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論　文　の　要　旨

Afghanistan is regarded as one of the poorest countries due to the long lasting wars and conflicts, in addition to frequent attacks of drought or heat. The reconstruction of agricultural sector is, thus, the urgent priority. Vegetables are especially important to improve health condition of infants, elderlies, pregnant women, and so on which require highly nutrient dishes. The author investigated the current situation of tomato production and postharvest handlings in east provinces in Afghanistan, and tried to develop a new appropriate way to prolong postharvest freshness using green mature fruit being kept under higher temperatures.

Tomato (*Solanum lycopersicum* L.) is an important crop in Solanaceae family which has been widely used in both fresh and processed consumption patterns (Harvey et al., 2003), and its production has increased to approximately 182 million tons by 2017 (FAOSTAT, 2019) and shares 16% of total horticultural production in Afghanistan. Tomato contributes significant nutritional components to human health (Stommel, 2007), and has been documented as foods with potential chemo-preventive activities against several chronic diseases because of the high levels of lycopene and other bioactive compounds (Giovannucci, 2002). Maturity stage of tomato fruit at harvesting time is one of the important factors for storage life and final fruit quality (Alam et al., 2006). In developing countries, farmers usually harvest tomato fruit at the ripe stage, while it is considered that ripen fruit is easily damaged and resulted in shorter shelf-life (Watkins, 2006). Since tomato fruit is perishable (Javid Ullah, 2009), and contains a large quantity of water, it eventually leads to severe post-harvest losses in some cases.

The shortage and instability of electricity and lack of proper cold storage are sometimes shelf life limiting factors for several fruits and vegetables in Afghanistan. In addition, because tomato is cold susceptible, low temperature storage might decline the fruit quality (Soto et al., 2005).

One of the possible solutions for these challenges to minimize tomato fruit damage during

transportation and to restart ripening in retail channels is to harvest tomato fruit at green mature stage. Lurie and Sabehat, (1997) reported that the storage of green mature tomato fruit at 38 ^{0}C prior to 2 ^{0}C storage could remove chilling injury development for up to 30 days without causing heat injury. Ogura (1975) stated that the storage of green mature tomato fruit at 33 ^{0}C for 5-33 days could prolong its postharvest freshness even when it was shifted to room temperature, though he did not show the physiological mechanism.

Since the limited researchers have investigated on post-harvest handling and physiology of green mature tomato fruit under high-temperature storage, this study aims to evaluate the physiological characteristics of green mature tomato fruit to determine the most suitable temperature and duration of high temperature storage.

The results suggest that the suppression of color development of green mature tomato fruit occurred during storage at higher temperatures; among the tested higher temperatures as 25, 29, 33, and 37 ^{0}C, the 37 ^{0}C inhibited the color formation most comparing to the other temperatures, even after shifting to 25 ^{0}C.

The weight loss of the tomato fruit was the lowest at 25 ^{0}C, and the higher the temperature, the more the weight loss.

The decreasing of tomato fruit firmness was faster when stored in higher temperatures, but it rather initiated to increase little by little after 1-month storage. The fruit peel seemed to be harder after losing some amount of water. It might be so-called “concentration effect,” where some water was lost and the fruit became harder.

Ethylene production was inhibited by the storage under 33 ^{0}C for a variety of durations in comparison with 25 ^{0}C. The ethylene production was suppressed at higher temperatures, but whenever shifted to 25 ^{0}C, it rapidly increased in case of 10, 20, and 30 days storage at 33 ^{0}C.

The result of respiration was similar to the findings of Ogura et al. (1976); 33 °C storage before shifting to 25 ^{0}C resulted in the suppression of respiration in tomato fruit.

Brix value was lowest in the fruit stored at 25 ^{0}C and the higher the storage temperature, the higher the Brix value. It may well be attributed to the “concentration effect”; the more water was lost, the higher the relative sweetness.

Effect of high-temperature storage on ascorbic acid of green mature tomato stored in 25, 29, 31, 33 and 35 ^{0}C after harvest, the 33 ^{0}C storage showed the best among others.

Ethylene production was inhibited by the storage under 33 ^{0}C in comparison with 25 ^{0}C along with the decreased level in ACC content and the deactivation of ACC oxidase.

Based on the above results, the author suggests that to harvest green mature tomato fruit can be practical to bear long time transportation to sell them to far distant market, while it is better to harvest at the fully ripe stage tomato fruit to maximize nutritional value in case of local markets.

This work might contribute to the harvesting operation in summer season and help the storekeepers to enhance their income and ensure food security through reduction in post-harvest losses.

文要要旨

アフガニスタンは長年の戦争によって国土が荒廃し、世界の最貧国の一つに数えられている。それゆえ農業基盤の再建は急務の課題であり、特に緑黄色野菜の供給が、乳幼児や高齢者、周産期女性とはじめとする人々の健康維持にとって重要である。著者はアフガニスタンの園芸作物の中で１６％のシェアを占めるトマトの栽培状況、収穫後の取扱いについてフィールド調査を行い、高度な貯蔵施設を必要としない緑熟期トマトの高温貯蔵について研究を行った。緑熟期のトマト果実は、機械的な損傷に対する抵抗性が高く、アフガニスタンのようなインフラストラクチャーが未整備の途上国では輸送中のロスを軽減するのに有利である。

著者はまず、緑熟期トマトの貯蔵性について、２５℃、２９℃、３３℃、３７℃、４１℃で貯蔵実験を行い、３３℃貯蔵が最もすぐれていることを見いだした。

緑熟期トマトを３３℃で２０日以上貯蔵すると、エチレンの前駆体であるACC含量やACCオキシダーゼ活性が低下し、エチレン生成が抑制されるが、これらの果実を２５℃に戻すと、エチレン生成能力が回復し、果実の成熟が再開することが明らかとなった。ただし、７０日以上の長期貯蔵では、２５℃に戻しても、エチレン生成能力は回復しなかった。

果実の糖度と酸度は３３℃貯蔵の方が２５℃貯蔵よりも高くなったが、これは水分損失が大きいことによる濃縮効果であると考えられた。３３℃貯蔵により、水分損失ははじめ大きいものの、２０日以上の貯蔵である程度水分を失うと果皮の硬度が増加するため、２５℃貯蔵との差はわずかであった。糖や有機酸含量が増加したのは、いわゆる濃縮効果によるものと考えられた。

果実の外見に関しては、３３℃以上の高温で貯蔵した場合、２５℃に戻しても、赤色色素の蓄積は抑制され、果実は黄色がかった色となり、カロチノイド合成系の中でも、高温で抑制される経路とそうでない経路があると推察された。

これらの研究の結果、輸送や貯蔵中における物理的損傷が少ない緑熟期トマトを収穫して高温下で半年以内を目安に貯蔵を行い、市場価格や流通量にあわせて出荷することが実用的観点から推奨されるといえる。本研究の成果は、低温貯蔵施設を有しない地方の小規模な農家でも利用可能な技術であり、アフガニスタンのような発展途上国におけるトマトの収穫後貯蔵･輸送技術の改善、農業所得の向上、栄養環境の改善に対する貢献が期待される。