Improving Handling Systems of Tomato (*Solanum lycopersicum*) in Cameroon

ABSTRACT

In Cameroon, tomato (*Solanum lycopersicum*) is among the most important fruits with a consumption of about 35%. A 5-months study was conducted in two tomato production basins, namely Tsinfou and Litieu. This study aims to reduce postharvest losses of tomato for contribute to increase income and standard of living of producers in the Menoua division. The postharvest technics adopted by producers, transporters and traders were identified through investigations and direct observations. The rate loss of tomato and its deterioration over a certain period of time were evaluated. Also, the type, nature and causes of these postharvest losses were determined. The results from this study show that, inappropriate post-harvest technics are practiced in all links of the supply chain. The average rate loss during harvest, transport, conservation is 7.50%, 6.50% and 35.50% respectively. They are caused by mechanical, biological and microbial actions, environmental and socio-economic factors. These losses reduce actor's incomes and the availability of tomatoes on the market, hence the inaccessibility for poor citizens. Avoiding overloading and mixed transport of tomato crates with other products and using planks in lorry to overlap crates to minimize compression are two technics implemented by this study for reduce tomatoes postharvest losses. Establishment of affordable processing and conservation units, qualified workforce and maintaining a good state of roads should be adopted.

Keywords: Postharvest losses, Supply chain, Handling, Transport, Tsinfou, Litieu.

1. INTRODUCTION

As a result of a global increase in food demand due to increase in world population and the particularity of fruits and vegetables, an estimated 500 million small farmers are now producing 80% of the world's fruits and vegetables, yet over 40% are never consumed but lost during postharvest handling [1]. In 2011, Rockefeller Foundation Africa estimates that in the Sub-Saharan Africa, 50% of fruits and vegetables are lost.

In Cameroon, although fruits and vegetables (tomatoes, carrots, cabbage, leek, etc.) are discarded (25-30%) after harvest, the production of horticultural crops has been on the rise these past years due to cultivation technologies used [2]. These losses vary depending upon the type of produce, handling practices throughout the supply chain. Amongst the practices, harvest marks the beginning of the deterioration process and the longer the crop is stored without use, the lower will be its quality [2]. About 815 millions of persons in the world suffer from hunger and 45% of infant less than 5years old die of illnesses (diarrhea) linked to alimentary issues and malnutrition [3]. By 2050, the world population will increase by 2 billion people, that of Central Africa will increase by a factor of three. In this context of galloping demography where 54% of the population lives in urban areas, this proportion will increase to 65% by 2050. Faced with this strong increase in the world population in general and in urban areas in particular, a major problem is that of urban food security. The agricultural sector in Cameroon is the backbone of the economy as it employs over 70% of the total population [4]. According to [5] in 2007, the agricultural sector contributes to over 45% of

Gross Domestic Product (GDP). Food crops ensure food security and fight against poverty especially in rural areas [6].

According to food and agricultural organization (FAO), during a research on Food Security and Livelihood (FSL), postharvest losses was recognized as an area of attention to improve agricultural productivity, linkages between farmers and markets [7]. In west Cameroon, Bafou is a production basin of fruits and vegetable crops which supply most neighboring town markets. Tomato as one of these crops has a consumption of about 35% in Cameroon [8]. Tomato is used in most meals as its rich in vitamin A, C and E. Tomato is subject to losses from the fields by biological and microbial action (snails, birds, insects, etc.) as well as inappropriate technics (harvesting at incorrect time of the day) used during its handling [9]. Despite precautions taken (sorting and grading in shaded areas as a form of pre-cooling), postharvest losses are still very high [10,11]. This is because, the revenue and standard of living of the population are low and they can't afford expensive postharvest practices within the supply chain such as the use of refrigerated systems. Hence, analyzing the post-harvest handling practices of tomato will be an approach on providing adequate information to reduce PHL, thereby realizing agriculture's full potential to meet the world's increasing food and energy needs.

The aim of this study was to identify the local post-harvest handling practices used by producers and the repercussions on post-harvest losses of tomatoes in the production basin of Tsinfou and Litieu, by characterizing the practices used and evaluation of the rate loss during harvest, transport and conservation.

2. MATERIAL AND METHODS

2.1 Area of the study

This study was carried out in the west region of Cameroon, more precisely in Bafou situated between latitude 5°20' and 5°27' North of the equator and between longitude 10°03' and 10°06' East of the Greenwich Meridian. Bafou is a village in the Nkong-Ni subdivision and of the Menoua division, covering a total surface area of about 175km^2. Bafou has a tropical climate characterized by average temperatures ranging from 18 to 25°C and abundant rainfall of about 1500 to 2500mm. this climate type alongside a fragmented relief with lowland soils, has made it one of the largest tomatoes production basin in the Menoua division.

2.2 Characterization of post-harvest practice

2.2.1 On-farm post-harvest practice

An on-farm investigation was carried at the production basin in Litieu and Tsinfou in order to characterize the practices that are common to producers of tomatoes in the locality with respect to the post-harvest treatments given to the fresh product from harvest to transport. An observation was made on the basis of some element of appreciation in Table 1, which are commonly being used,

Table 1: Elements used to characterized on-farm post-harvest practices

Post-harvest activity	Harvest	Sorting and grading	Packaging	Transportation	Storage
Elements of appreciation	Stage of maturity at	Sorting conditions or	Packaging environment	Farm to road description	Nature of storage

	harvest	environment		and means used	used
	Harvesting time of the day	Grading and sorting criteria	Package description	Road to market description and means used	Reigning conditions in warehouse
	Harvesting technology	/	Packaging criteria	/	/
	Labor type	Labor type	Labor type	Labor type	Labor type

2.3 Quantification of postharvest losses of tomatoes

2.3.1 Harvest and on-farm transport

In order to diagnosed post-harvest losses and an appreciation of tomato production, so as to be able to suggest better ways of maintaining quality and extend shelf life of the fruit [12,13]. The ratio of mechanically damaged tomatoes to total tomatoes (on the weight basis, that is; the masses of total fruit and the damaged discarded fruits, were measured with a balance) both at harvest and after transport was calculated. This ratio was calculated for 15 crates of harvested tomatoes and 15 other crates of tomatoes that had been transported to the road (on-farm transport) to be loaded into Lorries. This was done for three harvesting days.

$$R_{LT} - \frac{M_{LT}}{M_T} * 100 \qquad \text{Equation 1}$$

Where:

R_{LT} = rate loss of tomatoes (%)
M_T = total mass of tomatoes (kg)
M_{LT} = total mass of lost tomatoes (kg)

2.3.2 Conservation

For conservation, an amount of 60 freshly harvested tomatoes of diameter between 50-60mm were measured on-farm with the help of a venire caliper and kept in a conducive environment (similar to a warehouse as used by producers). Before being placed in the atmosphere, the fruits were disinfected and wash with clean water and later on, the mass of each tomato was measured with a small dish, balance and placed in a shelves in two sets off 30 tomatoes each, with their known masses recorded (Figure 1).

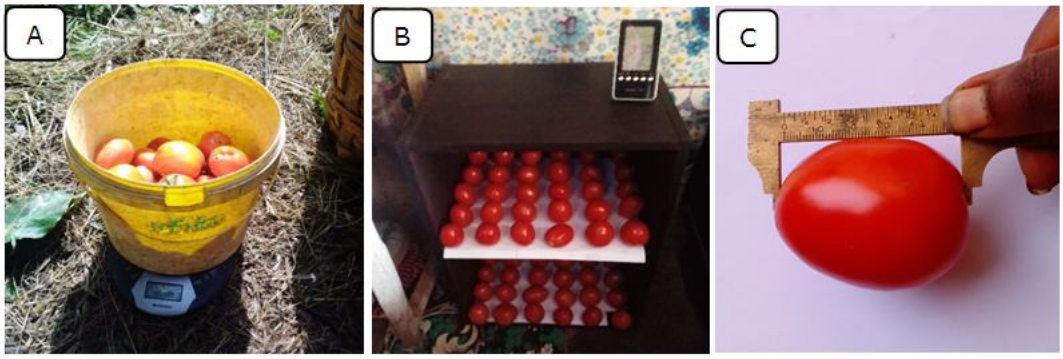

Figure 1: Weighing (A), shelf for conservation (B) and grading (C)

Every day, during a conservation period of 52 days, a thermo-hydrometer was used to obtain the ambient conditions (temperatures and relative humidity) of the room where tomatoes were stored. As the masses were measured before the storage began, each time a fruit was spoiled the corresponding mass was recorded. Equation1, is then again used. This was done twice.

2.4 Data analysis

The software Excel2016 was used to produce histograms presenting the rate of tomatoes post-harvest losses during each stage of post-harvest system.

3. RESULTS AND DISCUSSION

3.1 Characterised post-harvest practices

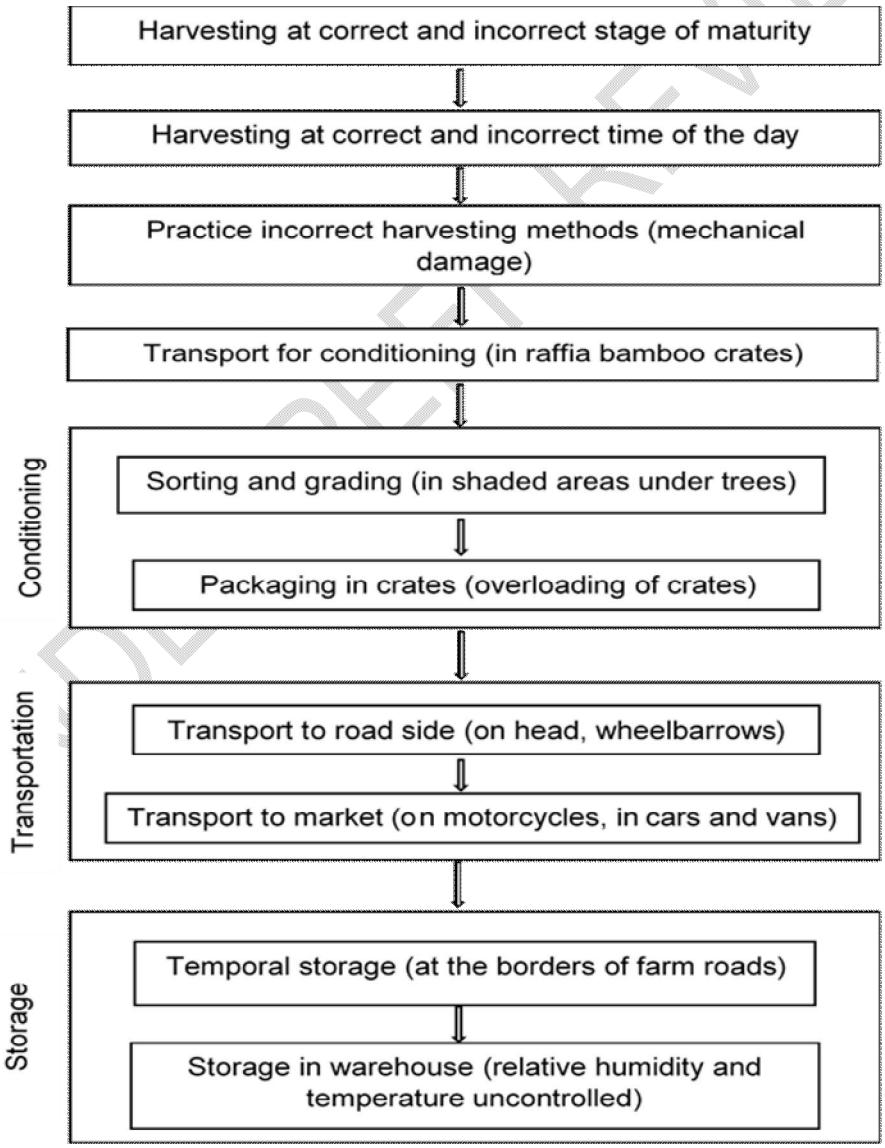

Figure 2: Flow chart of tomatoes postharvest system

3.1.1. On-farm harvesting, sorting and packaging

Harvesting of fresh tomatoes in the production basin is done manually (Figure 2), with producers harvesting the fruits at varying stage of maturity (half ripe, over ripe, mature green and turning pink). Harvesting is done throughout the day from 7am to 4pm giving the limited labor force for harvesting made up of a majority of women and children. Findings of [14] on harvesting time of the day of fruits and suggested the early hours of the morning as being the best period for harvest, which in this case was not respected to it fullness.

Figure 3: Manual harvesting of tomatoes

Harvested fruits (Figure 3) are placed in locally made crates with raffia bamboo and are taking to shelters were temperatures are lower for sorting and grading. Under the shelters of trees, sorting is based on fruit size, maturity stage and on the injuries sustained by the fruit during the short transit to the shelters sorting and grading is mostly done by women.

Generally, the sorted and graded tomato fruits are mixed mostly by women into raffia bamboo crates (Figure 4) in that; at the bottom, middle and top are found small (partially ripe fruits), varied size (injured fruits) and large (ripped fruits) and covered by dry grass. Such packaging is not taking into consideration the nearby markets and the distant markets. Special consideration is to be made for distant markets like; loading crates destine for distant market only with partially ripe fruits [15]. Again, the fruits are not clean nor washed before packaging due to the non-awareness of the farm holders and non-availability of clean water. Inappropriate crates and overloading are very frequent during packaging as some tomatoes' crates are placed on top of others. This is not in accordance to [16] where clean, smooth and ventilated crates are used to prevent mechanical injuries and spoilage.

Figure 4 : Sorting and grading (A) and Packaging (B)

3.1.2. Transportation

The crates when loaded are weighing between 20-35kg and are transported by men in wheelbarrows (Figure 5B), motor cycles, trucks and on their head (Figure 5A) from sorting and packaging sites to the road, where the crates are temporally stored/kept under ambient conditions in wait to be loaded into lories (Figure 5D), cars (Figure 5C) and vans to be

transported again to the different markets. due to the nature of the routes leading to the main roads and the transport means used, the harvested and packaged fruit suffer from a lot of mechanical shock, vibrations and frictions which contribute to further damage within the packaged crates. The temporal on-road storage of the fruits coupled to the heat produced due to high metabolic activities taking place within the fruit, favors the short shelf life of the fruits.

Figure 5: On-farm transport to road (A), raod transport by rickshaw (B), road transport by car (C) road transport by lorry (D)

3.1.3. Conservation

Conservation was done in an environment where the reigning average temperature and relative humidity ranges between 18-22°C and 72-86% respectively for 52 days.

3.2 Quantified tomatoes post-harvest losses

3.2.1 Harvest and transport

During harvest, the mean mass of tomatoes per crate, mass of undamaged tomatoes and damaged tomatoes are 13.77kg, 12.73kg and 1.03kg respectively, whereas during transport they are of 14.81kg, 13.84kg and 0.97kg. These differences can be due to the calibrations and selections that are done on each crate during packaging, where some damaged injured fruits are discarded and the crates filled with undamaged fruits before being transported. Also the fruits suffer a lot of handling damages from harvest to before packaging than during transport.

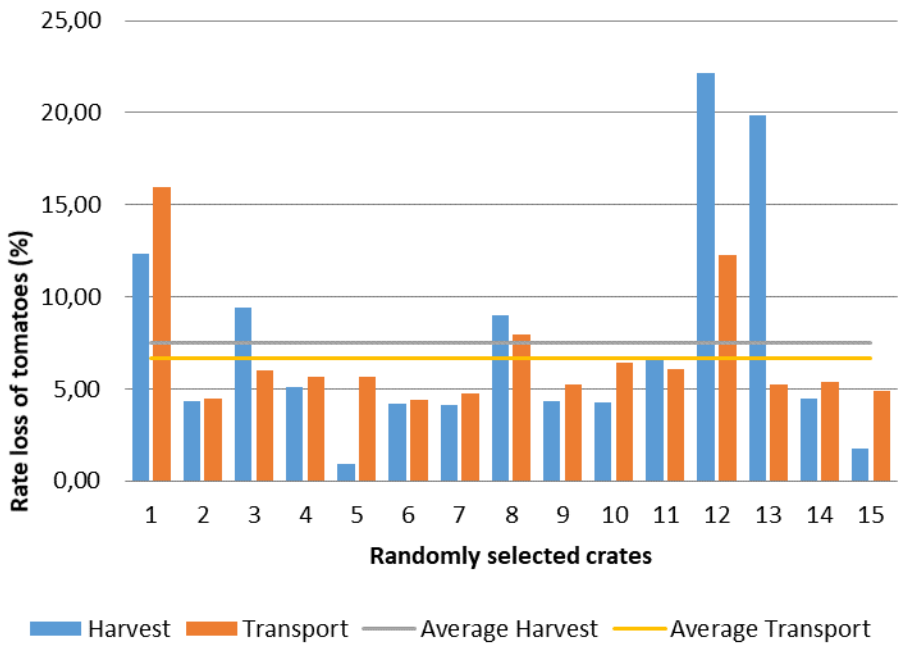

Figure 6: Rate losses at harvest and on-farm transport

The evaluation by weighing rate of tomatoes shows that the mean rate loss of tomatoes during harvest is 7.50% (Figure 6), higher compared to 5.30% rate loss from the production basin in Mbouda [17] but lower to 6.20% loss rate found by [18] for most African countries (including Cameroon). Comparing the rate losses obtained to those recommended, we noticed that the rate loss of tomatoes is higher than those recommended as a result of the tomatoes being influenced by several factors (mechanical, biological and environmental).

Rate loss with regard to transport had a mean value of 6.50% (Figure 6), which is lower to 8.80% and 20.00% rate loss in Mbouda production basin and African countries, as reported by [17] and [18] respectfully. Losses during harvest are always greater than after on-farm transport because, the different harvester do not know on what basis to harvest and the fact that they throw the fruits to ground before sorting is done.

3.2.2 Conservation

During 52days of conservation, it was observed that the rate loss varied a lot with (Figure 7) peak loss (13.79% per 4days) recorded from the 25th day to the 28th day and a minimum loss rate (2.77% per 4 days) recorded towards the last days from 49th day to the 52nd day with an average loss rate of 7.25% per 4 days.

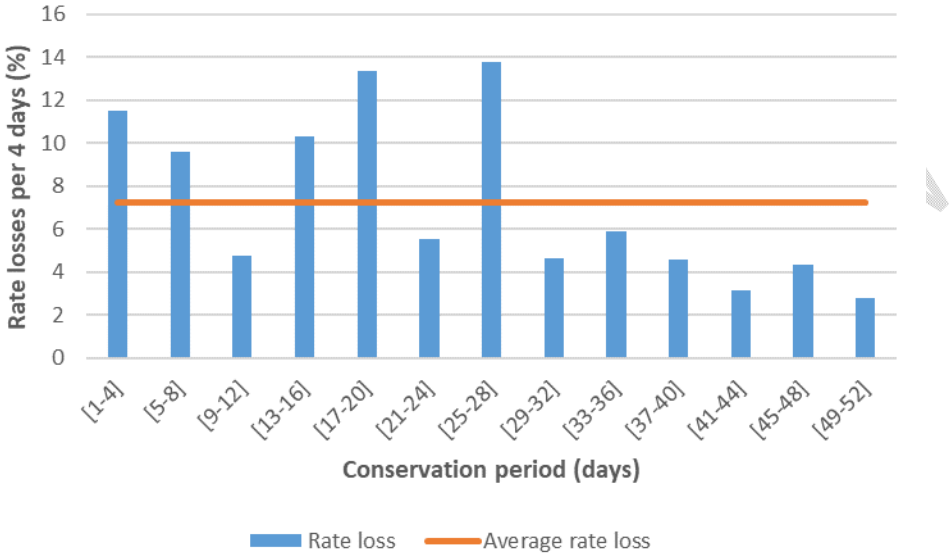

Figure 7: Rate losses due to conservation for 52 days

The rate loss during conservation (7.25% per 4 days, which is 1.81% a day) was less than that during harvesting (7.50% a day) and transport (6.50% a day) in that, a lot of mechanical shocks coupled to the hash environmental condition under which the tomatoes were harvested and transported compared to a more stable environment in which the conserve tomatoes enjoyed. It should be noted that the deterioration or the damaged of the fruits during conservation was mainly due to physiological and infestation causes than mechanical injuries, this corroborates the results of [19,20].

4. CONCLUSION

This study conducted in the Litieu and Tsinfou production basins aimed to reduce post-harvest losses in tomatoes in the Menoua department. The results made it possible to understand the causes of losses in the supply chain from the farm to the consumer's table. These results showed that due to poor post-harvest practices like inappropriate harvesting time of the day and maturity stage alongside poor grading and transportation infrastructure, made tomato fruits suffered average rate losses of 7.50%, 6.50% and 35.50% during harvest, transport and conservation respectively. This study implemented several actions to reduce tomatoes postharvest losses. These actions include avoiding overloading and mixed transport of tomato crates with other products with a view to minimizing shocks and accelerating the ethylene reaction; and the use of planks to overlap crates to minimize. Future research could evaluate the chemical and biochemical factors that influence tomatoes post-harvest losses.

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