Research Article

Evaluation of Chlorophyll and Cellulose Content in Different Varieties of Aonla during Room Temperature Storage

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Abstract

Cellulose content of aonla fruits decreased during the period of storage in all the cultivars. Fruits of cultivar Chakaiya had highest cellulose content whereas minimum cellulose content was recorded in fruits of cultivar Krishna during storage. Chlorophyll 'a', Chlorophyll 'b' and total chlorophyll content decreased with increasing period of storage i.e. from 0-15 days in all the cultivars of aonla. Maximum Chlorophyll 'a', Chlorophyll 'b' and total chlorophyll content was recorded in fruits of cultivar Hathijhul whereas minimum Chlorophyll 'a', Chlorophyll 'b' and total chlorophyll content was observed in fruits of cultivar Krishna on all periods of storage.

Keywords: Aonla, Cellulose, Chlorophyll content, Fibre

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Introduction

Emblica officinalis (aonla) is native of tropical India and Southeast Asia, commonly named as 'Indian gooseberry'. Nutritional, commercial and medicinal significance of aonla fruit makes it popular all over the world [1]. Aonla is an excellent source of ascorbic acid (300-900 mg/100 g), as well as fiber content and amino acid along with phytochemicals such as polyphenols, tannins, emblicol, linoleic acid, corilagin, phyllemblin and rutin [2]. Owing to its excellent nutritional profile and physico-chemical properties, aonla is processed into different types of product. Aonla fruit having sour and astringent taste, generally utilized raw, cooked or in the form of pickle. Murrabas, juice, jam, cheese, candy, powder, beverage, chutney are the different types of aonla products available in the market and preferred by the consumer being the rich source of vitamin C and antioxidants. Aonla is one of the main constituent of many ayurvedic preparations like Triphla and Chyawanprash [3].

As fruit matures and ripen, green colour decline and develops yellow, red or other colours due to the presence of accessory pigments, which are characteristic of the various fruits and their cultivars. Chlorophyll is the major pigment that dominates in unripe stages of fruits and vegetables. Chlorophyll 'a' and 'b' are most common pigments in all photosynthetic and storage tissues. The colour change in fruits from green to yellow is mainly due to chlorophyll degradation, which subsequently reveals the presence of yellow carotenoids pigments [4]. Cell wall composition i.e. cellulose, acid detergent fiber plays an important role in determining fruit firmness in different fruit crops. Cellulose is a straight chain polymer of glucose and represents one of the most abundant compounds. The primary cell wall of fruits which can be viewed as biphasic composites of cellulose micro fibrils and a matrix element consisting of two polysaccharide classes-pectin and hemicelluloses, undergoes structural and compositional changes during storage. Cellulase is considered to be responsible for the hydrolysis of cellulose fibrils of the cell wall. There is dearth of literature availability on physico-chemical properties of various Indian cultivar of aonla. The present investigation was therefore planned to evaluate the physico-chemical properties and nutritional composition of five different varieties of aonla.

Materials and methods

Present investigations were carried out in post harvest laboratory of the Department of Horticulture, and in Department of Botany & Plant Physiology, Chaudhary Charan Singh Haryana Agricultural University, Hisar. Fully mature aonla fruits of five cultivars namely Chakaiya, Banarasi, Hathijhul, Krishna and Kanchan of uniform size,

color and free from blemishes were harvested from the orchard of the Horticulture department with the help of secateurs keeping small intact pedicel with each fruit.

Fruit treatment

Two kg of fruits of each cultivar of aonla were packed in cardboard boxes with newspaper as cushioning material. Each box was treated as one replicate and all the treatments were replicated four times. Fruits were stored at room temperature. Three fruits at random were taken from each replication for analysis of quality parameters in fresh fruits and then at two day interval.

Cellulose

Cellulose was estimated by the method of Van Soest [5]. Fruit sample was dried till constant weight and acid detergent fibre (ADF) content was estimated in dried sample.

Acid detergent fibre (ADF)
Reagents

Cetrimide - 5g, Sulphuric acid - 28ml, Volume was made 1 litre with distilled water.

Procedure

ADF was determined by refluxing 1g of dried fruit sample with 100ml ADF extraction reagent as indicated above for 1 hour. The solution was filtered through sterilized glass crucibles, washed, dried overnight at 100^0C and weighed. It was expressed as percent.

$$\text{ADF (\%)} = \frac{\text{Residue weight}}{\text{Sample weight}} \times 100 \quad (1)$$

Cellulose

Residue left after the extraction of ADF was taken in sintered crucibles and washed twice by stirring with 72% sulfuric acid. Acid filled crucibles were kept for 3 hours and after that acid were removed. Contents were made acid free by washing with hot water. Crucibles were dried overnight at 100^0C and weighed. The loss in weight from original amount of acid detergent fibre corresponded to cellulose which is expressed as percent.

$$\text{Cellulose (\%)} = \frac{\text{(Weight of acid detergent fibre – Weight of residue after sulfuric acid treatment)}}{\text{Weight of sample}} \times 100 \quad (2)$$

Chlorophyll content (chl a, chl b and total chl)

Chlorophyll a, chlorophyll b and total chlorophyll were estimated by dimethyl sulphoxide method of Hiscox & Israelstam [6]. 3g of fruit pulp was suspended in a test tube containing 5ml dimethyl sulphoxide. The test tubes were then placed in an oven at 60^0C for about 2 hours to facilitate the extraction of pigment. After 2 hours, the absorbance was read at 645 and 665nm on spectrophotometer using DMSO was used as blank. Calculations for different pigments were made according to following equations:

$$\text{Chlorophyll 'a' mg g}^{-1} = (12.3A_{665} - 2.86A_{645}) \times V \times 1000 \times W$$
$$\text{Chlorophyll 'b' mg g}^{-1} = (19.3A_{645} - 3.6A_{665}) \times V \times 1000 \times W$$

V= volume of DMSO (ml), W= weight of tissue, Total chlorophyll = Chl 'a' + Chl 'b'

Results and discussion

Cellulose (Acid detergent fibre)

Decrease in cell wall component i.e. acid detergent fibre and cellulose content (**Table 1** and **2** respectively) was observed in aonla fruits with the advancement in storage period (0-15 days). Decrease in cell wall components might be related to cell wall degrading enzymes such as pectin methyl esterase, responsible for de-esterification of pectin, polygalactouronase and cellulase causing change in pectin, hemocellulose and cellulose. Decrease in cell wall components during storage have been reported in guava [7] and in ber [8].

In present study, decrease in cell wall component i.e. acid detergent fibre and cellulose content was found to be cultivar dependent. Maximum cellulose content was recorded in the fruits of cultivar Chakaiya at the end of the storage *i.e*. on 15th day where as fruits of cultivar Krishna had minimum cellulose content on same period of storage. Acid detergent fibre was found to be minimum in fruits of cultivar Banarasi at the end of storage (15th day) and fruits of cultivar Krishna had maximum acid detergent fibre on same period of storage. Variation in cell wall component among the cultivars could be due to different rate of various above said enzyme activities during storage. Results of differential decrease in cell wall components are in accordance with the findings of [9, 10] in different cultivars of guava and ber, respectively.

Table 1 Acid detergent fibre (ADF) (%) in fruits of aonla (*Emblica officinalis* G.) during storage in different cultivars at room temperature

Cultivars (C)	ADF (%)						Mean
	Period of storage (D)						
	0	3	6	9	12	15	
CHAKAIYA	27.00	25.57	23.53	22.27	21.17	20.40	23.32
BANARASI	26.53	24.67	23.10	21.97	20.17	19.90	22.72
HATHIJHUL	27.13	26.20	24.57	23.07	21.73	20.86	23.92
KRISHNA	27.70	26.10	24.73	23.30	22.27	21.70	24.30
KANCHAN	26.60	24.73	23.63	22.37	20.87	20.30	23.08
Mean	26.99	25.45	23.91	22.60	21.24	20.63	
CD at 5%, C = 0.63, D = 0.74, CxD = 0.98							

Table 2 Cellulose content (%) in fruits of aonla (*Emblica officinalis* G.) during, storage in different cultivars at room temperature

Cultivars (C)	Cellulose (%)						Mean
	Period of storage (D)						
	0	3	6	9	12	15	
CHAKAIYA	10.01	9.91	8.80	7.71	6.62	6.23	8.20
BANARASI	9.85	8.73	7.66	6.80	6.54	5.88	5.78
HATHIJHUL	8.79	7.70	6.62	5.88	5.51	5.40	6.65
KRISHNA	7.75	7.12	6.60	6.01	5.45	5.07	6.33
KANCHAN	9.81	8.72	7.65	7.19	6.70	6.12	7.70
Mean	9.24	8.44	7.47	6.71	6.16	5.74	
CD at % 5, C = 0.02, D = 0.04, C x D = 0.06							

Chlorophyll content (chl a, chl b and total chl)

Chl a (**Table 3**), chl b (**Table 4**) and total chlorophyll (**Table 5**) content decreased with increasing period of storage i.e. from 0-15 days in all the cultivars of aonla. Chlorophyllase enzyme is mainly responsible for chlorophyll degradation [11]. Decrease in chlorophyll level in photosynthetic cells after harvesting is indicator of senescence. Decrease in chlorophyll content in aonla during storage has also been reported by [12] and [13] in aonla. Roongruangsri *et al.* (2013) has also recorded decrease in chlorophyll content with advancement in storage period in apple and tangerine fruits, respectively [14].

A significant variation in Chl a, chl b and total chlorophyll content in different cultivars of aonla was observed during storage. Among the various cultivars studied, maximum content of chl a, chl b and total chlorophyll was recorded in fruits of cultivar Hathijhul on 15th day of storage whereas minimum content of chl a, chl b and total chlorophyll was observed in fruits of cultivar Krishna at the same period of storage (15th day). This might be due to differential activity of chlorophyllase enzyme activity in different cultivars of aonla. Results of differential decrease in total chlorophyll are in agreement with those reported in apple [15], tangerine cultivars [14] and in broccoli cultivars during storage [16].

Table 3 Chlorophyll 'a' (mg/g fresh weight) in fruits of aonla (*Emblica officinalis* G.) during storage in different cultivars at room temperature

Cultivars (C)	Chlorophyll 'a' (mg/g fresh weight)						Mean
	Period of storage (D)						
	0	3	6	9	12	15	
CHAKAIYA	1.43	1.40	1.37	1.33	1.29	1.24	1.34
BANARASI	1.40	1.36	1.30	1.28	1.25	1.22	1.30
HATHIJHUL	1.48	1.45	1.41	1.38	1.33	1.30	1.39
KRISHNA	1.40	1.36	1.32	1.27	1.22	1.19	1.29
KANCHAN	1.41	1.38	1.33	1.29	1.26	1.22	1.31
Mean	1.42	1.39	1.35	1.31	1.27	1.23	
CD at 5%, C = 0.04, D = 0.03, CxD = 0.06							

Table 4 Chlorophyll 'b' (mg/g fresh weight) in fruits of aonla (*Emblica officinalis* G.) during storage in different cultivars at room temperature

Cultivars (C)	Chlorophyll 'b' (mg/g fresh weight)						Mean
	Period of storage (D)						
	0	3	6	9	12	15	
CHAKAIYA	1.28	1.25	1.21	1.18	1.14	1.11	1.19
BANARASI	1.26	1.23	1.19	1.15	1.12	1.09	1.17
HATHIJHUL	1.30	1.28	1.24	1.20	1.17	1.13	1.22
KRISHNA	1.24	1.20	1.17	1.13	1.11	1.08	1.15
KANCHAN	1.26	1.22	1.19	1.16	1.14	1.10	1.18
Mean	1.27	1.24	1.20	1.16	1.14	1.10	
CD at 5%, C = 0.04, D = 0.05, C x D = NS							

Table 5 Total Chlorophyll content (mg/g fresh weight) in fruits of aonla (*Emblica officinalis* G.) during storage in different cultivars at room temperature

Cultivars (C)	Total Chlorophyll content (mg/g fresh weight)						Mean
	Period of storage (D)						
	0	3	6	9	12	15	
CHAKAIYA	2.71	2.65	2.58	2.51	2.43	2.35	2.53
BANARASI	2.66	2.59	2.49	2.42	2.36	2.33	2.48
HATHIJHUL	2.78	2.73	2.65	2.58	2.50	2.43	2.61
KRISHNA	2.64	2.57	2.49	2.40	2.33	2.28	2.45
KANCHAN	2.68	2.60	2.526	2.456	2.39	2.31	2.49
Mean	2.69	2.63	2.55	2.47	2.40	2.34	
CD at 5%, C = 0.09, D = 0.10, C x D = NS							

Conclusion

Among the five cultivars of aonla studied under Haryana agro climatic conditions, it was concluded that higher content of chlorophyll as well as cellulose content was recorded in fruits of cultivar Hathijhul and Chakaiya,

respectively during all periods of storage whereas, fruits of cultivar Krishna showed minimum chlorophyll as well as cellulose content during the storage.

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