The Importance of Computerized Analysis on Spoilage of Sweet Orange (Citrus Sinensis), Before Harvest and Carriage to Market, in Nigeria

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Abstract: This research work was carried out, to find the importance of computerized analysis on spoilage of sweet orange, before harvest and carriage to market in Nigeria. 4 Local governments, namely: (Ife East, Ife South, Ife Central and Ife North), local government areas were sampled. 3,200 open questionnaires were distributed to the 4 Local Governments, out of which 800 was used for farmers in each local government. A total of 32 different locations were visited and sampled in all the four Local Governments, out of which 100 questionnaires were used in each location. It was gathered that above 75% of the people supported that, the computerized analysis on spoilage of sweet orange, before harvest and carriage to market in Nigeria, was important, while less than 25% of the people, could not even understand whether there was any need, for the importance of computerized analysis on spoilage of sweet orange, before harvest and carriage to market in Nigeria or not. The results from the questionnaires when using Pearson one-tailed correlation coefficient, however revealed that there was no significant difference from all the farmers visited and sampled, \( p < 0.01 \) and \( p < 0.05 \) table 5. This shows a strong positive correlation, which implying that, the importance of computerized analysis on spoilage of sweet orange, before harvest and carriage to market in Nigeria, is strongly influenced and enhanced farmer’s support, from the four local government areas, visited and sampled, in Ile-Ife Kingdom of Osun State, and Nigeria in general, and therefore had made the research work to become a reality, \( p < 0.01 \) and \( p < 0.05 \), table 5 respectively. The reasons may be due to the fact that, sweet oranges are not only, an excellent source and very rich in vitamin C, folic acid; it is also as a good source of dietary fiber, containing a host of other important nutrient element like: folate, thiamine, niacin, phosphorus, magnesium and copper, \cite{1}. They are a good source of B vitamins including vitamin B1, pantothenic acid and folate as well as vitamin A, calcium, copper and potassium and are also known to be fat free, sodium free and cholesterol free. Histogram with curve was used to depict the summary data of each of the local government areas sampled.

Keywords: Sweet Orange (Citrus Sinensis), Harvest, Spoilage, 4 Local Governments, Osun State, Pearson Correlation

1. Introduction

Sweet Orange (citrus sinensis), the fruit of the citrus species, in the family Rutaceae (US National Institute of Health). It is widely rated as the most planted fruit in Nigeria. In Nigeria, this orange is grown in any part of the country as the climatic conditions in the country has proven to be suitable for its growth. About 930,000 tons of citrus fruits are produced annually from an estimated 3 million hectares of land. Sweet oranges are an excellent source and very rich in vitamin C, folic acid and it is also as a good source of dietary fiber, containing a host of other important nutrient element like: folate, thiamine, niacin, phosphorus, magnesium and copper, \cite{1}. They are a good source of B vitamins including vitamin B1, pantothenic acid and folate as well as vitamin A, calcium, copper and potassium. Sweet oranges are also known to be fat free, sodium free and cholesterol free. Citrus species are grown for the juice of their fruits. It is also called sweet orange to distinguished it from the related (citrus avoantium), referred to as bitter orange. The sweet orange...
reproduces asexually, varieties of sweet orange arise through mutation, [2]. Sweet oranges are one of the most popular fruits around the world. While they are delightful as a snack, or as a recipe ingredient, for many Americans; it is their juice that most associated with good health, having a reputation for being an integral part of a healthy breakfast. Sweet oranges are round citrus fruits with finely textured skins, that are having colour like pulpy flesh, usually range from about two to three inches in diameter, [3]. Oranges are classified into two general categories: Sweet and bitter. Sweet oranges, being the type most commonly consumed. The popular varieties of the sweet orange (citrus sinensis), include Valencia, Navel and Jaffa oranges, as well as blood orange, a hybrid species that is smaller in size, more aromatic in flavour and has red hues running throughout its flesh. Bitter oranges (citrus aurantium), are often times used to make jam or marmalade, and their zest serves as the flavouring for liqueurs, such as Grand mamier and cointreau, [4].

**Figure 1.** Sweet Orange (citrus sinensis), the fruit of the citrus species, in the family Rutaceae.

**ORANGE HISTORY/ORIGIN:**

Oranges originated thousands of year ago in Asia, in the region from Southern China to Indonesia from which they spread to India. Sweet oranges were introduced into Europe around the 16th century by various groups including the moors and the Portuguese, as well as the Italian traders, and explorers who found them on their voyages to Asia and the middle East. Sweet oranges trees began to be grown in the Caribbean Islands in the late 15th century after Christopher Columbus brought the seeds there on his second voyage to the new world. Spanish explorers are responsible for bringing oranges to Florida in the 16th century, while Spanish Missionaries brought them to California in the 18th century, beginning the cultivation of this citrus fruit in the two states widely known for their oranges, [5].

YEARS OF MATURITY OF SWEET ORANGE (citrus sinensis) IN NIGERIA:

**Figure 2.** Orange, History/Origin.

Sweet orange matures very fast. Between 3 – 4 years, after planting. In the Southern Nigeria, Oranges are generally available from May/October, with seasonal variation depending on variety. After well grown, it became a seasonal and perishable fruits and goods for consumption both for the buyers and the people.

SWEET ORANGE (citrus sinensis), SPOILAGE BEFORE HARVEST AND CARRIAGE:

**Figure 3.** Sweet Orange, years of maturity.

In order to maintain high quality of sweet oranges, for both short term and long term harvest and carriage to Market,
there are some risks involved concerning spoilage before harvesting and carrying them. This is because, in Nigeria, sweet orange is extremely sensitive to issue of pest and disease, infection, premature fruits drop due to attack by nocturnal fruit piercing moths, termite damage to stem bark and tree roots and gummosis as well as death of budded seedlings.

**Figure 5. Sweet Orange, spoilage before harvest and carriage to market.**

The sweet orange fruits are usually prone to spoilage due to the bad roads and long hours of travel, before reaching the nearby markets, which is also caused by bad roads. The spoilage, in-turns, always lead to great loss for both the farmers and the buyers.

Most of the problems which affects sweet orange production in Nigeria is that, a significant percentage of the product are spoilt or denatured before getting to the consumer markets. Also, some pests and disease of the orange crop can easily spread from one tree to the other if not tackled on time and most times causes reduction in productivity.

**SWEET ORANGE (citrus sinensis), CARRIAGE TO MARKET:**

In Nigeria, the major markets for this fruit are basically made up of two categories: the fresh fruits Market,(since the fresh fruits are majorly perishable and not durable). And the processed fruits Market, (where electro-mechanical devices/machines is used for changing such raw materials into finished goods for the consumers). The major producing States for Sweet Oranges are: Oyo, Ogun, Osun, Kogi, Nassarawa, Bennue, Ebonyi, Kaduna, Taraba, Ekiti, Imo, Kwara, Edo, and Delta.

2. **Material and Methods**

The responses of the farmers in different locations of the four local government areas can be seen from the decision table as below:

| Sub | Above 75% | Below 25% | Open headed Questionnaires |
|-----|-----------|-----------|---------------------------|
| Computerized Analysis on spoilage of sweet orange before harvest and carriage to market is important in Nigeria. | X | X | |
| I do not know | | | X |
| State open questionnaires | | | |

The below are the points ticked by the majority of the people (above 75% table 1) from the questionnaires who understood and supported, the importance of computerized analysis on spoilage of sweet orange, before harvest and carriage to market in Nigeria.

**Figure 6. Sweet Orange, harvest and carriage to market.**

It can be used to produce fruit juice and other end products like: frozen concentrates, fragrant peels, pectin, flavours etc. [d]. Vitamin C in oranges contain fiber, potassium and choline, all of which are good for your heart. [e]. It helps to lower our risk for many diseases. [f]. Sweet oranges are a healthy source of fiber that may help lower blood sugar levels. [g]. Fiber also aids in digestion and may help lower cholesterol by blocking the absorption of cholesterol into the blood stream. [h]. Potassium, an electrolyte mineral, is vital for healthy functioning of the nervours systems. [i]. Lack of potassium can lead to an irregular heart beat (arrhythmia). [j]. Lack of potassium can lead to increased blood pressure. [k]. Lack of potassium can lead to a depletion of calcium in bones. [l]. Potassium found in sweet oranges help to lower pressure, thereby protecting the human body against stroke. [m]. Too much of potassium can lead to hyperkalemia. [n]. Sweet oranges are high in folate, a B vitamin.. [o]. A B vitamin in orange helps the body to lower level of

[a]. In Nigeria, Sweet Oranges can be eaten in its raw form. [b]. sweet oranges are low in calories and full of nutrients. [c].

**Figure 7. Sweet Orange, and its importance.**
homocysteine, an amino acid that is common in red meat and is linked with poor heart health. [p]. Sweet orange promotes clear, and healthy skin. [q]. Most citrus fruits have a good deal of vitamin C. [r]. Vitamin C, a potent antioxidant, that protects cells by scavenging and neutralizing harmful free radicals. [s]. The vitamin C in sweet oranges may boost a person’s immunity to everyday viruses and infections. [t]. The vitamin C in sweet oranges is associated with a reduced risk of colon cancer, due to preventing DNA mutations from taking place. This shows that, about 10 to 15 percent of colon cancers have a mutation in a gene called BRAF.

3. Case Study Area

The study has been conducted in Nigeria. It is located in the West of Africa on the Gulf of Guinea and has a total of 923,768 km$^2$ (356.669 square mile), making it the world’s 32$^{nd}$ – largest country (after Tanzania). It is comparable in size to Venezuela, and is about twice the size of California. It shares a 4,047 kilometres (2,515 square mile), border with Benin (773 km.), Niger (1,497 km.), Chad (87 km.), Cameroon (1,690 km.), and has a coastline of at least 853 km. [51]. Nigeria lies between latitude 4° and 14°N, and longitude 2° and 15°E (Encyclopaedia Britannica).

Nigeria is a densely populated country with the highest density of 477.0/square mile. As at a (2012) estimate, the country held a population of more than 168.8 million people up from the 140 million recorded in her (2006) population census (World Bank Nigeria Data (2012)). Of this population, about 87 million people (52%) dwell in rural areas while 81 million dwell in urban areas (Trading Economics Rural Population Chart (2012)). The Male/Female ratio is 1:05, where male commands 51.21%, while females, 48.79% (Nigerian Census, (2006)).

4. Results and Discussion

Questionnaires were distributed to 4 Local government areas that is, (Ife East, Ife South, Ife Central and Ife North). The results from the questionnaires however revealed that, the importance of computerized analysis on spoilage of sweet orange, before harvest and carriage to market in Nigeria, are manifold:

There was no significant difference on the people in all the local government areas visited, [p < 0.01] and [p < 0.05].

Table 2. People’s respondent.

| Wards         | Ife East                  | Ife South                   | Ife Central                | Ife North                   |
|---------------|---------------------------|-----------------------------|----------------------------|-----------------------------|
| People’s      | The importance of         | The importance of           | The importance of          | The importance of           |
| Response      | computerized             | computerized                | computerized               | computerized               |
|               | analysis on spoilage of   | analysis on spoilage of     | analysis on spoilage of    | analysis on spoilage of     |
|               | sweet orange, before      | sweet orange, before        | sweet orange, before       | sweet orange, before        |
|               | harvest and carriage to   | harvest and carriage to     | harvest and carriage to    | harvest and carriage to     |
|               | market in Nigeria.        | market in Nigeria.          | market in Nigeria.         | market in Nigeria.          |
|               | I do not know             | I do not know               | I do not know              | I do not know               |
|               | 568, 71.0%                | 232, 29.0%                  | 554, 69.3%                 | 246, 30.7%                  |
|               |                           |                              | 557, 69.6%                 | 243, 30.4%                  |
|               |                           |                              | 552, 69.0%                 | 248, 31.0%                  |

Figure 8. The Study Area Map of Nigeria.
From the above table 2, in Ife East, there are 568 people’s response with 71.0%, Ife South, 554 with 69.3%, Ife Central, 557 with 69.6%, and Ife North, 552 with 69.0%, were those People who supported that, the computerized analysis on spoilage of sweet orange, before harvest and carriage to market in Nigeria was important., while in Ife East, 232 with 29.0%, Ife South, 246 with 30.7%, Ife Central, 243 with 30.4%, and Ife North, 248 with 31.0% respectively, could not even know whether there was any need or not for the computerized analysis on spoilage of sweet orange, before harvest and carriage to market in Nigeria.

Table 3. The different locations and local governments, also the summary data collected, from the 4 Local Governments sampled, out of which 800 were used in each local government.

| LOCAL GOVERNMENT | LOCATION | IFE EAST | IFE SOUTH | IFE CENTRAL | IFE NORTH |
|------------------|----------|----------|-----------|-------------|-----------|
| Peoples Respondent | A        | 71       | 68        | 75          | 68        |
|                   | B        | 77       | 72        | 73          | 74        |
|                   | C        | 69       | 79        | 78          | 72        |
|                   | D        | 75       | 64        | 62          | 65        |
|                   | E        | 62       | 60        | 59          | 62        |
|                   | F        | 72       | 70        | 69          | 70        |
|                   | G        | 68       | 69        | 70          | 64        |
|                   | H        | 74       | 72        | 71          | 70        |
| TOTAL =           | 8        | 568      | 554       | 557         | 552       |
| Grand Total =     | 8        | 800      | 800       | 800         | 800       |

Table 4. The descriptive statistics.

| Descriptive Statistics | Mean   | Std. Deviation | N |
|------------------------|--------|----------------|---|
| IFEEAST                | 71.000 | 4.72077        | 8 |
| IFESOUTH               | 69.250 | 5.67576        | 8 |
| IFECENTRAL             | 69.625 | 6.36817        | 8 |
| IFENORTH               | 69.000 | 5.58058        | 8 |

Correlations

Table 5. The Pearson Correlation of the 4 local governments.

| Correlations       | IFEEAST | IFESOUTH | IFECENTRAL | IFENORTH |
|--------------------|---------|----------|------------|----------|
| Pearson Correlation| .368    | .337     | .629       |          |
| Sig. (1-tailed)    | .185    | .207     | .047       |          |
| Sum of Squares and Cross-products | 156.000 | 69.000 | 71.000 | 116.000 |
| Covariance         | 22.286  | 9.857    | 10.143     | 16.571   |
| N                  | 8       | 8        | 8          | 8        |
| Pearson Correlation| .368    | 1        | .892**     | .758*    |
| Sig. (1-tailed)    | .185    | .001     | .015       |          |
| Sum of Squares and Cross-products | 69.000 | 225.500 | 225.750 | 168.000 |
| Covariance         | 9.857   | 32.214   | 32.250     | 24.000   |
| N                  | 8       | 8        | 8          | 8        |
| Pearson Correlation| .337    | .892**   | 1          | .699*    |
| Sig. (1-tailed)    | .017    | .001     | .027       |          |
| Sum of Squares and Cross-products | 71.000 | 225.750 | 283.875 | 174.000 |
| Covariance         | 10.143  | 32.250   | 40.554     | 24.857   |
| N                  | 8       | 8        | 8          | 8        |
| Pearson Correlation| .629*   | .758*    | .699*      | 1        |
| Sig. (1-tailed)    | .047    | .015     | .027       |          |
| Sum of Squares and Cross-products | 116.000 | 168.000 | 174.000 | 218.000 |
| Covariance         | 16.571  | 24.000   | 24.857     | 31.143   |
| N                  | 8       | 8        | 8          | 8        |

*. Correlation is significant at the 0.05 level (1-tailed).

**. Correlation is significant at the 0.01 level (1-tailed).
Table 6. The Frequency Table of (Ife East, Ife South, Ife Central, and Ife North) including the mean, mode std. deviation of the 4 local government areas.

FREQUENCIES VARIABLES=IFEEAST IFESOUTH IFECENTRAL IFENORTH.
/NTILES=4.
/NTILES=10.
/STATISTICS=STDDEV VARIANCE RANGE MINIMUM MAXIMUM SEMEAN MEAN MEDIAN MODE SUM SKEWNESS SESKEW.
KURTOSIS SEKURT.
/GROUPED=IFEEAST IFESOUTH IFECENTRAL IFENORTH.
/HISTOGRAM NORMAL.
/ORDER=ANALYSIS.

| Statistics | IFEAST | IFESOUTH | IFECENTRAL | IFENORTH |
|------------|--------|----------|------------|----------|
| N Valid    | 8      | 8        | 8          | 8        |
|           | Missing| 0        | 0          | 0        |
| Mean      | 71.0000 | 69.2500  | 69.6250    | 69.0000  |
| Std. Error of Mean | 1.66905 | 2.00669  | 2.25149    | 1.97303  |
| Median    | 71.5000  | 69.5000  | 70.5000    | 68.6667  |
| Mode      | 62.00  | 72.00    | 59.00      | 70.00    |
| Std. Deviation | 4.72077 | 5.67576  | 6.36817    | 5.58058  |
| Skewness  | -.826 | .032     | -.634      | .651     |
| Std. Error of Skewness | .752 | .752    | .752       | .752     |
| Kurtosis  | .824 | .794     | -.311      | .017     |
| Std. Error of Kurtosis | 1.481 | 1.481   | 1.481      | 1.481    |
| Range     | 15.00  | 19.00    | 19.00      | 17.00    |
| Minimum   | 62.00  | 60.00    | 59.00      | 62.00    |
| Maximum   | 77.00  | 79.00    | 78.00      | 79.00    |
| Sum       | 568.00 | 554.00   | 557.00     | 552.00   |
| 10 Percentiles | 63.8000  | 61.2000  | 59.9000    | 62.6000  |
| 20 Percentiles | 68.1000  | 64.4000  | 62.7000    | 64.1000  |
| 25 Percentiles | 68.5000  | 66.0000  | 65.5000    | 64.5000  |
| 30 Percentiles | 68.9000  | 67.6000  | 68.3000    | 64.9000  |
| 40 Percentiles | 70.4000  | 68.7000  | 69.7000    | 67.1000  |
| 50 Percentiles | 71.5000  | 69.5000  | 70.5000    | 68.6667  |
| 60 Percentiles | 72.6000  | 70.4000  | 71.6000    | 69.7333  |
| 70 Percentiles | 74.1000  | 71.4667  | 73.2000    | 71.6000  |
| 75 Percentiles | 74.5000  | 72.0000  | 74.0000    | 72.6667  |
| 80 Percentiles | 74.9000  | 73.8667  | 74.8000    | 73.7333  |
| 90 Percentiles | 76.4000  | 77.6000  | 77.1000    | 77.5000  |

a. Calculated from grouped data.
b. Multiple modes exist. The smallest value is shown.
c. Percentiles are calculated from grouped data.

Tables (7, 8, 9, and 10) The frequency Tables for (Ife East, Ife South, Ife Central and Ife North).

Table 7. Valid and cumulative percentages of Ife East.

| IFEAST | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------|-----------|---------|---------------|--------------------|
| 62.00  | 1         | 12.5    | 12.5          | 12.5               |
| 68.00  | 1         | 12.5    | 12.5          | 25.0               |
| 69.00  | 1         | 12.5    | 12.5          | 37.5               |
| 71.00  | 1         | 12.5    | 12.5          | 50.0               |
| 72.00  | 1         | 12.5    | 12.5          | 62.5               |
| 74.00  | 1         | 12.5    | 12.5          | 75.0               |
| 75.00  | 1         | 12.5    | 12.5          | 87.5               |
| 77.00  | 1         | 12.5    | 12.5          | 100.0              |
| Total  | 8         | 100.0   | 100.0         |                    |
Table 8. Valid and cumulative percentages of Ife South.

| IFESOUTH | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------|-----------|---------|---------------|--------------------|
|          | 60.00     | 1       | 12.5          | 12.5               |
|          | 64.00     | 1       | 12.5          | 25.0               |
|          | 68.00     | 1       | 12.5          | 37.5               |
|          | 69.00     | 1       | 12.5          | 50.0               |
|          | 70.00     | 1       | 12.5          | 62.5               |
|          | 72.00     | 2       | 25.0          | 87.5               |
|          | 79.00     | 1       | 12.5          | 100.0              |
| Valid    | 8         |         |               |                    |
| Total    | 8         |         | 100.0         | 100.0              |

Table 9. Valid and cumulative percentages of Ife Central.

| IFECENTRAL | Frequency | Percent | Valid Percent | Cumulative Percent |
|------------|-----------|---------|---------------|--------------------|
|            | 59.00     | 1       | 12.5          | 12.5               |
|            | 62.00     | 1       | 12.5          | 25.0               |
|            | 69.00     | 1       | 12.5          | 37.5               |
|            | 70.00     | 1       | 12.5          | 50.0               |
|            | 71.00     | 1       | 12.5          | 62.5               |
|            | 73.00     | 1       | 12.5          | 75.0               |
|            | 75.00     | 1       | 12.5          | 87.5               |
|            | 78.00     | 1       | 12.5          | 100.0              |
| Valid      | 8         |         |               |                    |
| Total      | 8         |         | 100.0         | 100.0              |

Table 10. Valid and cumulative percentages of Ife North.

| IFENORTH | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------|-----------|---------|---------------|--------------------|
|          | 62.00     | 1       | 12.5          | 12.5               |
|          | 64.00     | 1       | 12.5          | 25.0               |
|          | 65.00     | 1       | 12.5          | 37.5               |
|          | 68.00     | 1       | 12.5          | 50.0               |
|          | 70.00     | 2       | 25.0          | 75.0               |
|          | 74.00     | 1       | 12.5          | 87.5               |
|          | 79.00     | 1       | 12.5          | 100.0              |
| Valid    | 8         |         |               |                    |
| Total    | 8         |         | 100.0         | 100.0              |

Figures: (9, 10, 11, and 12). The Histogram with Curve, for (Ife East, Ife South, Ife Central and Ife North).

Histogram

The vertical coordinates represent the frequency (that is, the rate of observations or occurrences) from the data analysis while the horizontal coordinates represent the range from the valid data in Table 7, (that is, based on 1 unit interval as [60, 65, 70, 75, 80], respectively.

![Figure 9. The Histogram with Curve of Ife East.](image)

![Figure 10. The Histogram with Curve of Ife South.](image)
The vertical coordinates represent the frequency (that is, the rate of observations or occurrences) from the data analysis while the horizontal coordinates represent the range from the valid data in Table 8, (that is, based on 1 unit interval as \([55, 60, 65, 70, 75, 80, 85]\), respectively.

The vertical coordinates represent the frequency (that is, the rate of observations or occurrences) from the data analysis while the horizontal coordinates represent the range from the valid data in Table 9, (that is, based on 1 unit interval as \([55, 60, 65, 70, 75, 80, 85]\), respectively.

5. Recommendations

1. Nigerian Government should encourage sweet orange plantation, by given funds/loans to prospective investors.
2. Federal government should support the farmers by given enough assistance in terms of seedlings subsidy, so as to boost their production.
3. Workshop at different intervals should be organised to farmers, so as to educate them in the uses of current farmer’s equipments, to increase their sweet orange output production and eradicate sweet orange spoilage.
4. Some of the rural areas roads in, Nigeria, are bad. Government should provide good motor-able roads to farmers in plantation areas with high concentration of sweet orange farm.
5. Government should provide electricity in rural areas for Farmers to enable them to stay longer in their farm for maximum increase in their sweet orange harvest Production.
6. Government should organised Agricultural extension services to farmers by providing and bringing agricultural equipments closer to them, so as to reduce the cost of sweet orange harvest to the buyers.
7. Government should erect large storage facilities at intervals for sweet orange farmers, to avoid losses and spoilage.
8. For high Productivity and ultimate high investment, The Federal Government of Nigeria should encouraged sweet orange farmers to make research and seek expert opinion and advice for the latest productivity techniques to maximize profit.

6. Conclusion

The following conclusions are made based on the findings of this study. Since sweet oranges are an excellent source and very rich in vitamin C, folic acid and it is also as a good source of dietary fiber, containing a host of other important nutrient element for human health, like: folate, thiamine, niacin, phosphorus, magnesium and copper; the results of this study provide the empirical evidence that the importance of computerized analysis on spoilage of sweet orange, before harvest and carriage to market in Nigeria, had enhanced people’s achievement in our society and in Nigeria at large. The society, therefore should use, the importance of computerized analysis on spoilage of sweet orange, before harvest and carriage to market in Nigeria’s techniques, to argument peoples’ maximal output in businesses, in order to attain minimum goal needed for everybody in the society.

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