Smoothing tomatoes’ bumpy ride to market

Potholes and other road hazards are not only the bane of motorists’ lives; tomatoes, too, suffer when they are transported across rough surfaces over long distances.

**Tomatoes are one of consumers’ favourite foods.** According to the Food and Agriculture Organization of the United Nations (FAO), it is the second most widely cultivated fruit in the world. Tomatoes are also good for us because of their high levels of antioxidant compounds. Although South African tomatoes are largely grown for domestic consumption, their road to market is not a smooth one. The way they are handled once they’ve been harvested is the greatest hazard to the quality and shelf life of tomatoes.

Post-harvest losses are caused by mechanical injuries, inadequate storage, unsuitable handling and transport, and the length of time they are left on display in retail outlets. The physical damage they suffer as a result may cause metabolic and physiological changes that negatively impact on flavour, smell and firmness. Physical damage may also significantly affect the chemical and physical composition of the pericarp and locular tissue of tomatoes.

The incidence and severity of damage suffered depends on the impact energy, number of impacts, cultivar and ripening stage, all of which adds up during a tomato’s post-harvest life.

It stands to reason, therefore, that better management of transport logistics as well as handling practices between field and consumer, should result in better quality tomatoes with a longer shelf life.

Technologies that have been developed to curb post-harvest losses include use of 1-MCP to delay ripening, hot water rinsing and brushing to slow down decay, a short anoxia/ hypoxia treatment to reduce decay at relatively high storage temperatures, and coating to reduce physiological deterioration.

Of all the potentially damaging activities, transport seems to be particularly troublesome in South Africa. The rural road network – on which most farmers depend – is in a poor state, with poor roads that lead to transport delays. Furthermore, tomatoes are left exposed to the elements for too long at storage temperatures that are not optimal.

Previous studies have noted that, depending on the harvest sites, tomatoes can travel up to 128km before removal of field heat starts, in certain instances the situation is aggravated when the tomatoes are not transported to the packhouse as soon as they have been picked. From the packhouse, the tomatoes are commonly transported in non-refrigerated vehicles to fresh produce markets, representing a break in the cold chain.

Despite the fact that the post-harvest stresses that tomatoes are subjected to are well documented, there is no model that relates the damage incurred during transit to the shelf life of tomatoes. Having identified this gap, Prof. Tilahun Workneh, of the Department of Agricultural Engineering at the University of KwaZulu-Natal, secured PHI Programme and industry funding for a study that would evaluate the quality losses in a South African tomato supply chain due to transportation and handling practices.

**Project scope and objectives**

The project scope covered post-harvest handling and road transport activities from the field to the fresh produce market. The scope was broken down into seven objectives:

1. Measure and quantify the stresses and strains exerted on tomatoes during a range of transport conditions (speeds, packaging types, vehicle types, etc.).
2. Develop deterioration models that can be used to predict quality losses under different supply chain conditions.
3. Refine an existing model for the management of the transport logistics chain of post-harvest tomatoes to be relevant to South African conditions.
4. Develop integrated post-harvest treatments and handling methods to extend the shelf life of tomatoes.

**Methodology**

Tomatoes for analysis were sourced from ZZ2 farms in three regions of the Limpopo province. ZZ2 is South Africa’s single largest producer of tomatoes. Mohale Farming within the Letaba Municipality in Limpopo was the emerging farmer whose participation ensured that the data generated from the study would represent the full spectrum of tomato producers.

Two experimental trials, one during...
Tomatoes

Prof. Wyand Steyn, from the University of Pretoria, conducted road profiling and testing to measure surface roughness, texture and rutting at road and highway speeds. Lugs filled with tomatoes are stacked on a trailer on their way to the packhouse. Accelerometers and pressure mats were used to measure the frequencies that tomatoes were exposed to while in transit. Road conditions were evaluated separately, along with the effect of road conditions on the vehicles used.

Harvested tomatoes at three maturity stages were transported over three supply roads, each in a different condition, to the Pietermaritzburg fresh produce market depot. From there they were transported to the laboratory and assigned different treatments under a completely randomised design. The treated tomatoes were stored under either ambient or controlled temperature (11°C) conditions for 30 days. During this time, the tomatoes’ firmness, colour, pH, titratable acidity, marketability, total soluble solids, total bacterial counts, electron microscopy imaging, sugar and bioactive compounds were measured and analysed.

Additionally, seven post-harvest treatments, individually and in different combinations, were used on all the samples. These included biocontrol B13 coating, gum arabic coating, hot water treatment, chlorine and electrochemically active water (anolyte). Sampling was done at selected intervals, and data collected will be analysed and used to develop shelf life and quality models.

Biochemical and chemical analyses of the samples were carried out using high-performance liquid chromatography (HPLC) and spectrophotometric methods. In this case, the parameters analysed included sugar content, ascorbic acid content and lycopene.

The induced damage is a function of the road condition, the period of time tomatoes are exposed to certain frequencies and the packaging method. Given that tomatoes transported in bins ripened faster and had more structural damage than those transported in cartons, it is clear that packaging choices during transport offer an important avenue to mitigate post-harvest losses.

Post-harvest disinfection and coating treatments have a significant impact on the quality of tomatoes stored under both ambient and refrigerated temperatures. Treatments that combined surface decontamination and bio-coating resulted in the best shelf life and quality for pink and red tomatoes. Hot water treatment delivered the best results for tomatoes harvested at the green-mature stage.

Results

In-transit pressures do affect the shelf life of tomatoes. The induced damage is a function of the road condition, the period of time tomatoes are exposed to certain frequencies and the packaging method. Given that tomatoes transported in bins ripened faster and had more structural damage than those transported in cartons, it is clear that packaging choices during transport offer an important avenue to mitigate post-harvest losses.

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Why the project matters

• Quantifying the impact that road surface quality has on the shelf life of tomatoes can help to determine transportation routes and incentivise/support the development of infrastructure.
• An improved understanding of transport conditions and their impact on post-harvest damage can increase the productivity of the tomato industry.
• An integrated approach to the post-harvest management of tomatoes can be achieved by combining treatment and handling best practices.
• The study delivered information that both large-scale and emerging farmers can use to improve their post-harvest operations.
• The quality deterioration model can be used as a tool to support decision-making in the tomato supply chain, and may be adapted to other supply chains.

The summer season tomato samples ripened and deteriorated faster than those grown in winter, which is expected from a biochemical and microbiological perspective. The maximum shelf life for tomato samples supplied during winter was 32 days, compared to 24 days for the summer samples.

• The quality deterioration model can be used as a tool to support decision-making in the tomato supply chain, and may be adapted to other supply chains.

When transported across rough surfaces over long distances, tomatoes may suffer physical damage resulting in metabolic and physiological changes that negatively impact flavour, smell and firmness of the fruit.

Prof. Tilahun Workneh

The rural road network – on which most farmers depend – is in a poor state of repair, and tomatoes are reaching the market the worse for it.

Tomatoes arriving at the Cape Town fresh produce market.