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IMPACT OF STORAGE ON VARIATIONS IN VOLATILES, ESSENTIAL PHYTONUTRIENTS AND MINERALS IN AGGREGATUM ONION

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Abstract

This study was carried out from 2020 to 2023 at Anbil Dharmalingam Agricultural College & Research Institute (Tamil Nadu Agricultural University), Tiruchirappalli, Tamil Nadu, India, with the indigenous aggregatum variety. Growers in southern India, particularly in Tamil Nadu, traditionally store aggregatum onions in conventional storage structures for up to 6 months. During the 30-day preservation period, certain phytonutrients were examined. Quercetin is an important phytonutrient that decreases after 30 days of storage, dropping from 11.1 to 1.11 mg/kg. Similarly, selenium levels decreased from 150.6 to 80.04 µg/g. Additionally, GCMS/MS was used to evaluate the metabolites during the initial and 30-day storage periods. Beneficial metabolites were dramatically reduced, with 17 different metabolites lowered after 30 days of storage. This study focuses on the loss of essential phytonutrients during the storage of aggregatum onions in typical storage structures, which has tremendous impacts on their quality.

Aggregatum onion (*Allium cepa* L. var. *aggregatum* Don.) also referred as multiplier onion, is popular in southern India, particularly Tamil Nadu. Aggregatum onions are typically planted between April and May and harvested between October and November. Onion is known to be highly perishable items as it contains 89% water. Farmers in Tamil Nadu use traditional storage structures for storing aggregatum onions which is being supplied to market when there is an increased demand. Most of these structures lack sufficient ventilation and have a higher loading height, resulting in greater storage losses. Aeration and air circulation in bulk storage are inappropriate and very inadequate, resulting in an increase in storage temperature, which negatively affects the physiology and pathology of the stored product (Dabhi *et al*. 2008). The onions stored in these structures frequently display deterioration due to increased humidity and post-harvest infections, leads to 15% to 30% yield loss. Efficient onion storage structure is essential for increasing its availability throughout the year in addition to nutrient retention without loss in quality (Sharma and Lee 2016).

This study mainly focuses on the alteration of phytonutrient (quercetin) content upon storage in onion. Quercetin, a flavonoid found in various fruits and vegetables, is recognized for its antioxidant properties and potential health benefits. Selenium is an essential component of a group of enzymes and proteins known as selenoproteins. It is vital for thyroid hormone metabolism, DNA synthesis, reproduction, and defense against oxidative damage and infection. Therefore, it is critical to investigate the quality of aggregatum onion and the changes in the concentration of essential phytonutrients during storage.

The present study was conducted at Anbil Dharmalingam Agricultural College & Research Institute (TNAU), Tiruchirappalli during 2020 to 2023. The indigenous aggregatum onion samples were collected from the traditional storage structures located in the farmer's field at Perambalur

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district, Tamil Nadu by following proper sampling procedures. The collected samples were first cleaned, cut into small pieces, dried in an oven for 72 hrs at 40ºC. Liquid nitrogen was used to deep freeze the dried onions, which were subsequently ground into a fine powder using a mortar and pestle in preparation for additional biochemical analysis.

The phytochemical screening of aggregatum onion samples were performed with Rtx-5 GC fused silica column cross linked with diphenyl dimethyl poly siloxane phase, with the single quadrupole mass analyzer (Agilent, USA). The flow rate of carrier gas was 1 ml/ min and 2 µl injection volume. The mass to charge ratio (m/z) was set at 50-550 amu and the source and inlet temperatures were set to 250 and 290°C, respectively. The findings of the MS were interpreted using the NIST database, and the spectrum of unknown substances were compared with known samples contained in the library database (Sahni *et al.* 2014).

A ten-gram powdered onion sample was homogenized with 25 ml of 100% methanol. Samples were vortexed and placed in a sonicator and centrifuged. The supernatant was filtered using syringe filter and then put into an HPLC system (Agilent Technologies 1100 Series, USA) for quercetin analysis. Shimpack C18 column (5 µm, 250 × 4.6 mm particle size) was used to distinct different forms of quercetin at a temperature of 30^{o}C. The mobile phase was a mixture of 6% acetic acid in 2 mM sodium acetate with a final pH of 2.55, v/v (solvent A) and acetonitrile (solvent B). The sample was run for 90 minutes with the thermostat set to 5^{o}C. The chromatogram was checked for the presence of quercetin by comparing the retention time of the samples to the quercetin standard (Tsao and Yang 2003).

Ten gram of the powdered onion sample was turned into slurry with double distilled water. Specifically, 0.5 g of onion slurry was (added with 5 ml of HNO_3 + 5 ml of H_2O_2) transferred to the microwave digester and heated at 200^{o}C for 15 minutes. The contents were chilled at ambient temperature and subjected to ICP - OES for selenium analysis. It was measured and compared to the selenium reference wavelength of 196.026 nm (AOAC 2019).

All analysis were performed in triplicates, and the data are shown as mean ± standard deviation on a dry weight (DW) basis. The data is tested with one-way analysis of variance (ANOVA) using Duncan's Multiple Range Test (DMRT) (version 26) in SPSS statistics.

The post-harvest storage losses of bioactive components in native aggregatum onion bulbs were investigated on the very initial day (0^{th}) and after 30 days of storage to determine the freshness and quality.

Metabolites were compared before and after 30 days of storage. As shown in Fig. 1 one-third of the metabolites were lost throughout the 30-day storage period. Sugar derivatives, carboxylic acids, saturated and unsaturated fatty acids, and additional compounds are commonly eluted in the GC MS/MS. This indigenous cultivar revealed 37 distinct metabolites in GCMS/MS immediately following harvest. However, after 30 days of storage, the number of metabolites was reduced to 20. Fourteen of the 20 chemicals shared similarities with the initial period, whereas 6 were novel *viz*., 1-Butanol, 3-methyl- acetate; 2-Butanone, 4-hydroxy-3-methyl-; 2-Benzyl-2-methyl-1,3-oxathiolane; Piperidine, 1-(1-pentenyl)-; 3(2H)-Furanone, 5-methyl-2-octyl-; and 4-(Aminomethyl)-1-benzylpyrrolidin-2-one. Despite the fact that various cholesterol-lowering compounds, such as 5-(Hydroxymethyl)dihydrofuran-2(3H)-one and Ethyl propionylacetate, were eluted during the initial harvest period but not after 30 days of storage. Furthermore, a loss of numerous beneficial metabolites was also noted during storage. Water losses, sprouting and rooting occurrences, and chemical composition changes all have a significant impact on the quality of onion bulbs during storage. Carbohydrate content is greatly reduced during storage owing to increased respiration, which results in higher nitrogen and protein content in the dry

matter. Hence, good storage facilities with temperature control are required to keep harvested onion bulbs stable.

The amount of quercetin detected in indigenous variety immediately after harvest (0^{th} day) was 11.11 (mg/Kg DW) with a retention time of 65.3 minutes and after 30 days, the amount of quercetin was reduced to 1.11 mg/Kg DW with a retention period of 64.5 minutes. The study of quercetin by UHPLC method in indigenous cultivars confirmed quercetin post-harvest loss. He post-harvest storage loss of quercetin is represented in Fig. 2.

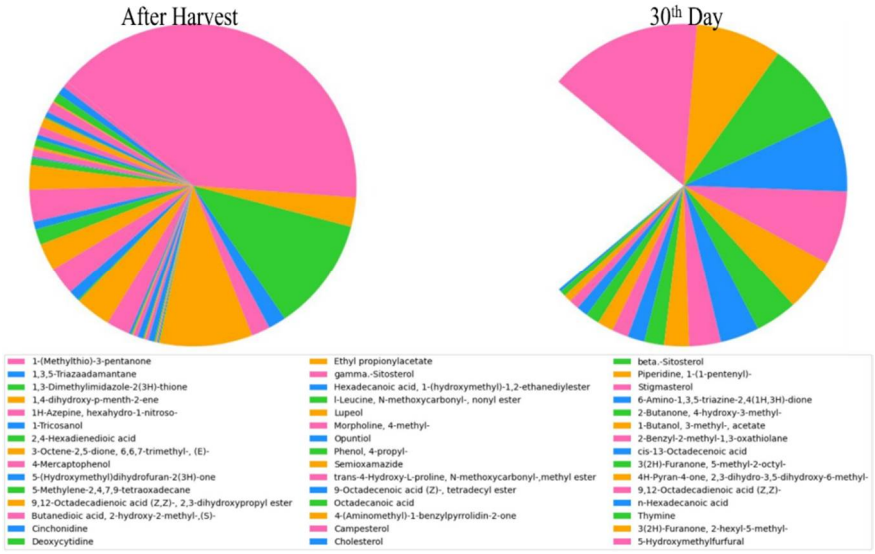

Fig. 1. Comparison of metabolites in the aggregatum onion after harvest and 30 days of storage.

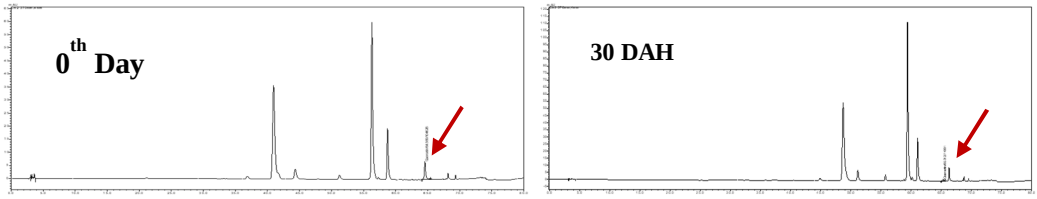

Fig. 2. UHPLC quercetin chromatogram (marked in red) of Perambalur Local variety at 0^{th} and 30 DAH
DAH - Days after harvest

Table 1. Loss of selenium content during storage.

Mineral	Wave length (nm)	Conc (µg/g)		RDA
		Initial	30^{th} Day	50 - 100 µg
Selenium	196.026	150.6 ± 3.9	89.04 ± 1.8	

Means in each column followed by the same letter were not significantly different (P< 0.05) as determined by the one-way ANOVA and Duncan's Multiple Range Test (DMRT). Values were the means of three replications ± standard deviation.

*The Recommended Dietary Allowance for selenium is indicated in the table (Vasudevan *et al.* 2019)

Selenium is a trace element that is essential for optimal health because it works as a cofactor for various antioxidant enzymes. Allium species are known to contain significant amounts of selenium (0.29 - 0.052 µg/g) and the RDA for the selenium (50 - 100 µg/day) is easily met out from the allium species. In this study, selenium levels were evaluated by ICP OES immediately after harvest (0^{th} day) and 30th day of storage and found to drop from 150.6 ± 3.9 to 89.04 ±1.8 µg/g. It shows that the selenium concentration in indigenous variety was decreased after the 30^{th} day. It was confirmed that there is a loss of micronutrients over the storage period. The onion undergoes dormancy breaking and eventual bulb degradation during storage at room temperature. Table 1 shows the amount of selenium detected in the study.

This study found that the amounts of quercetin and selenium in stored onions had declined. Similarly, key metabolites like as cholesterol-lowering chemicals were eluted in the indigenous variety immediately following harvest but not 30 days later. Therefore, the pathophysiology of nutrient losses and post-harvest storage losses in the aggregatum onion in conventional traditional storage structures should be taken seriously. Thus, farmers can adopt upgraded structures to limit nutrient losses and maintain quality while conserving indigenous features, and nutrient losses should be examined in depth in the future.

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