Survey on the Use of Calcium Carbide as Ripening Agent in Ilorin Metropolis

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Abstract — This research work examined the use of calcium carbide as ripening agent for banana and plantain in major markets within Ilorin metropolis. Open ended/structured questionnaires were administered to banana/plantain handlers in six different markets, afterward samples of ripe banana and plantain were also collected from different points in each market at the same time for physiochemical and mineral analyses. Results showed that a total of 85 respondents returned their questionnaires from all the markets; of which majority were female (99 percent), 89 percent of them were married, only 35 percent had formal education, 94 percent of them do store their plantain/banana, 83 percent were aware of the use of calcium carbide in ripening of plantain/banana but only 1 percent admitted using it. Comparing with the control samples, the physicochemical and mineral analyses showed that there were reduced moisture and vitamin C contents with increased values of arsenic and phosphorus being recovered from banana and plantain samples. Many authors had associated induced ripening with the use of ripening agent such as calcium carbide with reduced moisture and vitamin C contents with elevated values of arsenic and phosphorus in ripe fruits which had many health risks. Samples of banana and plantain collected from Ilorin markets were probably forced ripen with artificial ripening agents. The needs for constant education of the public especially fruits handlers on the health implications of the use of calcium carbide as ripening agent cannot be overemphasized.

Index Terms — Artificial ripening, banana, climacteric fruits, ethylene, health risk, phytohormone, plantain.

I. INTRODUCTION

Ripening is a biochemical process through which fruits attain desirable flavor, colour, tissue softening and other physiological properties. It is associated with changes in the composition of a fruit, especially the conversion of starch to sugar [1]. During ripening, there is increased rate of respiration and emission of ethylene gas. Ethylene promotes the conversion of fruits’ starch to sugar and hence regulates the ripening process. Ethylene is an inherently existing plant hormone referred to as a ‘phytohormone’. Based on the ripening behavior of different fruits, they are grouped into two major classes; climacteric and non-climacteric fruits; the climacteric fruits continue to ripen even after harvest when an exogenous gas is present. Hence, they are known to be ethylene dependent fruits, but the non-climacteric fruits do not ripen unless attached to the parent plant to maturity [2].

Artificial ripening agents can be used to effect ripening much the same way as the naturally occurring ripening agent (ethylene) because they increased the rate at which fruits ripen. An example of artificial ripening agent is calcium carbide-CaC2 [3]. When CaC2 comes in contact with moisture, it releases acetylene (C2H2) which is much similar in its effects to the natural ripening agent-ethylene [3], [4]. Treatment with CaC2 increased the rate at which ripening takes place in fruit as depicted by increase in the rate at which they soften, respire and change in flavor and colour. It is the commonly used chemical for ripening of fruits, due to its low price and availability in most local markets [5]. However, the industrial grade CaC2 often used by fruits handlers contains traces of impurities in form of calcium arsenide (Ca3As2) and Calcium phosphide (Ca3P2). These impurities interact with water forming phosphine (PH3) and arsine (AsH3) respectively [3], [6], [7]. These hydrides formed are soluble in fat, and can dissolve in the layer of fruits wax, then migrate from the peel to the flesh which might cause health hazards [6]. Hence, its use as artificial ripening agents has been promulgated as illegal in many countries [8]. There are several alternative chemical and non-chemical agents for hastening ripening process; some chemical methods are use of ethephon (2-Chloroethyphosphonic acid), an ethylene releasing compound which has been categorized as non-carcinogenic to human by appropriate agency. Other chemicals are oxtocin (generates ethylene catalytically), ethylene glycol (C2H4O2), ethanol, methanol, propylene, methyl jasmonate. Examples of non-chemical methods are the use of smoke, hot pepper (dried or fresh), exposure to ethylene gas from already ripe fruits such as apple, avocado and banana or bush mango [2]. Despite the available piece of information on the health hazards resulting from the use of calcium carbide in ripening of fruits, some handlers still employ this short practice. Therefore, the goal of this research was to evaluate fruits handlers’ perception on the use of calcium carbide as an artificial ripening agent for banana/plantain in six major markets in Ilorin metropolis, Nigeria and to examine some selected physicochemical, nutritional properties and mineral compositions of banana and plantain samples collected from the markets at the same time of
survey, in order to compare them with naturally ripen fruits under the laboratory conditions.

II. MATERIALS AND METHODS

A. Reagents

All reagents and chemicals used were of analytical grade, they were purchased from accredited distributors in Nigeria.

B. Study Area

Ilorin, Nigeria is a city located on the latitude 8° 30’N and longitude 4° 32’E (Fig. 1). A large city in the North-Central Nigeria with population of about 850,000 people. Ilorin is the headquarters of Kwara State, Nigeria. It is an important industrial and commercial centre with plenty of small manufacturing and trade companies. It also serves as collection points for many agricultural products such as banana/plantain, oranges, yams, maize etc. from neighboring states of Osun, Ekiti and Ondo States.

D. Drying of Banana and Plantain Pulps

The ripe fruits were thoroughly washed, and the peel being removed. They were then sliced uniformly (0.55 mm) and spread thinly on stainless trays and dried with parabolic solar dryer (55±5 ºC, 65±2% RH) for 48h before being used for further studies.

E. Physicochemical and Nutritional Analyses

Moisture and vitamin C analyses were conducted on the fresh ripe fruits. The moisture contents of fruits’ pulp of both the control and collected samples were determined by hot-air oven method in accordance with [9]. Similarly, the 2, 6-dichlorophenol indophenol titration method as described by [9] was adopted for the determination of ascorbic acid (vitamin C) contents of banana and plantain samples.

F. Mineral Analysis

The mineral analysis was also conducted on the dried fruit pulp. The method described by Association of Official Analytical Chemists [9] with little modifications was used for mineral analysis as follow; the samples were ashed at 450°C for 6h and the resulting ash was boiled in 10 mL of 20 percent hydrochloric acid in a beaker and then filtered into a 100 mL standard flask. This was made up to the mark with deionized water. The arsenic was determined from the resulting solution using Atomic Absorption Spectrophotometer (AAS PG INSTRUMENTS; MODEL 990 FG). Phosphorus was determined with UV/VIS spectrophotometer (MODEL: 752N).

G. Statistical Analysis

All collected data were analyzed using One-Way Analysis of Variance (ANOVA) on SPSS Software Package Version 20.0.0 (IBM Statistics Inc). Significance between means was determined by New Duncan Multiple Range F-Test (DMRT) at 95% confidence limit (p=0.05).

III. RESULTS AND DISCUSSION

A. Socio-economic Characteristics of the Respondents

The socio-economic characteristics of respondents in the survey of plantain/banana handlers in Ilorin metropolis was presented in Table 2. Results showed that a total of 85 questionnaires were returned by the respondents from six markets (Ago, Gamo, Ipata, Mandate, Oja-Titun and Yoruba Road) covering four Local Government Areas of Kwara State (Ilorin East, Ilorin South, Ilorin West and Ifelodun LGA). Out of the total respondents, only one fell between the ages of 20 years and below representing 1.2% of the total respondents. Also, 14 were between the ages of 21-30 years representing 16.5% of the respondents, 30.6% were between the ages of 31-40 years; 20.0% were between ages of 41-50 years while a total of 21.2% were between the ages of 51-60 years.

This finding also revealed that educational status does not matter in marketing of plantain/banana since 35.3% of the respondents has no formal education; 32.9% has primary education and 21.2% have secondary education while only 10.6% of the respondent had tertiary education. The table also shows that 89.4% of respondents were married which indicates the level of responsibilities of the respondents.
engaging in marketing of plantain/banana. Majority of the respondents (83.5%) were members of the association of fruit sellers in their various markets within the metropolis of the study area.

| TABLE 2: SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS |
|-----------------|--------------|--------------|
| Variable        | Frequency    | Percentage   |
| Local Govt.     |              |              |
| Ilorin West     | 35           | 41.2         |
| Ilorin East     | 12           | 14.1         |
| Ilorin South    | 6            | 7.2          |
| Ifoledun        | 32           | 37.6         |
| Market          |              |              |
| A               | 31           | 36.5         |
| B               | 5            | 5.9          |
| C               | 14           | 16.5         |
| D               | 13           | 15.3         |
| E               | 14           | 16.5         |
| F               | 8            | 9.4          |
| Gender          |              |              |
| Male            | 1            | 1.2          |
| Female          | 84           | 98.8         |
| Age             |              |              |
| 20 years and below | 1         | 1.2          |
| 21 – 30years    | 14           | 16.5         |
| 31 – 40years    | 26           | 30.6         |
| 41 – 50years    | 17           | 20.0         |
| 51 – 60years    | 18           | 21.2         |
| 61 years and above | 9          | 10.6         |
| Level of Education |            |              |
| No Formal       | 30           | 35.3         |
| Education       |              |              |
| Primary Education | 28         | 32.9         |
| Secondary       | 18           | 21.1         |
| Education       | 9            | 10.6         |
| Tertiary Education |            |              |
| Marital Status  |              |              |
| Single          | 1            | 1.2          |
| Married         | 76           | 89.4         |
| Divorce/Seperated | 2           | 2.4          |
| Widow/Divorced  | 6            | 7.0          |
| Membership of Association |    |              |
| Yes             | 71           | 83.5         |
| No              | 14           | 16.5         |
| Total           | 85           | 100.0        |

Source: Field Survey, 2020.

B. Sources, Quantity and Transportation of Plantain/Banana

The sources, quantity of plantain/banana purchased at once, means of transporting the produce and marketing level of the respondents are as presented (Table 3). Result showed that respondents sourced their plantain/banana majorly from four (4) states of the federation (Ekiti, Kwara, Ondo and Osun). The table indicated that majority (42.4%) buy only 1-5 dozen at a time. Furthermore, taxi and pick-up van were the major means of transporting plantain/banana to these markets representing 43.5 and 22.4 percent respectively. Retailers (64.7%) are the majority of the respondents in this current survey. This was so because majority (42.4%) bought only 1-5 dozen at a time.

C. Ripening Methods Employed and Awareness of Calcium Carbide Utilization

The ripening methods employed by handlers and the awareness of calcium carbide utilization in the ripening of plantain/banana were as presented in Table 4. The results show that majority (94.4%) of the handlers store their fruits. All of them indicated that they ripen their banana/plantain by wrapping with cloth, nylon or sack, and then put them inside clay pot or drum which can either be plastic or metal. The result shows that 82.5% of the respondents are aware of the utilization of carbide for plantain/banana ripening. This considerable awareness of use of CaC₂ in ripening of plantain brings concern and need for confirmation of used of CaC₂ in the ripening of plantain for the market, based on the suspicion of the use of carbide for ripening by some handlers of banana/plantain, which could justify recommendation for more enlightenment campaign on the dangers of use Calcium Carbide for ripening of plantain. The indication that only one respondent used CaC₂ for ripening of plantain comes doubtful, given the large indication of awareness that use of CaC₂ for ripening plantain was common. The analysis of peels and pulp of plantain from the markets for arsenic and phosphorus would have indicated the risk being faced by plantain handlers and consumers.

D. The Moisture Contents of Ripe Banana and Plantain Samples Collected from Ilorin Markets

The moisture contents of ripe banana and plantain collected from respondents with the control samples was as represented in Fig. 2. The result indicated that moisture
contents of banana and plantain were between 58.50–77.49% and 56.41–70.50% respectively. The results showed that moisture content of banana samples was higher than those of plantain from the same market. It was also observed that moisture contents of control samples were higher (p=0.05) than the ripe ones collected from the markets especially that of plantain samples. This indicated that there were reduced moisture contents in most of the ripe banana and plantain from the markets. Increased administration of calcium carbide had been linked to increase in some food contents such as ash, fibre and carbohydrates contents and decrease in some food contents such as moisture, protein, and vitamin C according to [10].

E. Vitamin C Compositions of Banana and Plantain Samples from Ilorin Markets

The amount of vitamin C in banana and plantain samples collected from six (6) major markets within Ilorin metropolis with their control sample was as presented (Fig. 3). The results showed that vitamin C contents of banana and plantain ranged from 3.933–16.013 and 8.654–17.52 mg/100 g respectively. Unlike the moisture content, the vitamin C contents of plantain were higher than that of banana from the same market including the control. However, the vitamin C contents of all the banana and plantain samples collected from the six (6) major markets were significantly lower (p=0.05) than the value recorded for the control samples. Reduced vitamin C contents in the ripe fruits has been linked to induced ripening with calcium carbide [10].

F. Arsenic Contents of Banana and Plantain Samples Collected from Ilorin Markets

The concentrations of arsenic and phosphorus in samples of banana and plantain collected from Ilorin markets were as presented (Fig. 4).

Arsenic contents of banana and plantain from Ilorin markets ranged from 0.77–45.46 µg/100 g and 1.04–15.73 µg/100 g respectively. The results showed that banana and plantain collected from six major markets had high level of arsenic contents compared to naturally ripen samples (controls). Elevated amount of arsenic (As) which is a toxic metal in the fruit pulps (mesocarp) might indicated the used of artificial ripening agent (CaC₂). A study [4] has shown that As and P were not present in the exocarp and mesocarp of mango treated with both laboratory and commercial grades CaC₂ because there was direct contact between the chemicals and the samples during treatment. It is possible that handlers in the present study area allowed contamination of the fruits with CaC₂ during application.

G. Phosphorus Contents of Banana and Plantain from Ilorin Markets

The phosphorus contents of banana and plantain samples from Ilorin markets were as shown (Fig. 5). The results showed that phosphorus contents of banana and plantain ranged from 22.26–235.57 µg/100 g and 23.26–69.33 µg/100 g respectively. In both cases, phosphorus levels of ripe ones collected from the markets exceeded those of naturally ripen fruits. Similarly, this was an indication that most of the ripe banana and plantain from six major markets in Ilorin must have been ripen with the aid of artificial agent. Although, phosphorus is an essential mineral required in human body, excessive intake may interfere the normal calcium metabolism [7]. According to these authors, the maximum daily requirement of 750 mg for average adult body weight.
**IV. CONCLUSIONS**

The study has shown the demographic distribution of respondents in the survey of banana and plantain handlers from six major markets in Ilorin metropolis. A total of 85 questionnaires were returned from all the six markets comprising 1 male 84 females. Although only 1 respondent attested to applying calcium carbide in the ripening of banana/plantain; results from the chemical analyses showed that some samples exhibited significant lower moisture and vitamin C contents than the control samples. Furthermore, results from mineral analysis showed that higher levels of arsenic and phosphorus were recovered from samples of banana and plantain collected from these markets compared to the naturally ripened fruits. This might indicate the use of calcium carbide in the ripening stage. The need for stringent policies against the use of CaC₂ for ripening of fruits in Nigeria cannot be overemphasized.

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