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# Biochemical analysis of low chilling apple varieties in Assam

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**Abstract**
The present experiment was conducted with 3 low chilling apple varieties viz., HRMN-99(V1), Dorsett Golden (V2) and Anna (V3) at the Department of Horticulture, Assam Agricultural University, Jorhat during 2023-24. The experiment was laid out in Randomized Block Design (RBD) with seven replications. For fruit biochemical parameters a statistically significant variation was observed with the highest TSS (11.53ºB), TSS: acid ratio (19.54), pulp: peel ratio (23.89) and juice content (40.59%) were recorded in V3. The highest anthocyanin (12.09 mg/100 g) and vitamin C (20.37 mg/100 g) were recorded in V1. The highest total sugar (5.73%) and shelf life (5.19 days) were noted in V2. Thus from the study, V3 (Anna) was found to be superior in terms of highest TSS while V2 (Dorsett Golden) had the maximum shelf life and V1 (HRMN-99) recorded the highest anthocyanin content.

**Keywords:** Low chilling apple varieties, biochemical, HRMN-99, Dorsett Golden, Anna

## 1. Introduction
Apple (*Malus domestica*) is one of the most important temperate fruit crop in the world and popularly known as the king of temperate fruits. It is grown in high latitude regions of the world where temperatures may reach upto-40 °C at high elevations (Janick, 1974) [8]. With a world production estimated to be 68.7 million tonnes in 2018, apples rank third worldwide among the fresh fruits traded (Iriarte *et al*, 2019) [7]. Genetic diversity in crop species can be determined using morphological and agronomic characteristics, as well as biochemical and DNA marker analysis (Liu, 1997) [13]. In India, the cultivation of apple is largely done in Jammu & Kashmir, Himachal Pradesh and Uttarakhand. Presently, there are more than 7,500 known cultivars of apples, with a wide range of fruit characteristics and climatic suitability. Apple cultivars are generally propagated by grafting onto favorable rootstocks, which determine the size of the tree. Generally, for most apple varieties the chilling hours required are 1000-1500 hr below 7 °C. After the bud break, during the growth, long day hours with high light intensity, warm days (not hot days) viz., 12-15 °C and cool nights (not freezing nights) viz., 7-8 °C are favourable for production of quality fruits. However, with the ongoing research, various low chilling varieties of apple have been developed that are suitable for growing in the tropical and sub-tropical climatic condition of the world. Low chilling varieties are those apple varieties which can be successfully cultivated in warm areas with around 200-300 hrs of chilling temperature (below 7 °C). Some of the Low Chilling Apple varieties are Anna, Tropical Beauty, Early Fuji, Tamma, Neomi, Parlin's Beauty, Golden Dorsett, HRMN-99 etc (Carter, 2007; Rai *et al.*, 2015) [4, 16]. Biochemical analysis of the fruits is essential for the description, classification and characterization of germplasm collections. Being a new and temperate crop to be cultivated in the sub-tropical conditions of Assam, it is important to conduct a biochemical of these low chilling apple varieties, so as to understand the response of our soil and climatic condition on the quality prospects of the fruits.

## 2. Materials and Methods
The present study was conducted at the Department of Horticulture, Assam Agricultural University, Jorhat during the period 2023-24. The experiment was laid out in a randomized block design (RBD) with three low-chilling apple varieties, viz.V1 (HRMN-99), V2 (Dorsett

Golden) and V3 (Anna) and seven replications. The plants were planted on 10th May, 2022 in pits of size 1 m x 1 m x 1 m with a spacing of 3 m x 3 m covering an experimental area of 540 $m^2$. The fertilizer dose includes 5 kg FYM + 150 g urea+ 210 g SSP+ 120 g MOP/ plant for Assam condition. Matured fruits were collected from the experimental farm under the department of horticulture and biochemical analysis was conducted

Biochemical fruit characters such as TSS (°B), moisture content (%), pH and fruit firmness (kg/$cm^2$) were estimated using a hand refractometer, moisture meter, pH meter and penetrometer respectively. Pulp: peel ratio and Juice content (%) were noted by dividing the pulp weight by the peel weight and the net juice weight by the fruit weight respectively. Anthocyanin content in the peel of the fruits was estimated spectrophotometrically by taking peel tissue as given by Srivastava (Srivastava *et al*., 2002) [21]. For estimation of vitamin C, the procedure proposed by Sadasivam and Balasubraminan (Sadasivam *et al*., 1987) [23] was followed. The titratable acidity was determined following the standard method and reducing sugar, non-reducing sugar and total sugar content of the fruits were determined by Lane and Eynon's method as reported by Ranganna (1995) [17]. The sugar: acid ratio of the fruits was determined by dividing the TSS content by titratable acidity. The specific gravity of the fruits of all the three varieties was measured by dividing the density of the fruits by density of water. Shelf life (days) of the fruits was recorded under room temperature until it becomes inedible for consumption. The significance of variance was analysed by computing the respective 'F' values as per the procedures given by Panse and Sukhatma (1978) [15].

## 3. Results and Discussion

The data on biochemical fruit parameters differed significantly except for pH (Table 1 & 2). The maximum TSS and titratable acidity were recorded in V3 (Anna) (11.53°B) and V1 (HRMN-99) (0.89%) respectively. Kumari (2024) [12] reported similar TSS in HRMN-99 (10.42-11.92°B) and Dorsett Golden (10.56-11.99°B) and Devi (2021) in different genotypes of Ambri (0.85-0.89%) apple for titratable acidity. The variations in TSS and titratable acidity are attributed to varied sugar and acid content of different varieties and also might be the effect of climate and soil, and the presence of varying amount of organic acids in different cultivars (Kishor *et al*., 2017 and Erkan *et al*., 2019) [9, 6]. The highest vitamin C content was noted in V1 (HRMN-99) (20.37 mg/100 g) followed by V2 (Dorsett Golden) (16.39%), which was statistically at par with 16.39% in V3 (Anna). Baba (2023) [2] recorded similar vitamin C (19.46-22.96 mg/100 g) content in different Ambri apple genotypes. This variation is due to different ability of the varieties to synthesize ascorbic acid in the fruits during the ripening stage, which is again influenced by the individual genotype of the varieties and also the prevailing climatic condition. The maximum reducing sugar, non-reducing sugar and total sugar were recorded in V2 (Dorsett Golden) (5.40%), V3 (Anna) (0.47%) and V2 (Dorsett Golden) (5.73%) respectively. The variation in the sugar content is due to the genetic differences among the varieties which would influence their ability to convert starch in young fruits into sugar at fruit maturity and also might be the influence of the prevailing climatic condition of the site (Kishor *et al*., 2017) [9]. Similar result for total sugar (5.92%) was reported by Kishor *et al*. (2017) [9] in Winter Banana apple varieties and Abbas *et al*. (2018) [1] for reducing sugar in Kashmiri Nashpati (5.30%) and Kashmiri Nakh (5.40%) pear varieties. The highest TSS: acid ratio was noted in V3 (Anna) (19.54%). Similar results for TSS: acid ratio was recorded by Devi (2021) [5] in ambri apple genotypes(13.08-18.85) and the variation is due to varied TSS and titratable acidity content of all the three varieties, which might be due to the genetic differences among them. The maximum anthocyanin content was recorded in V1 (HRMN-99) (12.09 mg/100 g), which was statistically at par with V3 (Anna) (11.27 mg/100 g). Similar variation in the anthocyanin content was recorded by Siqueria *et al.* (2011) [20] in different guava varieties, which is probably due to different genetic makeup of the varieties and also might be the influence of the prevailing climatic conditions of site during the colour development stage.

The highest pulp: peel ratio was recorded in V3 (Anna) (23.89) followed by V2 (Dorsett Golden) (16.75), which was statistically at par with V1 (HRMN-99) (15.57). Similar variations were recorded by Meghana *et al*. (2020) [14] in different selections of custard apple, which is attributed to differences in the pulp and peel weight of the varieties as influenced by factors such as fruit weight, no. of seeds/fruit and peel thickness. The highest moisture content was recorded in V3 (Anna) (85.16%), which was statistically at par with V2 (Dorsett Golden) (84.69%). Baba (2023) [2] recorded similar moisture content in Red Delicious (84.52%) and Golden Delicious (85.43%) apple varieties, which is probably a result of genetic differences among the varieties, geographic locations and technique of drying (Tadeo *et al*., 2008) [22]. The maximum juice content was recorded in V3 (Anna) (40.59%), which was statistically at par with V2 (Dorsett Golden) (37.72%). Similar variation in juice content of different citrus genotypes were reported by Saikia (2023) [18]. The longest shelf life was recorded in V2 (Dorsett Golden) (5.19 days), which was statistically at par with V1 (HRMN-99) (5.02 days). Kumari (2024) [12] recorded similar variations for shelf life in HRMN-99(6-7 days), Dorsett Golden (7-9 days) and Anna (6-8 days). Such variation in juice content and shelf life is usually caused by variations in the genetic makeup, growing region, prevailing climatic conditions, method of juice extraction and moisture content estimation of the fruits. The highest firmness (1.60 kg/$cm^2$) and specific gravity (1.22 g/cc) were noted in V2 (Dorsett Golden). Bodh *et al*. (2020) [3] and Kishor *et al*. (2017) [9] observed similar variation in different peach and apple accessions for firmness and specific gravity respectively. The variation in firmness is attributed to the varied ability of the varieties to breakdown the insoluble proto-pectin to soluble pectin compounds which ultimately affects cell wall consistency (Kumar *et al*., 2006) during fruit maturity stage and for specific gravity, it is probably due to the corresponding changes in fruit weight and volume of the all the three varieties (Kishor *et al*., 2017) [9].

**Table 1:** Fruit biochemical parameters

| Variety | TSS (°B) | pH | Titratable Acidity (%) | Vit C (mg/100 g) | Reducing sugar (%) | Non reducing sugar (%) | Total sugar (%) | TSS: Acid ratio |
|---|---|---|---|---|---|---|---|---|
| V1 (HRMN-99) | 11.16 | 4.95 | 0.89 | 20.37 | 4.76 | 0.35 | 5.11 | 12.53 |
| V2 (Dorsett Golden) | 11.33 | 5.00 | 0.77 | 16.39 | 5.40 | 0.33 | 5.73 | 14.71 |
| V3 (Anna) | 11.53 | 5.00 | 0.59 | 15.12 | 5.06 | 0.47 | 5.53 | 19.54 |
| SED(±) | 0.07 | 0.10 | 0.03 | 1.25 | 0.05 | 0.005 | 0.05 | 0.82 |
| CD (P=0.05) | 0.16 | NS | 0.08 | 2.76 | 0.12 | 0.01 | 0.12 | 1.82 |

**Table 2:** Fruit Biochemical parameters

| Variety | Anthocyanin (mg/100 g) | Pulp: Peel ratio | Moisture content (%) | Juice content (%) | Shelf life (days) | Firmness (Kg/cm$^2$) | Specific gravity (g/cc) |
|---|---|---|---|---|---|---|---|
| V1 (HRMN-99) | 12.09 | 15.57 | 83.56 | 33.99 | 5.02 | 1.52 | 1.18 |
| V2 (Dorsett Golden) | 9.85 | 16.75 | 84.69 | 37.72 | 5.19 | 1.60 | 1.22 |
| V3 (Anna) | 11.27 | 23.89 | 85.16 | 40.59 | 4.64 | 1.55 | 1.12 |
| SED(±) | 0.62 | 3.34 | 0.42 | 1.50 | 0.17 | 0.01 | 0.03 |
| CD (P=0.05) | 1.37 | 1.51 | 0.93 | 3.31 | 0.37 | 0.04 | 0.06 |

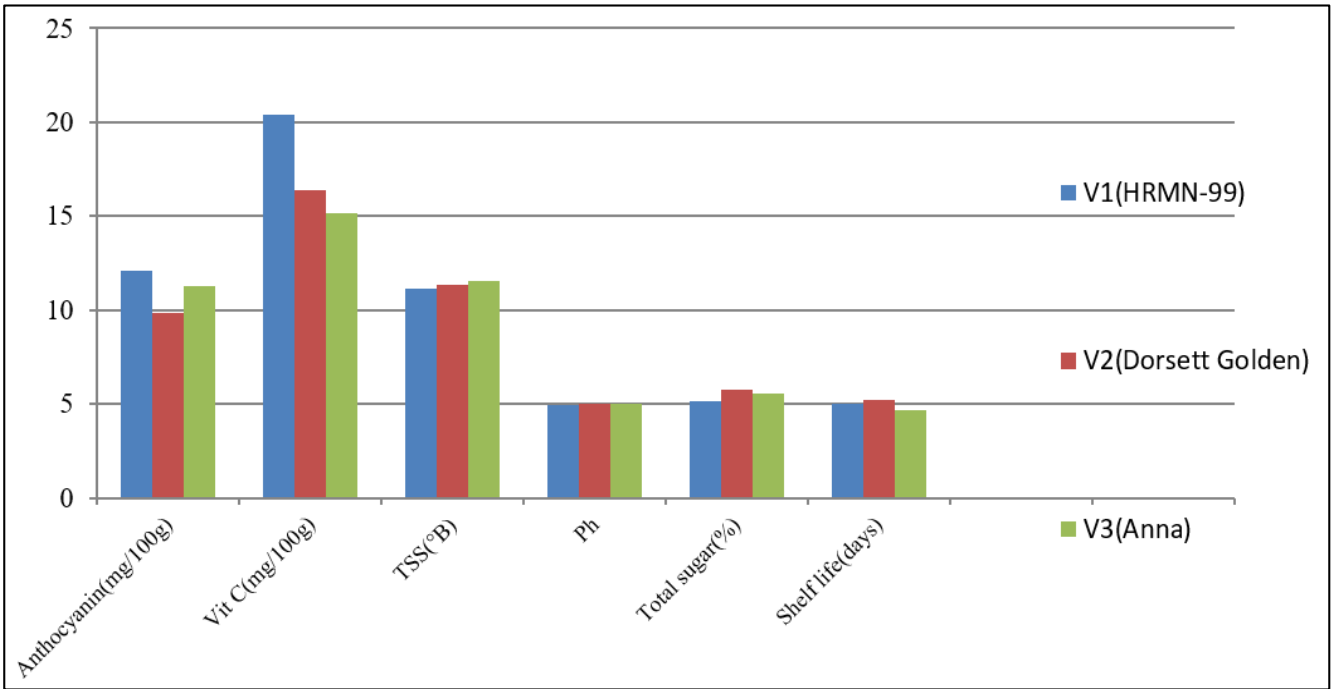


**Fig 1:** Graphical representation of some important parameters

## 4. Conclusion

The study on the biochemical parameters of these low chilling apple varieties were essential to evaluate its performance as the per the prevailing climatic condition of the experimental site, since it's a new and temperate crop planted in our sub-tropical climatic condition. From the present study, it could be concluded that the sub-tropical climatic condition of Assam would offer opportunities for cultivation of low chilling apple varieties. Successful growth and development of the varieties under study were achieved which was marked by adequate flowering and fruit set as per the age of the plants so far.

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