# ASSESSMENT OF POSTHARVEST TRANSIT LOSSES OF TOMATO USING DIFFERENT PACKAGING SYSTEMS/UNITS IN NIGERIA

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**ABSTRACT**

Road transport system has increased significantly and it's gradually becoming the most dominant means of transporting agricultural products. The most widely used packaging facility for tomato in Nigeria today is done with the traditional cane woven conical baskets. A preliminary study on this packaging method show a lot of wastages while on transit. This leads to design of rectangular shaped woven baskets based on mechanical, physical and rheological properties of UC-82B tomato cultivar. The designed packaging facility is of specification 500 mm x 400 mm x 200 mm (length, width and depth, respectively) with filling capacity of 25 kg. The conical basket having specification: top diameter x bottom diameter x depth (550 x 340 x 340 mm) was found to carry 40 kg of tomato. The two baskets at full load with UC-82B tomato cultivar were field tested concurrently on a Canter Truck via a single asphalted high way from Mairuwa village, a major tomato production area in Katsina State to Ibadan, a major tomato consumption area in Oyo State, covering a distance of 877 km. At the destination of the journey, tomato loss assessment was conducted; the conical basket recorded post-harvest loss in transit of tomato of 13.22% and tomato weight loss per day of 6.85% while the rectangular basket recorded post-harvest loss in transit of tomato of 3.58% with tomato weight loss per day of 1.91%. The analysis of the generated data, using paired t-test, indicated that, the differences in tomato loss in transit and weight loss per say of two packages were highly significant. The rectangular shaped woven basket stands superior in transit as it was observed to have minimum tomatoes damage and wastages.

**Keywords:** Mechanical damage, Post- harvest losses, Packaging system, Tomato, Transit losses,
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## INTRODUCTION

The problem of food wastages, particularly post-harvest losses has been and is still a global problem [1]. The major step towards achieving a greater level of food increase and security is to prevent food losses between harvest and consumption. Annual tomato (*Lycopercicum exculuntum*) production among other horticultural crops in Nigeria is about 6 million tons [2]. The defect in post-harvest handling, transportation and storage had caused between 20 - 50% loss of fruit loss [3, 4, 5]. The major cause of these losses was the mechanical damage as a result of static and dynamic stresses during post-harvest transit [6]. The Nigerian tomatoes has been handled and transported using tradition bamboo woven baskets. These baskets were not specifically designed to handle or transport tomato, but they have been in existence as general agricultural produce support containers since pre-civilization times. Various sizes of these baskets have been employed for tomato distribution nationwide, using un-refrigerated transport facilities such as DAF trucks, 911 trucks and Canter truck service, covering distances of over 1000 km, thereby contributing to the above stated losses. Dzivama, *et al.* [7] indicated that tomato losses due to transit in Nigeria are purely as a result poor packaging facility.

The current packaging method of tomato utilizes a woven conical basket of 40% carrying capacity [7]. This basket has the limitations of low space utilization and short life span, hence the need for developing a new rectangular basket using willow material.

The rectangular basket was designed to carry 25 kg of fresh tomato. The objective of the study was to determine the best tomato packaging system in Nigeria with minimum post-harvest transit loss.

## MATERIALS AND METHODS

### Materials

The two identified packaging methods (conical and rectangular) were subjected to field trial using Canter truck (Plate 1). The field trial was conducted in the month of April and the truck took off from Mairuwa town in Katsina state (11°11'N, 07°38'E) along a single asphalted highway and stopped finally at Ibadan, Oyo State (07º22'N, 03°58'E) a distance of 877km. The conical shaped basket was produced in the south western part of Nigeria and distributed nation wide as tomato transport packages. The baskets were purchased from a dealer in Mairuwa town.

The experimental material used was the UC-82B tomato variety. In order to have homogenous material; the UC-82B tomato was grown in the Mairuwa flood plain in Funtua local government area of Katsina State. The tomato received all the necessary cultural and agronomic practices as done by farmers (production, harvest, cleaning, sorting, grading and packaging). The basket is made of bamboo cane, having specification: top diameter x bottom diameter x depth (550 x 340 x 340 mm), carriage capacity of 40 kg (Plate 2). The designed rectangular basket was made of willow strands and was produced by willow whicker workers of the northern part of Nigeria. Its specifications are 500 x 400 x 200 mm for length, width and depth, respectively, and a carrying capacity of 25 kg (Plate 3). Vine ripened UC-82B tomato cultivar produced at Mairuwa (Katsina State) flood plain during the dry season production of 2021 was used for the field trial.


**Plate 1:** Mitsubishi Canter Truck containing the tomato loaded packages at Ibadan

**Plate 2: conical Basket**

**Plate 3: Rectangular Basket**

**Methods**

The transport device used in the field trial was Mitsubishi Canter Truck. Basic instrumentation used includes 50 kg capacity weighing scale of resolution 0.05 kg. Nevertheless, a distance of 877 km was used as test span from Mairuwa to Ibadan. This route was: Mairua - Funtua, Funtua - Birnin Gwari, Birnin Gwari - Ilorin, and Ilorin - Ibadan. Fifty packages were selected randomly from the lot of each packaging unit (Plates 2 and 3), cleaned and loaded with the graded tomato at net loading capacities of 40 and 25 kg in the evening at the time of harvest (manual) at the farm gate. The conical baskets (Plate 2) were arranged at the inner part of the truck in three layers (due to its stacking nature) while the rectangular baskets were neatly stacked in six layers towards the tail end of the truck body. Thus, the two packing units constituted an independent store on the same vehicle shearing similar advantages and disadvantages in terms of vibrations. The vehicle took off in the company of the researchers and covered the said distance on asphalted single highway for 11 hr in a night journey. The vehicle also re-fueled twice before reaching its destination.

At the final destination in Ibadan, the loaded baskets were immediately offloaded. A random sample of twenty baskets each was selected and set for loss assessment as adopted by Idah *et al.* [2] and Bani *et al.* [8]. Gross weight of each basket was recorded and the net weight of tomato in each computed. In each basket, damaged and undamaged tomatoes were separated and the damaged was further separated in those that are at hookean level (10 % diameter bruise depth), non-hookean level (40 % diameter bruise depth) and those at visco-plastic level (70 % and above diameter bruise depth) as adopted by El-Okene [9]. All the weights were recorded separately for the conical and the rectangular packages. In Nigeria, damaged tomatoes have some market values, as such they were integrated in the determination of the transit losses. Loss of weight of tomato per day was also computed from each selected basket.

Paired t-test was used in comparing the performance of the two packaging units. The method used in calculating the post-harvest transit loss was considering the tomato market price in Ibadan at the arrival date in Nigerian currency:

**Fresh vine ripened tomato;**

| | | | |
|---|---|---|---|
| Morning Price | ₦1500/40kg | or | ₦37.5/kg |
| Afternoon Price | ₦1400/40kg | or | ₦35.0/kg |
| Evening Price | ₦1200/40kg | or | ₦30.0/kg |
| Mean Price | ₦36.9 /kg | | |

**Damaged Tomato Prices;**

| | |
|---|---|
| Hookean and Non-Hookean | ₦10.7/kg |
| Visco-Plastic | ₦4.87/kg |

However, the prices of these categories were constant on the assessment day.

Sample calculation of the post-harvest Transit Loss:

Fresh farm gate marketable tomato = 40 kg
Price at market = 36.9 x 40 = ₦1476
Fresh undamaged tomato at market = 32.3 kg
Price at market = 32.3 x 36.9 = ₦ 1191.87
Damaged tomato (hookean) = 3 kg
Price at market = 3 x 10.7 = ₦ 32.1
Damaged tomato (visco-plastic) = 1.2 kg
Price at market = 1.2 x 4.87 = ₦ 5.84
Total price of the tomato at the market = 1191.87 + 32.1 + 5.84 = ₦ 1229.8
Loss of tomato = 1476 – 1229.8 = ₦ 246.8
% Post-harvest Loss of Tomato in Transit = (246.8/ 1476) x 100 = 16.7%

## RESULTS AND DISCUSSION

The result obtained for the conical basket is shown in Table 1. Due to its geometry, the tomatoes at the bottom suffered from hookean and visco-plastic damage. This is an indication of over loading of the basket. The basket that suffers more damage equally suffers more weight loss. Analysis of the mean post-harvest transit loss of tomato with this packaging system was 13.22 % and mean tomato weight loss of 6.85 %. This result is in agreement with the findings of Idah *et al.* [2] and Dzvama *et al.* [7]. No collapsed basket was found in the truck during the off loading, indicating that the stacking layer adopted as shown in Plate1 was adequate [7].

Table 2 indicated the result of loss assessment of the rectangular basket. The packaging system suffers hookean and non-hookean damage. No basket recorded visco-plastic damage. This could translate to mean that the tomato loading in the basket was appropriate. The mean post-harvest transit loss of tomato in this packaging system was 3.58 % and a tomato weight loss of 1.91 %. From the result of the paired t-test, the difference of post-harvest transit loss of the two-packaging unit is highly significant at 5% level. The loss in weight of tomato was also significant at the same level.

**Table 1:** Tomato Transit Loss Assessment (Conical Basket)

| Basket S/No | Basket Wt (kg) | Farm gate Tomato Net Wt (kg) | Market Tomato Net Wt (kg) | Fresh Marketable Tomato (kg) | Damaged Tomato (kg) | | | Wt Loss (kg) | % Wt Loss | % Transit Loss |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Hookean Level | Non Hookean | Visco Plastic Level | | | |
| 1 | 1.0 | 40 | 36.5 | 32.3 | 3.0 | - | 1.2 | 3.5 | 8.6 | 16.7 |
| 2 | 1.2 | 40 | 36.8 | 34.0 | 1.8 | - | 1.0 | 3.2 | 8.0 | 13.4 |
| 3 | 1.0 | 40 | 36.8 | 33.6 | 2.0 | - | 1.2 | 3.2 | 8.0 | 14.1 |
| 4 | 1.0 | 40 | 34.4 | 32.3 | 1.4 | - | 0.7 | 5.6 | 14.0 | 18.0 |
| 5 | 1.0 | 40 | 30.6 | 27.95 | 1.55 | - | 1.1 | 9.4 | 23.5 | 28.6 |
| 6 | 1.2 | 40 | 37.3 | 34.2 | 2.1 | - | 1.0 | 2.7 | 6.8 | 12.6 |
| 7 | 1.3 | 40 | 38.9 | 36.1 | 2.2 | - | 0.6 | 1.1 | 2.8 | 7.9 |
| 8 | 1.2 | 40 | 40 | 35.4 | 3.4 | - | 1.2 | 0.0 | 0.0 | 8.6 |
| 9 | 1.2 | 40 | 39.8 | 36.9 | 1.6 | - | 1.3 | 0.2 | 0.5 | 6.2 |
| 10 | 1.2 | 40 | 39.0 | 34.8 | 3.0 | - | 1.2 | 1.0 | 2.5 | 10.4 |
| 11 | 1.2 | 40 | 37.8 | 35.0 | 2.0 | - | 0.8 | 2.2 | 5.5 | 10.8 |
| 12 | 1.2 | 40 | 36.6 | 34.6 | 1.6 | - | 0.4 | 3.4 | 8.5 | 12.2 |
| 13 | 1.2 | 40 | 37.6 | 33.4 | 3.0 | - | 1.2 | 2.4 | 6.0 | 13.9 |
| 14 | 1.2 | 40 | 38.2 | 35.1 | 2.0 | - | 1.1 | 1.8 | 4.5 | 10.4 |
| 15 | 1.2 | 40 | 39.0 | 36.1 | 2.1 | - | 0.8 | 1.0 | 2.5 | 8.0 |
| 16 | 1.0 | 40 | 37.0 | 33.3 | 2.4 | - | 1.3 | 2.1 | 5.3 | 14.6 |
| 17 | 1.0 | 40 | 35.0 | 31.2 | 2.6 | - | 1.2 | 5.0 | 12.5 | 19.7 |
| 18 | 1.0 | 40 | 37.4 | 34.6 | 1.8 | - | 1.0 | 2.6 | 6.5 | 11,9 |
| 19 | 1.2 | 40 | 36.2 | 33.4 | 2.0 | - | 0.8 | 3.8 | 9.5 | 14.8 |
| 20 | 1.2 | 40 | 39.2 | 34.0 | 2.6 | - | 2.8 | 0.6 | 1.5 | 12.2 |

**Table 2:** Tomato Transit Loss Assessment (Rectangular Basket)

| Basket S/No | Basket Wt (kg) | Farmgate Tomato Net Wt (kg) | Market Tomato Net Wt (kg) | Fresh Marketable Tomato (kg) | Damaged Tomato (kg) | | | Wt Loss (kg) | % Wt Loss | % Transit Loss |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Hookean Level | Non Hookean | Visco Plastic Level | | | |
| 1 | 2.2 | 25 | 24.25 | 23.55 | 0.4 | 0.3 | - | 0.75 | 2.0 | 5.0 |
| 2 | 2.2 | 25 | 24.8 | 23.95 | 0.6 | 0.25 | - | 0.20 | 0.8 | 3.2 |
| 3 | 2.2 | 25 | 25.0 | 24.25 | 0.5 | 0.25 | - | 0.0 | 0.0 | 2.1 |
| 4 | 3.0 | 25 | 23.6 | 23.40 | 0.2 | - | - | 1.4 | 5.6 | 6.2 |
| 5 | 3.2 | 25 | 24.0 | 23.2 | 0.6 | 0.20 | - | 1.0 | 4.0 | 6.3 |
| 6 | 2.5 | 25 | 24.3 | 23.9 | 0.4 | - | - | 0.7 | 2.9 | 3.9 |
| 7 | 2.6 | 25 | 24.2 | 23.75 | 0.45 | - | - | 0.8 | 3.2 | 4.5 |
| 8 | 2.6 | 25 | 24.6 | 24.20 | 0.6 | - | - | 0.4 | 1.6 | 2.7 |
| 9 | 3.0 | 25 | 24.6 | 23.90 | 0.6 | 0.10 | - | 0.4 | 1.6 | 3.6 |
| 10 | 2.6 | 25 | 24.2 | 23.45 | 0.75 | - | - | 0.8 | 3.2 | 5.3 |
| 11 | 2.4 | 25 | 24.1 | 23.70 | 0.4 | - | - | 0.9 | 3.6 | 4.7 |
| 12 | 3.0 | 25 | 24.8 | 24.00 | 0.8 | - | - | 0.2 | 0.80. | 3.1 |
| 13 | 2.4 | 25 | 25.0 | 24.10 | 0.6 | 0.30 | - | 0.0 | 0.0 | 2.6 |
| 14 | 2.2 | 25 | 24.8 | 24.20 | 0.6 | - | - | 0.2 | 0.8 | 2.5 |
| 15 | 2.6 | 25 | 24.6 | 24.20 | 0.4 | - | - | 0.4 | 1.6 | 2.7 |
| 16 | 2.9 | 25 | 24.4 | 24.00 | 0.4 | - | - | 0.6 | 2.4 | 3.5 |
| 17 | 2.4 | 25 | 24.5 | 23.50 | 1.0 | - | - | 0.5 | 2.0 | 4.8 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 18 | 2.2 | 25 | 25.0 | 24.20 | 0.8 | - | - | 0.0 | 0.0 | 2.3 |
| 19 | 2.4 | 25 | 24.7 | 24.40 | 0.3 | - | - | 0.3 | 1.2 | 2.0 |
| 20 | 2.2 | 25 | 25.0 | 24.80 | 0.2 | - | - | 0.0 | 0.0 | 0.6 |

## CONCLUSION

Post-harvest transit losses of tomato in the two packaging systems were assessed and the following conclusions are hereby drawn:

i) There was high tomato loss in transit with the conical basket when compared with the rectangular basket. Thus, the rectangular basket stands superior in mass transportation of tomato.
ii) The conical basket suffers from tomato overloading which contributed to more tomato weight loss.

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