)	57(20.4)	186(92.5)	15(7.5)	69(88.5)	9(11.5)
6.	Most fruits ripened with artificial ripeners such as carbide appear ripened but	338(72.5)	128(27.5)	234(83.9)	45(16.1)	178(88.6)	23(11.4)	61(78.2)	17(21.8)

	are actually raw inside and taste sour. (True)							
7.	Fruit ripened with chemicals are usually soft and rot quickly. (True)	292(62.7)	174(37.3)	201(72.0)	78(28.0)	175(87.1)	26(12.9)	62(79.5)
8.	Fruit-ripening chemicals do not reduce the nutritional qualities of fruits. (False)	198(42.5)	268(57.5)	108(38.7)	171(61.3)	59(26.4)	142(70.6)	53(67.9)
9.	Ripening fruits by subjecting them to smoke does not reduce the nutritional qualities of the fruits. (False)	129(27.7)	337(72.3)	55(19.7)	224(80.3)	22(10.9)	179(89.1)	41(52.6)
10.	Different fruits require different fruit-ripening chemicals. (True)	203(43.6)	263(56.4)	87(31.2)	192(68.8)	65(32.3)	136(67.7)	30(38.5)
11.	Calcium carbide is the most available and widely used chemical for fruit ripening due to its cheap price. (True)	222(47.6)	244(52.4)	155(55.6)	124(44.4)	104(51.7)	97(48.3)	29(37.2)
12.	Fruits ripening chemicals cannot enter the flesh of the fruits. (False)	275(59.0)	191(41.0)	111(39.8)	168(60.2)	75(37.3)	126(62.7)	41(52.6)
13.	Eating fruits ripened with chemicals such as carbide can cause diarrhoea. (True)	266(57.1)	200(42.9)	190(68.1)	89(31.8)	135(67.2)	66(32.8)	29(37.2)
14.	Eating fruits ripened with chemicals such as carbide can cause stomach cramps and vomiting. (True)	290(62.2)	176(37.8)	178(63.8)	101(36.2)	151(75.1)	50(24.9)	32(41.0)
15.	Eating fruits ripened with high concentration of chemicals such as carbide can lead to liver disease and even liver cancer. (True)	245(52.6)	221(47.4)	157(56.3)	122(43.7)	116(57.7)	85(42.3)	25(32.1)
16.	Chest and abdominal burns could result from eating chemically ripened fruits. (True)	235(50.4)	231(49.6)	178(63.2)	101(36.2)	120(56.7)	81(40.3)	24(30.8)
17.	Eating fruits ripened with chemicals can lead to miscarriage or malformation of the unborn child. (True)	173(37.1)	293(62.9)	129(46.2)	150(53.8)	75(37.3)	126(62.7)	16(20.5)
18.	Ripening fruits with chemicals like carbide can cause serious health problems such as skin ulcers to the vendors. (True)	195(41.8)	271(58.2)	161(57.7)	118(42.3)	106(52.7)	95(47.3)	14(17.9)
19.	Those who ripen fruits with carbide are likely to inhale	294(63.1)	172(36.9)	180(64.5)	99(35.5)	138(68.7)	63(31.3)	28(35.9)

	carbide gas and this can lead to respiratory disorders such as cough, catarrh and chest pain. (True)								
20.	Ripening fruits through smoking can lead to inhalation of dangerous gases that affect the lungs causing diseases. (True)	322(69.1)	144(30.9)	211(75.6)	68(24.4)	163(81.1)	38(18.9)	38(48.7)	40(51.3)
21.	Other chemical ripening agents like, ethrel and ethylene glycol are considered less hazardous to health, but they must be used within recommended safe limits. (True)	209(44.8)	257(55.2)	134(48.0)	145(52.0)	60(29.9)	141(70.1)	19(24.4)	59(75.6)
22.	Ethylene is the only safe and worldwide accepted chemical ripener for banana. (True)	163(35.0)	303(65.0)	78(28.0)	201(72.0)	18(9.0)	183(91.0)	13(16.7)	65(83.3)
23.	Keeping unripe fruits together with certain fruits such as avocados or apple inside airtight bag causes fruits to ripen very fast. (True)	315(67.6)	151(32.4)	211(75.6)	68(24.4)	165(82.1)	36(17.9)	66(84.6)	12(15.4)
24.	Mangoes can be ripened by dipping them in a pot of boiled water. (True)	359(77.0)	107(23.0)	215(77.1)	64(22.9)	174(86.6)	27(13.4)	75(96.2)	3(3.8)
25.	Bananas and plantains can be ripened by wrapping them in airtight paper bags or sacks. (True)	409(87.8)	57(12.2)	270(96.8)	9(3.2)	189(94.0)	12(6.0)	74(94.9)	4(5.1)
Average Percentage		255(54.7)	211(45.3)	166(59.5)	113(40.5)	116(57.7)	85(42.3)	35(44.9)	43(55.1)
<20% = Very Low, 21-39% = Low, 40-59% = Average, 60-80% = High, 80 % and above = Very High									

Table 3 revealed the grand mean of 54.7% right responses for consumers that are <31 years, 59.5% for those within 31 – 40 years, 57.7% of 41-50 years and 44.9% for those that are 51 years and above. The findings showed that consumers in the various age groups had average knowledge of artificial fruit ripening. However, those that are 51 years and above had a grand mean of 44.9% indicating they are slightly less knowledgeable than their counterparts about artificial fruit ripening.

Research Question 4: What is the knowledge of artificial fruit ripening among consumers in Rivers State based level of education?

Table 4: Knowledge of artificial fruit ripening among consumers in Rivers State based on level of education

S/n	Items	No formal education (n=26)		Primary education (n=83)		Secondary education (n=384)		Tertiary education (n=531)	
		TRUE (%)	FALSE (%)	TRUE (%)	FALSE (%)	TRUE (%)	FALSE (%)	TRUE (%)	FALSE (%)
1.	Most fruits sold in the market have been chemically induced to ripe. (True)	6(23.1)	20(76.9)	57(68.7)	26(31.3)	117(30.5)	267(69.5)	315(59.3)	216(40.7)
2.	Fruits sold during off seasons are usually ripened with chemicals. (True)	1(3.8)	25(96.2)	43(51.8)	40(48.2)	120(31.3)	264(68.8)	354(66.7)	177(33.3)
3.	Fruits ripened with chemicals are not uniformly ripened and attractive. (False)	1(3.8)	25(96.2)	63(75.9)	20(24.1)	210(54.7)	174(45.3)	399(75.1)	132(24.9)
4.	Banana, mango, plantain and pawpaw are commonly ripened with chemicals such as carbide. (True)	1(3.8)	25(96.2)	56(67.5)	27(32.5)	186(48.4)	198(51.6)	328(61.8)	203(38.2)
5.	Naturally ripened fruits are uniformly ripened and attractive. (False)	25(96.2)	1(3.8)	58(69.9)	25(30.1)	340(88.5)	44(11.5)	431(81.2)	100(18.8)
6.	Most fruits ripened with artificial ripeners such as carbide appear ripened but are actually raw inside and taste sour. (True)	22(84.6)	4(15.4)	63(75.9)	20(24.1)	262(68.2)	122(31.8)	464(87.4)	67(12.6)
7.	Fruit ripened with chemicals are usually soft and rot quickly (True)	21(80.8)	5(19.2)	59(71.1)	24(28.9)	244(63.5)	140(36.5)	406(76.5)	125(23.5)
8.	Fruit-ripening chemicals do not reduce the nutritional qualities of fruits. (False)	5(19.2)	21(80.8)	41(49.4)	42(50.6)	223(58.1)	161(41.9)	149(28.1)	382(71.9)
9.	Ripening fruits by subjecting them to smoke does not reduce the nutritional qualities of the fruits. (False)	3(11.5)	23(88.5)	25(30.1)	58(69.9)	113(29.4)	271(70.6)	106(20.0)	425(80.0)
10.	Different fruits require different fruit-ripening chemicals. (True)	1(3.8)	25(96.2)	32(38.6)	51(61.4)	100(26.0)	284(74.0)	252(47.5)	279(52.5)
11.	Calcium carbide is the most available and widely used chemical for fruit ripening due to its cheap price. (True)	1(3.8)	25(96.2)	24(28.9)	59(71.1)	144(37.5)	240(62.5)	341(64.2)	190(35.8)
12.	Fruits ripening chemicals cannot enter the flesh of the fruits. (False)	13(50.0)	13(50.0)	40(48.2)	43(51.8)	199(51.8)	185(48.2)	250(47.1)	281(52.9)
13.	Eating fruits ripened with chemicals such as carbide can cause diarrhoea. (True)	17(65.4)	9(34.6)	39(47.0)	44(53.0)	157(40.9)	227(59.1)	407(76.6)	124(23.4)
14.	Eating fruits ripened with chemicals such as carbide can cause stomach cramps and vomiting. (True)	21(80.8)	5(19.2)	43(51.8)	40(48.2)	154(40.1)	230(59.9)	433(81.5)	98(18.5)
15.	Eating fruits ripened with high concentration of chemicals such as carbide	22(84.6)	4(15.4)	45(54.2)	38(45.8)	110(28.6)	274(71.4)	384(72.3)	147(27.7)

16.	can lead to liver disease and even liver cancer. (True)								
16.	Chest and abdominal burns could result from eating chemically ripened fruits. (True)	1(3.8)	25(96.2)	32(38.6)	51(61.4)	124(32.3)	260(67.7)	400(75.3)	131(24.7)
17.	Eating fruits ripened with chemicals can lead to miscarriage or malformation of the unborn child. (True)	1(3.8)	25(96.2)	30(36.1)	53(63.9)	82(21.4)	302(78.6)	280(52.7)	251(47.3)
18.	Ripening fruits with chemicals like carbide can cause serious health problems such as skin ulcers to the vendors. (True)	25(96.2)	1(3.8)	42(50.6)	41(49.4)	100(26.0)	284(74.0)	333(62.7)	198(37.3)
19.	Those who ripen fruits with carbide are likely to inhale carbide gas and this can lead to respiratory disorders such as cough, catarrh and chest pain. (True)	22(84.6)	4(15.4)	60(72.3)	23(27.7)	138(35.9)	246(64.1)	420(79.1)	111(20.1)
20.	Ripening fruits through smoking can lead to inhalation of dangerous gases that affect the lungs causing diseases. (True)	22(84.6)	4(15.4)	62(74.7)	21(25.3)	206(53.6)	178(46.4)	444(83.6)	87(16.4)
21.	Other chemical ripening agents like, ethrel and ethylene glycol are considered less hazardous to health, but they must be used within recommended safe limits. (True)	25(96.2)	1(3.8)	47(56.6)	36(43.4)	106(27.6)	278(72.4)	268(50.5)	263(49.5)
22.	Ethylene is the only safe and worldwide accepted chemical ripener for banana. (True)	2(7.7)	24(92.3)	38(45.8)	45(54.2)	79(20.6)	305(79.4)	153(28.8)	378(71.2)
23.	Keeping unripe fruits together with certain fruits such as avocados or apple inside airtight bag causes fruits to ripen very fast. (True)	5(19.2)	21(80.8)	41(49.4)	42(50.6)	311(81.0)	73(19.0)	400(75.3)	131(24.7)
24.	Mangoes can be ripened by dipping them in a pot of boiled water. (True)	23(88.5)	3(11.5)	67(80.7)	16(19.3)	311(81.0)	73(19.0)	422(79.5)	109(20.5)
25.	Bananas and plantains can be ripened by wrapping them in airtight paper bags or sacks. (True)	26(100.0)	0(0.0)	69(83.1)	14(16.9)	373(97.1)	11(2.9)	474(89.3)	57(10.7)
Average Percentage		14(53.8)	12(46.2)	45(54.2)	38(45.8)	170(44.3)	214(55.7)	344(64.8)	187(35.2)

<20% = Very Low, 21-39% = Low, 40-59% = Average, 60-80% = High, 80 % and above = Very High

Table 4 showed that 23.1% of consumers that had no formal education affirmed that most fruits sold in the market have been chemically induced to ripe, while those with primary education had 68.7% correct responses, consumers with secondary education had 30.5% and tertiary

education had 59.3%. Also, consumers with tertiary education concurred that fruits sold during off seasons are usually ripened with chemicals with a percentage of 66.7%, followed by 51.8% correct responses from those that with primary education, the least was 3.8% for consumers with no formal education. On the contrary, high percentages of the consumers across the various levels of education indicated wrong responses to item 8: "... that fruit-ripening chemicals do not reduce the nutritional qualities of fruits," which ranges from 80.8% - 28.1%. On the average, 64.6% consumers with tertiary education answered the items on the questionnaire correctly, followed by 54.8% of those with primary education, 53.8% of those with no formal education and the least was 44.3% of those with secondary education. The table indicated that consumers in Rivers State had average knowledge of artificial fruit ripening regardless of their education level.

Hypothesis 1: There is no significant difference in knowledge of artificial fruit ripening among consumers in Rivers State based on gender.

Table 5 answered hypothesis 1.

Table 5: Summary of χ^2 analysis on the difference in knowledge of artificial fruit ripening among consumers in Rivers State based on gender

VARIABLE	n	Df	$\chi^2_{cal.}$	p-value	Level of Sig.	$\chi^2_{crit.}$	Decision
Male	578	1	22.474	0.000	0.05	3.89	Significant
Female	446						

Table 5 revealed that showed that the overall calculated chi-square value of 22.474 at 1 degree of freedom is greater than the table chi-square value of 3.89 at .05 level of significance ($\chi^2_{cal} = 22.474 > \chi^2_{crit} = 3.89$, $p < 0.05$). The obtained p -value of 0.000 is less than 0.05, therefore the null hypothesis that there is no significant difference in knowledge of artificial fruit ripening between consumers based on gender was rejected. This indicated that there was a significant difference between male and female consumers on knowledge of artificial fruit ripening in Rivers State.

Hypothesis 2: There is no significant difference in knowledge of artificial fruit ripening among consumers in Rivers State based on age.

Table 6 answered hypothesis 2.

Table 6: Summary of χ^2 analysis on the difference in knowledge of artificial fruit ripening between consumers in Rivers State based on age

Age	N	Df	$\chi^2_{cal.}$	p-value	Level of Sig.	$\chi^2_{crit.}$	Decision
Less than 31	466	3	32.256	0.000	0.05	11.41	Significant
31-40 yrs	279						
41-50 yrs	201						
51 & above	78						

Table 6 revealed that the χ^2_{cal} is 32.256 with df = 3 and $p < 0.05$. The obtained p -value of 0.000 is less than 0.05, therefore the null hypothesis that there is no significant difference in knowledge of artificial fruit ripening between consumers based on age was rejected. This indicated that there was a significant difference in knowledge of artificial fruit ripening among consumers in Rivers State based on age.

Hypothesis 3: There is no significant difference in knowledge of artificial fruit ripening among consumers in Rivers State based on level of education.

Table 7 answered hypothesis 3.

Table 7: Summary of χ^2 analysis on the difference in knowledge of artificial fruit ripening among consumers in Rivers State based on level of education

Level of Education	n	Df	$\chi^2_{cal.}$	p-value	Level of Sig.	$\chi^2_{crit.}$	Decision
No formal Education	466	3	213.562	0.000	0.05	11.41	Significant
Primary Education	279						
Secondary Education	201						
Tertiary Education	78						

Table 7 revealed that the χ^2_{cal} is 213.562 with df = 3 and $p < 0.05$. The obtained p -value of 0.000 is less than 0.05, therefore the null hypothesis that there is no significant difference in knowledge of artificial fruit ripening between consumers based on level of education was rejected. This indicates that there was a significant difference in knowledge of artificial fruit ripening among consumers in Rivers State based on level of education.

DISCUSSIONS

The findings of the study were discussed under the following subheadings which represent the major variables that were investigated.

Knowledge of Artificial Fruit Ripening among consumers

The findings in Table 1 showed that the respondents had a grand mean of 56.8% correct responses to the items on knowledge and 43.2% of incorrect responses. The table established that the respondents had average knowledge of artificial fruit ripening. This agrees with the earlier findings of Rokonuzaman (2017) which showed that consumers had a reasonable level

of knowledge about ripening immature fruits by using toxic chemicals. The table also revealed that respondents indicated that eating fruits artificially ripened with calcium carbide can cause serious health problems such as diarrhea (60.5%), stomach cramps and vomiting (63.6), liver diseases (53.0), chest and abdominal burns (54.4) among others. This is in sync with the earlier findings of Oguntade and Fatumbi (2019) and Islam, Imtiaz, Alam, Nowshad, Shadman, and Khan (2018), which stated that fruits artificially ripened with carbide have high levels of heavy metals and impurities, as such, may pose health-related issues to the consumers eating to the fruits.

Relationship between Demographic Factors and Knowledge of Artificial fruit Ripening

Result from table 2 revealed that male consumers had a higher knowledge of artificial fruit ripening than their female counterparts with grand mean of 59.2% and 51.3% of correct responses, respectively. The result established that male consumers were more knowledgeable about artificial fruit ripening than their female counterparts. The findings as revealed in this table were not expected. Females were expected to be more knowledgeable about artificial fruit ripening than their male counterparts due to the fact that during pregnancy they are advised to consume more fruits and should be more conversant with artificial ripening of fruits than their male counterparts. More so, Rahim (2012) recorded that a significant number of pregnant women who consumed fruit ripened with carbide, gave birth to children with abnormalities (Rahim, 2012). Thus, it was expected that females should be more knowledgeable than their male counterparts as they are more likely to be exposed to health education on effects of fruits they consume during antenatal classes.

Data from table 3 established that consumers had average knowledge of artificial fruit ripening with grand mean of 54.7%, 59.5%, 57.7% and 44.9% for those less than 31 years, 31-40 years, and within 41-50 years and those are over 50 years respectively. The table also indicated that consumers that are 51 years and above were slightly less knowledgeable than their counterparts with a grand mean of 44.9%. This could be as a result of their age as research has it that the brain tends to shrink, and certain kinds of memory tend to diminish with age (Peters, 2006).

In terms of education, Table 4 revealed that consumers with tertiary education had the highest level of right response with grand mean of 64.8%. This could be attributed to their level of exposure as those who are more educated tend to be more informed and exposed to media. This is in sync with the findings of Rokonuzaman (2017), which showed that 83% of the consumers knew about the harmful health hazards of eating fruits artificially ripened with chemicals through exposure to electronic and print media. However, it disagrees with the findings of Babu, Deshmukh, Rao, Kafila and Sabita (2019), which concluded that most literate fruit consumers could not recognize whether fruits are ripened by carbide or ethylene.

The result of the hypotheses showed that there was a significant difference in the knowledge of artificial fruit ripening among consumers in Rivers State based on gender, age and level of education.

CONCLUSION

Based upon the findings revealed in this study, it is appropriate to conclude that consumers in Rivers had average knowledge of artificial fruit ripening and there was a significant difference

in knowledge of artificial fruit ripening among consumers in Rivers State based on gender, age, and level of education.

RECOMMENDATIONS

Consequent upon the findings and conclusions of this study, the following recommendations were made:

1. Community health workers should organise regular and effective health awareness campaigns concerning the dangers of artificial fruit ripening among consumers in Rivers State.
2. Community health workers should advocate to policy makers in Rivers to legislate and enforce laws against artificial fruit ripening in the state.
3. Media agencies in Rivers State should disseminate information about the health hazards of artificial fruit ripening through jingles, shows, programmes etc.
4. Schools should organise intervention programmes such as workshops to sensitise parents, students and even the fruit vendors on the menace.

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