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# RESPONSE OF PHYSICAL PROPERTIES OF TOMATOES TO HANDLING AND ENVIRONMENTAL FACTORS IN POST HARVEST PROCESSES

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**Abstract**
*Tomatoes production has witnessed huge growth over the years resulting from its economic, nutritional and health importance. Despite rapid progress in technology, handling, environmental factors and storage of tomato fruits are currently major problems experienced in postharvest practices. This study assessed responses of physical properties of tomatoes to handling and environmental factors in postharvest processes for sustenance of post-harvest quality and marketability in Ogba-Egbema-Ndoni Local Government Area of Rivers State,Nigeria . To this end, a survey of population comprising of all tomato marketers in Ogba-Egbema-Ndoni Local Government Area of Rivers State was made with a sample of 100 respondents randomly selected from the list of tomato marketers. Four research questions guided the study. Data was collected using a 20-item questionnaire and analyzed using frequency count and mean scores. The result revealed grand mean scores of 2.86, 3.3, 2.9 and 2.7 developed with respect to: tomatoes holding material, handling method, environmental factor and storage effect. This shows that marketers of tomatoes currently use traditional method for both holding and handling as well as for storage with the resultant effects on physical characteristics of surface bruises and compression, heat accumulation, rapid water loss, loss of weight, change in appearance, shape and reduction in size and firmness. This signifies that the current methods exposes the product to avoidable injuries that leads to losses. Awareness need to be created and improved devices made available and affordable to ensure sustainable post-harvest practices that enhances the quality of tomatoes and prolong its shelf life.*

**Keywords***: Environmental factors, storage method, Tomato loss, traditional basket,.*

## Introduction

Tomatoes (*Solanum lycopesicum*) is among highly cultivated vegetables worldwide for local use and for export. Nigeria is considered the second largest in the production of tomatoes and 13$^{th}$ globally (FAOSTAT, 2017). Tomatoes has a lots of great economic, nutritional values and health benefits as it contain many health enhancing compounds that is easily integrated to make our diet both nutritious and balanced. Besides consuming tomato fruits fresh, its processed products are applied in soups, juices and sauces (Krauss et al., 2006, Pem & Jeewon, 2015, Ralola et al., 2014, Freeman & Reimers, 2011). Tomatoes rate of deterioration is very high and are exposed to rapid quality loss after harvest. Postharvest calcium chloride application, best physical handling procedures and use of adequate storage device as well as controlled environment to maintain the quality after harvest becomes necessary. Post-harvest operations which can be done in the field, centre of collection as well as packing house involve actions performed on fresh produce in preparation for marketing to meet the demand of market and subsequent storage (Arah et al., 2015). Rapusas and Rolle (2009), highlighted basic rules that should be followed

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in wholesale and retail markets which serves as the outlets for tomato farmers, collectors and other traders. This involves: unloading the containing device carefully from the transporting vehicle with cover and handling to reduce mechanical damage. It's also important to resort, discard culls properly and re-grade tomatoes according to appearance, ripeness stage, size, in consideration of target market requirement. In the retail market, it is best to sell tomatoes in retail packs as this will prevent regular handling of buyers as they select tomatoes which may also lead to contamination. If retail packaging of tomatoes is not possible, it should be placed in appropriate containers during retail display. This prevents exposing tomatoes to contamination by laying it loose on the ground with plastic mat which may not offer adequate shield from contamination. When retailing in open-air market and roadside stalls, tomatoes on displaying when retailing in open-air market and roadside stalls under shade for protection from sun and rain (Hardenburg et al., 2013).

Kitinoja and Kader (2002) recommended rigid containers such as plastic crates adequate protection of tomatoes against compression damage and good characteristics over the traditional container of smooth inside finish, easily cleanable, stackable, reusable and returnable. Although more expensive than the traditional packaging containers, plastic crates have been shown to be cheaper on long run use (5-6 years). Plastic bags, plastic sack and red mesh bags do not provide adequate protection to the contents. They are readily damaged and will lead to fruit deterioration. Injuries often incurred include compression manifested as flattened areas and breaks in the skin (Hardenburg et al., 2013). According to FAO (2012) report, transport should fulfil the objective of insuring that tomatoes arrives in top quality form to the final market, from farm to collection center or packing shed to wholesale market, and to retail market. In all of these stages of transportation it is important to handle containers gently; avoid dropping or throwing each on the other, seating on top packed tomatoes during field transport, using container as steps to allow stacking to a greater height especially if semi-rigid containers like cartons are used, and exposure to sun during transport. It is also important to allow for air circulation in the stacks or piles of produce by providing space in between stacks. As noted, tomatoes are perishable product and losses during post-harvest processes are enormous and by this reasons most market runs at loss because the physical properties of tomatoes such as size, shape, appearance, feel etc. that quality is based on are compromised (Cantwell, 2019). The holding container, handling method, environmental factors and storage method affect the physical properties in similar and divers way (Taheri et al., 2011). This research therefore seeks to find out the response of physical properties of tomatoes to handling and environmental factors in post-harvest processes

**Research Questions**

The four research questions that guided the study are :

1. What is the effect of holding device on physical properties of tomatoes?
2. What is the effect of handling method on physical property of tomatoes?
3. What is the influence of environmental factors effects on the physical property of tomatoes?
4. What is the storage method effect on tomato physical properties

**Methodology**

In this study research survey method was used. Population for the study comprised of all tomatoes dealers in Ogba/Egbema/Ndoni local government area of Rivers State from where a sample of 100 respondents including marketers and transporters was randomly drawn specifically from Omoku, Akabuka Mgbede, Ndoni and Obrikom. The instrument used for data collection was the questionnaire. It consisted of twenty (20) items structured in likert scale format of strongly agree, agree, disagree and strongly disagree containing information about the effect of response of physical properties of tomatoes with respect to: holding material, handling

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method, environmental factor and storage method in Ogba, Egbema, Ndoni local government area. The questionnaire was administered to the respondents by the researcher and retrieved on the spot.

**Data analysis**

Data collected were analysed using mean score. A Likert-type rating scale of Strongly Agreed (SA=4), Agreed (A=3), Disagreed (D=2) and Strongly Disagree (SD=1), was used to elicit responses from the respondents. A mid-point of 2.5 was established based on the 4-poit scale. Decision rule was based on reached thus: any mean score that is greater than or equal to 2.5 was considered as agreement with the specified statement, whereas any mean score that is less than 2.5 was considered as disagreement with the specified statement

**Results and Discussion**

**Research Questions**

**1.** What is the effect of holding device on physical properties of tomatoes?

**Table 1:** Response on effect of holding device on physical properties of tomatoes

| S/N | Items | SA | A | D | SD | Total | Mean | Remark |
|---|---|---|---|---|---|---|---|---|
| | | 4 | 3 | 2 | 1 | | | |
| 1. | Major holding device is the tradition weaved basket | 80<br>320 | 18<br>54 | 2<br>4 | 0<br>0 | 100<br>378 | 3.78 | Agreed |
| 2. | Weaved basket has problem of aeration which can aid water loss and firmness | 92<br>368 | 8<br>24 | 0<br>0 | 0<br>0 | 100<br>392 | 3.92 | Agreed |
| 3. | Tomatoes are conveyed in devices other than the baskets to marketers and within market | 34<br>136 | 4<br>12 | 4<br>0 | 58<br>58 | 100<br>206 | 2.1 | Disagreed |
| 4. | The basket with rough surfaces can create damaging bruises, distortion in appearance and shrinkage. | 24<br>96 | 76<br>228 | 0<br>0 | 0<br>0 | 100<br>324 | 3.2 | Agreed |
| 5 | marketers are aware of other better and affordable holding devices to use. | 0<br>0 | 10<br>30 | 10<br>20 | 80<br>80 | 100<br>130 | 1.3 | Disagreed |
| | Grand Mean score | | | | | | 2.86 | Agreed |

*Source: Field Survey, 2022.*

Table 1, shows the response of physical property of tomatoes on current material used for its holding during transportation and marketing. Respondents agreed on item 1, 2 and 4. Signifying that respondents currently use traditional basket as a major container for holding tomatoes by marketers in Ogba/Egbema/Ndoni Local

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Government Area (ONELGA). This method has a challenge of air circulation down the body as the tomatoes are pile up one on top the other, creating a buildup and retention of high temperature whereas rough surfaces of the basket creates cuts on the surface of the tomatoes. Tomatoes responds as it losses water, firmness and shrinks. However, respondents disagreed on item 3 and 4. This indicates that besides being used as a holding container for tomatoes, it is used to convey the tomatoes during transportation from farm, collection centres and within markets. This is largely due to the fact that the marketers may not be aware of better holding and conveying devices available or they are not affordable.

**Research Questions 2 :** What is the effect of handling method on physical property of tomatoes?
Table 2 shows the response of the respondent on effect of handling method during post-harvest processes on the physical property of tomatoes.

**Table 2:** Response to effect of handling method on physical property of tomatoes

| S/N | Items | SA | A | D | SD | Total | Mean | Remark |
|---|---|---|---|---|---|---|---|---|
| | | 4 | 3 | 2 | 1 | | | |
| 1. | Marketers are aware of better and alternative means of handling tomatoes during transport and transaction during marketing | 0<br>0 | 0<br>0 | 20<br>40 | 80<br>80 | 100<br>120 | 1.2 | Disagreed |
| 2. | Tomatoes are conveyed in baskets using vehicles, hands and head. | 96<br>384 | 4<br>12 | 0<br>0 | 0<br>0 | 100<br>396 | 3.96 | Agreed |
| 3. | Bad roads can cause compression and exposure to sunlight leading to change in shape and loss of water | 100<br>400 | 0<br>0 | 0<br>0 | 0<br>0 | 100<br>400 | 4.0 | Agreed |
| 4. | Bruises or breakages may occur if tomato container are not handled with care during loading and offloading. | 72<br>288 | 20<br>60 | 4<br>8 | 4<br>4 | 100<br>360 | 3.6 | Agreed |
| 5 | Rough handling during sales can result in mechanical injury which affects tomato quality | 62<br>248 | 22<br>66 | 16<br>32 | 0<br>0 | 100<br>346 | 3.5 | Agreed |
| | **Grand Mean score** | | | | | | **3.3** | **Agreed** |

*Source: Field Survey, 2022.*

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From the table 2, respondents agreed on item 2, 3, 4 and 5. This indicates that as vehicles are used to move tomatoes from one point to the other and assisted manually by hands and head, a high possibility of rough and careless handling can cause tomato fruits to be compressed, or crushed, especially when loading, offloading or conveyed, leading to distortion in shape. Exposure to sunlight raises the fruits temperature, rate of water loss and weight loss. However respondent disagreed on item 1. This indicates that respondents are not enlightened or aware of alternative handling method for tomatoes that can prevent damages and promote or preserve quality of tomatoes.

**Research Questions 3 :** What is the influence of environmental factors effects on the physical property of tomatoes?

**Table 3:** Response of environmental factors effects on the physical property of tomatoes

| S/N | Items | SA 4 | A 3 | D 2 | SD 1 | Total | Mean | Remark |
|---|---|---|---|---|---|---|---|---|
| 1. | Tomatoes are best transported and sold during the early and late hours of the day | 56 224 | 40 120 | 2 4 | 2 2 | 100 350 | 3.5 | Agreed |
| 2. | Temperature and relative humidity are not regulated where tomatoes are sold. | 40 160 | 60 180 | 0 0 | 0 0 | 100 340 | 3.4 | Agreed |
| 3. | High temperature and low relative humidity causes rapid water loss in the market area | 52 208 | 30 90 | 10 20 | 8 8 | 100 326 | 3.3 | Agreed |
| 4. | Nature and size of the market prevent necessary precaution against deterioration | 60 240 | 20 60 | 20 40 | 0 0 | 100 340 | 3.4 | Agreed |
| 5 | Marketer have special means of preventing exposure to rain and sunlight | 0 0 | 0 0 | 18 36 | 82 82 | 100 118 | 1.2 | Disagreed |
| | **Grand Mean score** | | | | | | **2.9** | **Agreed** |

*Source: Field Survey, 2022.*

Table 3 shows environmental factors effect on physical properties of tomatoes during post-harvest processes. From the table, respondents agree on item 1 – 4, indicating that the following factors: temperature, relative humidity, nature and size of market are environmental factors that affects the physical property of tomatoes. Uncontrolled, these factors determines the rate at which physical properties of tomatoes are compromised leading to deterioration and by extension loss of quality.

**Research Questions 4:** What is the storage method effect on tomato physical properties?

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**Table 4:** Response on storage method effect on tomato physical properties

| S/N | Items | SA 4 | A 3 | D 2 | SD 1 | Total | Mean | Remark |
|---|---|---|---|---|---|---|---|---|
| 1. | Tomatoes are often left overnight in traditional basket for storage | 78 312 | 22 66 | 0 0 | 0 0 | 100 378 | 3.8 | Agreed |
| 2. | There is special device and method used for storing tomatoes after sale | 0 0 | 0 0 | 40 80 | 60 60 | 100 140 | 1.4 | Disagreed |
| 3. | Sorting is done to reduce induced deterioration | 92 368 | 8 24 | 0 0 | 0 0 | 100 392 | 3.9 | Agreed |
| 4. | tomatoes are spread on the floor for aeration aftermarket sales | 56 224 | 4 12 | 20 40 | 20 20 | 100 296 | 2.96 | Agreed |
| 5 | Storage method prevent rapid physical changes and extend tomatoes shelf life. | 0 0 | 8 24 | 20 40 | 72 72 | 100 136 | 1.36 | Disagreed |
| | **Grand Mean score** | | | | | | **2.7** | **Agreed** |

*Source: Field Survey, 2022.t*

Table 4 shows response on storage method effect on physical properties of tomato during post-harvest processes. Respondents agreed on item 1, 3 and 4 as tomatoes are simply left overnight in the basket as means of storage. Sometime sorting is done to limit infection whereas spreading on floor ensure air circulation. However, disagreement on item 2 and 5, indicates that marketers have no special devise for storage and the storage method adopted does not prevent adverse physical changes on stored tomatoes neither extend shelf life of tomatoes.

**Discussion of Findings**

Findings on effect of holding device on physical properties of tomatoes. In ONELGA, marketers are still using traditional basket for holding and conveying tomatoes. Physical properties of tomatoes are affected when the container have rough surfaces which exposes the contents to bruises and temperature buildup that leads to deterioration. In line with Hurst, (2010), a typical raffia basket is tightly woven with no air space for the tomatoes, thus increasing the rate of spoilage of the produce. The material (raffia) used for making the basket is very rough and pokes the tomato fruits inside. Findings on effect of handling method on physical property of tomatoes. No improved handling method is currently used in the study area to ensure smooth movement of the produce and to reduce deterioration. Physical property that responds with rough manual method is the body that shows visual distortion of shape in appearance and loose surfaces that initiates deterioration. In line with Kanlayanarat (2009), during manual handling, the inside of the baskets have sharp edges which causes mechanical injuries to the fruits and besides, the oversized nature of the baskets also results in excessive crushing forces acting on the fruits located at the base of the basket. This results in bruising and crushing of the fruit which breaks the integrity of the fruits for the introduction of disease causing pathogens.

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Finding on environmental factors effects on the physical property of tomatoes. Respondents have no means of controlling available weather while holding and marketing the product. High temperature and low relative humidity in the market area affects the physical properties of tomatoes by means rapid water loss, loss of weight, change in size and shape. Nature, size and comparative profit in the market prevents necessary precautions that should be taken such as sorting into different grades of quality. Spreading both healthy and broken tomatoes gives rise to further infection and more deterioration and loss. As noted by Workneh and Woldetsadik (2017), environmental parameters of temperatures and relative humidity are the main causes of deterioration and maintaining optimum temperatures of about 10–15°C and 85–95% relative humidity is necessary to sustain quality and extend shelf life. Findings on storage method effect on tomato physical properties. Respondents in ONELGA have no special devise for storage and the storage method adopted does not prevent adverse physical changes on stored tomatoes neither extend shelf life of tomatoes. According to the suggestion by Workneh and Woldetsadik (2017), a good storage system can be achieved in a simple developed cooling system, where air temperatures can be decreased to about 16°C, with relative humidity increased to about 91%, to reduce deterioration of harvested tomatoes due to physiological weight loss. Evaporative coolers can be manufactured locally using low cost materials like jute sacks, wooden planks, and basins

## Conclusion

Holding and conveying materials, Handling, and environmental factors of temperature and humidity as well as storage method affect the physical characteristics of tomatoes by way of surface bruises and compression, heat accumulation, rapid water loss, loss of weight, change in appearance, firmness, size and shape. Any of these singly or in combination reduces its quality and market value.

## Recommendations

Improved holding and conveying material such as plastic basket should be made available and affordable to marketers in ONELGA. Where traditional baskets are used, the surface should be properly developed to prevent surface cuts that may initiate deterioration and decay. Simple storage device that can control temperature and humidity within the environment of stored tomatoes should be developed to sustain quality within storable and marketable period.

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