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FRUIT BAGGING EFFECTS ON PHYSICO-CHEMICAL QUALITY AND SHELF LIFE OF DRAGON FRUIT VARIETIES

Vipasha D. Dangariya[1]*, Tandel B. M.[1] and Bhatt S. T.[2]

[1]Department of Fruit Science, ASPEE College of Horticulture, N.A.U., Navsari- 396450 (Gujarat), India.

[2]Director of Extension Education, N.A.U., Navsari-396450 (Gujarat), India.

*Corresponding author E-mail: vipashaddangariya@gmail.com

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ABSTRACT

The experiment was laid out in CRD with factorial concept comprised sixteen treatment combinations, consisting of two varieties *viz.*, V_1- Red Flesh and V_2- White Flesh and eight different type of bagging material *viz.*, B_1- control, B_2- newspaper bag, B_3- butter paper bag (white), B_4- butter paper bag (brown), B_5- non-woven red bag, B_6- non-woven green bag, B_7- non-woven white bag and B_8- butter paper water resistance white bag and repeated thrice. All bagging materials were reduced damaged fruits as compare to control. Butter paper water resistance white bag showed lowest peel thickness (0.27 cm), dry matter content (12.14%) and maximum fruit firmness with peel (9.40 kg cm^{-2}), specific gravity (1.20 w/v), edible portion (81.68%), moisture content (87.87%), TSS (14.18 °Brix), titratable acidity (0.41%), reducing sugars (6.58 %), total sugars (9.65%) ascorbic acid (10.07 mg 100 g^{-1}) and shelf life (10.69 days). Owing this study, it can be concluded that fruit bagged at seven days after an thesis with butter paper water resistance bag was found better for improving the physico-chemical quality and shelf life of dragon fruit.

***Key words*:** Dragon fruit, fruit bagging, physico-chemical quality and shelf life

Introduction

Dragon fruit (*Hylocereus* spp.) belongs to family cactaceae, which includes 120 to 200 genera with more than 1500-2000 species. Dragon fruit is “Wondrous fruit” of 21st century is set to ring in a revolution in the Indian Horticulture Scenario. It is a vine, terrestrial or epiphytic cactus which has received worldwide recognition, first as an ornamental plant and then as a fruit crop. It has vernacular names like *Kamalam* (Hindi), *Thangloy* (Vietnamese), *Pitayaroja* (Spanish), and *La Pitahaya Rouge* (French), *pitahaya*, *night blooming cereus*, *strawberry pear*, *Belle of the night*, *Cinderella plant* and *Jesus in the Cradle* (English).

Dragon fruit has recently attracted huge interest of researchers worldwide due to its health promoting properties. Dragon fruit helps in fighting against cough and asthma, healing wounds and cuts quickly due to it contains much amount of vitamin C. However, the high level of vitamin C found in dragon fruit plays an important role to improve immune system and also to stimulate the activity of other antioxidant in the body (Perween *et al.*, 2018). It suffers massive pre and post-harvest losses due to sun burning, fruit cracking, internal breakdown, insect attack and mechanical damage. Among the main problems that affect the quality of the dragon fruits, those caused by pests and diseases. It is observed that *Atta* and *Solenopsis* ants cause damages to the cladodes, flowers and fruits. *Trigona spinipes* can also cause great damage due to the reduction of fruits for commercialization. In addition, due to their attractiveness, attack of birds feed the fruits, consuming their pulp (Costa *et al.*, 2017). Dragon fruit can be damaged by long periods of intense heat, resulting in sunscald. Dragon fruit may also attract fruit flies. These insects can also hinder the production as well as quality of fruit. (Chowdhury *et al.*, 2020).

Bagging is a physical protection technique, commonly applied to many fruits, which is not only improves their visual appearance by promoting peel coloration but also reducing the incidence of fruit cracking and rusting. Bagging is also changing the micro environment for fruit

development, which can multiple effects on internal fruit quality. Bagging has been extensively used in several fruit crops to improve skin colour and reduce the incidence of fruit fly, diseases, sunburn of the skin, mechanical damage and bird damage. Due to its many beneficial effects, fruit bagging has become an integral part of different cultivation of fruits in many countries of the world (Chowdhury *et al.*, 2020). Bagging affects pigment synthesis, days to maturity, cell histology, physiology, shelf-life, storage behaviour, biochemical composition, pesticide residue content and insect severity. Recently fruit bagging has been an eco-friendly practice in many types of fruits in India such as mango, guava, banana, grapes, pomegranate, papaya and citrus *etc.* (Asrey *et al.*, 2019). However, very limited information is available on the effect of different bagging material on dragon fruit production in India. Therefore, keeping the above facts in view, the present investigation on "Fruit bagging effects on physico-chemical quality and shelf life of dragon fruit varieties".

Materials and Methods

The present investigation was carried out at the Regional Horticulture Research Station, ASPEE College Horticulture, Navsari Agricultural University, Navsari, Gujarat, India during the year 2022-2023. The experimental site was located between latitude 20° 572 N' 72° 542' E longitude and 11.83 m altitude above mean sea level. During the study period, the average maximum and minimum temperature were 32.2°C and 25.30°C, respectively. While the average relative humidity was 94%, sun shine hours 6.6 and rainfall 23mm. The experiment was laid out in completely randomized design with factorial concept with sixteen treatment combinations, consisting of two varieties *viz.*, V_1- Red Flesh and V_2- White Flesh and eight different type of bagging material *viz.*, B_1- control (no bagging), B_2- newspaper bag, B_3- butter paper bag (white), B_4- butter paper bag (brown), B_5- non-woven red bag, B_6- non-woven green bag, B_7- non-woven white bag and B_8- butter paper water resistance white bag. The treatments were repeated thrice. Thirty fruits for each treatment and variety were properly covered with bagging material and thirty similar aged fruits were kept open as control. Fruit bagging was executed at 7 days after an thesis with different bagging material.

Damaged fruits (%): From each treatment, fruits were observed for damaged fruit %. The damaged fruits were subtracted from total number of fruits for calculation. It was calculated by subtracting number of damaged by fruit flies, bird damage, sunburned and bruised fruits from total number of fruits.

Thickness of peel (cm): Thickness of peel of fruits was measured using digital *Verniercaliper*.

Fruit firmness with peel and without peel (kg cm^{-2}): At ripening, fruit firmness with peel and without peel of fruits was measured with help of penetrometer.

Specific gravity (w/v): At ripening, specific gravity of fruits was measured by using water displacement method.

Edible portion (%): Edible portion was calculated as below formula.

$$\text{Edible portion (\%)} = \frac{\text{Flesh weight (g)}}{\text{Fruit fresh weight (g)}} \times 100$$

Moisture content (%): Fifty grams (50 g) of fresh fruit sample of each treatment was taken and cut into small pieces on an aluminium foil and oven dried at 70°C until the constant weight was attained. Moisture content (%) was calculated according to the following formula.

$$\text{Moisture content (\%)} = \frac{\text{Fresh weight of sample (g) - Dry weight of sample (g)}}{\text{Fresh weight of sample (g)}} \times 100$$

Dry matter content (%): Dry matter content % was calculated according to the following formula.

Dry matter content (%) = 100 - moisture content (%)

TSS content (°Brix): Total soluble solids (TSS) of dragon fruit were estimated using digital refractometer. A drop of juice was squeezed from the dragon fruit flesh and taken on the prism of refractometer. TSS content was recorded from the direct reading of the instrument.

Titratable acidity (%): The method described by Ranganna (1986) was taken forestimation of titratable acidity. Five gram of homogenized dragon fruit pulp was taken to a 100 ml volume tricflask and the volume was made up with distilled water to known amount. The solution was well mixed and after 30 minutes, the suspension was filtered through Whatman No.1 filter paper. An aliquot (10 ml) was taken from the filtrate by pipetting and titrated against standard 0.01 N NaOH using phenolphthale in as an indicator. Appearance of colourless to light pink colour denotes the end point. The reading of burette was recorded. The results were expressed as percent anhydrouscitric acid. The titrat able acidity (%) was calculated by using following formula:

$$\text{Acidity (\%)} = \frac{\text{Titre} \times \text{Normality of NAOH} \times \text{Volume made up} \times \text{Equivalent weight of acid}}{\text{Volume of aliquote} \times \text{Weight of sample} \times 1000} \times 100$$

Reducing sugars (%): The titrimetric method of Lane and Eynon described by Ranganna (1986) was adopted for estimation of reducing sugar. Twenty gram of the dragon fruit pulp was taken in a volumetric flask and two ml of 45 per cent basic lead acetate solution

was added for clarification. After 30 minutes, the solution was deleaded by adding 2 ml potassium oxalate solution (22%) and the volume was made up to 250 ml with distilled water and filtered through Whatman No.1 filter paper. The filtrate was taken into a burette and titrated against boiling Fehling's mixture (5 ml of A and 5 ml of B) till the blue colour faded. Then one to two drops of methylene blue indicator (1 per cent) were added and the titration was continued till the contents attained a brick red colour. At this stage, titration was stopped and titre value was noted. The percentage of reducing sugar was calculated according to the following formula:

$$\text{Reducing sugars (\%)} = \frac{\text{Factor (0.05)} \times \text{Dilution}}{\text{Titre} \times \text{Weight of sample}} \times 100$$

Total sugars (%): For the estimation of total sugars, the filtrate obtained in the reducing sugar estimation was used. 100 ml aliquot from the filtrate was taken in volume tricflask and 5 ml hydrochloride acid was added and the inversion was carried out at room temperature for 24hours. Subsequently, the contents were cooled and neutralized with 40 percent sodium hydroxide using phenolphthalein as an indicator. The solution was filtered through Whatman No. 1 filter paper and titration was carried out using filtrate as detailed for reducing sugars content. The total sugars content was expressed as percent agein terms of invert sugars according to the following formula:

$$\text{Total Sugars (\%)} = \frac{\text{Factor (0.05)} \times \text{Dilution}}{\text{Titre} \times \text{Weight of sample}} \times 100$$

Non-reducing sugars: Non-reducing sugars content (%) was calculated by subtracting the reducing sugars content (%) from the total sugars content (%).

Ascorbic acid content (mg 100 g^{-1}): Titrimetric method described by Ranganna (1986) was adopted for estimation of the ascorbic acid. Ten grams of the homogenized dragon fruit pulp was taken and transferred in 100 ml volumetric flask and volume was made up with 4 % oxalic acid solution. After 30 minutes, the suspension was filtered through Whatman No. 1 filter paper. Before actual titration the 2, 6-Dichlorophenol indophenol (dye solution) was standardized by titrating against standard ascorbic acid solution and the dye factor was calculated. Five millilitres of the aliquot were taken from the filtrate and titrated against standardized dye solution through a burette. Titration was continued till the light pink colour persisted for 15 seconds. The ascorbic acid content was calculated adopting the following formula:

$$\text{Ascorbic acid (mg } 100g^{-1}) = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up}}{\text{Aliquote of extract taken} \times \text{Weight of sample} \times 5\text{ml}} \times 100$$

For estimation

$$\text{Dye Factor} = \frac{0.5}{\text{Titre}}$$

Shelf Life (Days): Harvested fruits were kept at room temperature and noted the days taken from harvesting to optimum eating stage and expressed in days.

Statistical analysis: The data collected from all the characters involved under study were subjected to the statistical analysis under completely randomized design with factorial concept (FCRD) as described by Panse and Sukhatme (1985). The means for all the treatments were calculated and analysis of variances (ANOVA) for all the parameters was performed by F-test. Duncan's multiple range test was used to compare means among different treatments at significance level of $P \leq 0.05$. All analyses were performed by using R- software.

Results and Discussion

Damaged fruits (%)

Damaged fruit percentage significantly varied between two varieties. Minimum damaged fruits (12.63%) were observed in Red Flesh variety than White Flesh variety (Fig. 1A). Fruit bagged with butter paper water resistance white bag was most effective in managing fruit fly incidence, diseases incidence, sunburning and fruit cracking (0.83%) (Fig. 1B). Significant variation found in damaged fruits percentage due to combine effect of variety and type of bagging material. It may be due to the direct damage by puncturing the fruit skin to lay eggs inside the fruit is prevented. A bagging created physical barrier between the pests and fruits it resulted in minimizing the attack of pest by (Brar *et al.*, 2019). Gawad *et al.*, (2017) found minimum number of sunburned fruits in mango.

A perusal of data presented in (Fig. 1C) clearly revealed that, the minimum damaged fruits were recorded with all the treatment except V_1B_4, V_1B_2, V_1B_1, V_2B_4,V_2B_2, and V_2B_1. Interaction between variety and type of different bagging material were found effective in reducing damaged fruits. The similar results are in line with the findings of Costa *et al.*, (2017) and Tran *et al.*, (2015) in dragon fruit.

Thickness of peel (cm)

Peel weight and thickness of peel was also varied significantly between both the variety with the minimum thickness of peel (0.28 cm) was obtained in Red Flesh variety than White Flesh variety (Fig. 2A). All type of bagging material significantly influenced thickness of peel of dragon fruit. Similarly, butter paper water resistance white bag fruit gave minimum thickness of peel (0.27

cm) while other bagged and non-bagged fruits produced thicker peel (0.35 cm) (Fig. 2B). It might be due to plant cuticle thickness reduced with low light intensity and high moisture prevalence in growing environment (Oren-Shamir 2009). So, this decrease peel thickness in bagged fruit may be due to more humidity inside bag, which could have affected cell structure, configuration and cuticle thickness (Amarante *et al.*, 2002).

The interaction between variety and type of bagging material had a significant impact on peel weight and thickness of peel. The lowest thickness of peel (0.27 cm) was achieved from the combination of Red Flesh variety fruit bagged with butter paper water resistance white bag (Fig. 2C). It might be due to begging protect the fruit surface from light and insect-pest attack that leads to thin peel which is supported by (Ding *et al.*, 2004). The findings of this research are corroborated with the results of Chowdhury *et al.*, (2020), Tuan *et al.*, (2017) and Malik *et al.*, (2018) in dragon fruit.

Fruit firmness with peel and without peel (kg cm^{-2})

The fruit firmness with peel and without peel significantly different between both varieties. Maximum fruit firmness with peel and without peel (9.01 and 0.43 kg cm^{-2}) was observed in Red Flesh variety. Pre-harvest bagging with eight types of bagging material significantly influenced the fruit firmness with and without peel. The maximum fruit firmness with peel and without peel (9.40 and 0.72 kg cm^{-2}) was recorded in fruit bagged with (B_8)

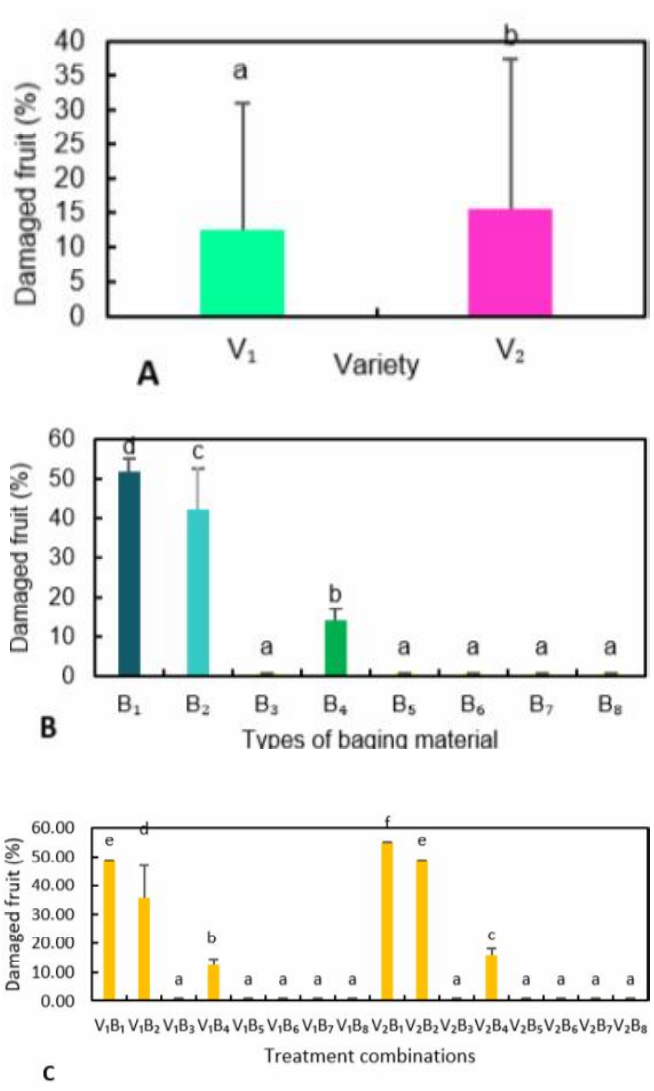

Fig. 1: Effect of variety A, type of bagging material B and combine effect of variety and type of bagging material on damaged fruits (%) C. Vertical bars indicate significance level of P ≤ 0.05.

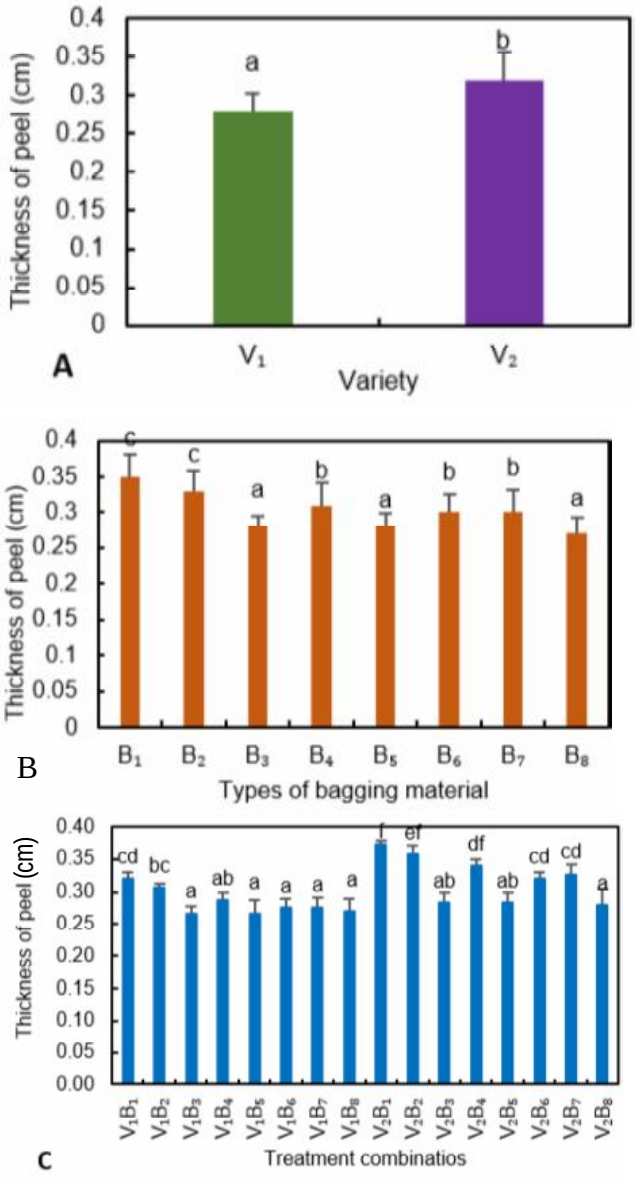

Fig. 2: Effect of variety A, type of bagging material B and combine effect of variety and type of bagging material on thickness of peel (cm) C. Vertical bars indicate significance level of P ≤ 0.05.

Table 1: Effect of variety and type of bagging material on quality parameters and shelf life of dragon fruit.

Treatments	Fruit firmness with peel (kg cm^{-2})	Fruit firmness without peel (kg cm^{-2})	Specific gravity (w/v)	Edible portion (%)	Moisture content (%)	Dry matter content (%)	TSS (^{o}Brix)	Titratable acidity (%)	Reducing sugars (%)	Total sugars (%)	Non reducing sugars (%)	Ascorbic acid (mg 100 g^{-1})	Shelf life (Days)
Variety (V)													
V_1:	9.01	0.43	1.13	75.64	85.70	14.30	13.55	0.34	6.73	9.53	2.80	9.50	9.53
V_2:	8.79	0.33	1.17	76.96	82.93	17.07	13.16	0.36	5.87	9.12	3.25	9.27	9.33
SEm±	0.07	0.005	0.01	0.35	0.72	0.15	0.13	0.004	0.08	0.08	0.03	0.09	0.10
CD at 5%	0.22	0.01	0.03	1.02	2.06	0.45	0.39	0.01	0.23	0.24	0.09	0.26	0.29
Types of Bagging Material (B)													
B_1:	8.23	0.05	1.06	66.61	79.92	20.09	12.11	0.31	5.90	8.88	2.98	9.29	8.17
B_2:	8.45	0.14	1.10	70.79	81.31	18.69	13.03	0.31	6.04	9.03	2.99	9.39	8.92
B_3:	9.25	0.58	1.18	79.77	86.03	13.97	13.71	0.39	6.52	9.57	3.05	9.85	10.18
B_4:	8.66	0.26	1.13	74.99	83.04	16.96	13.08	0.32	6.15	9.15	3.02	9.52	9.33
B_5:	9.36	0.67	1.18	80.74	87.10	12.90	13.77	0.39	6.55	9.61	3.05	9.97	10.44
B_6:	9.10	0.31	1.15	79.13	85.22	14.78	13.65	0.34	6.43	9.45	3.02	9.76	9.75
B_7:	8.76	0.30	1.16	76.70	84.03	15.97	13.29	0.34	6.27	9.29	3.02	9.63	9.56
B_8:	9.40	0.72	1.20	81.68	87.87	12.14	14.18	0.41	6.58	9.65	3.07	10.07	10.69
SEm±	0.15	0.010	0.02	0.71	1.44	0.31	0.27	0.007	0.16	0.16	0.06	0.18	0.20
CD at 5%	0.44	0.03	0.07	2.04	4.12	0.89	0.77	0.02	0.46	0.48	NS	0.52	0.59

butter paper water resistance white bag (Table 1). This might be due to reduced water loss in the fruits bagged with these bags whereas increased or rapid water loss in fruits bagged with other bags and also in control (Tran *et al.*, 2015). The similar results were obtained by (Mingire*et al.*, 2017) in mango and (Amarante *et al.*, 2002) in pear. With regard to fruit firmness with peel, the interaction effect of variety and type of bagging material were found non-significant and treatment combination (V_1B_8) Red Flesh variety fruit covered with butter paper water resistance white bag showed maximum fruit firmness without peel (0.74 kg cm^{-2}) (Table 2).

Specific gravity (w/v)

Highest specific gravity (1.17 w/v) was observed in White Flesh variety than Red Flesh variety (Table 1). It is evident from the data that higher specific gravity (1.20 w/v) was found in B_8 (butter paper water resistance white bag followed by non- woven red, white and green bag (Table 1). Comparative early maturation in butter paper water resistance white bag fruits might have induced rapid disintegration of pulp tissues, which has possibly facilitated escaping of cell air and resulted in higher specific gravity. Specific gravity has a strong relation with physical state of fruit like fruit firmness with and without peel. Similar findings were obtained in pomegranate by (Supe and Saitwal, 2016). Maximum edible portion (83.67) was found when White Flesh variety bagged with butter paper water resistance white bag (V_2B_8).

Edible portion (%)

Significant variations were found between two varieties on edible portion (%). Maximum edible portion (76.96%) were noticed in White Flesh variety followed by Red Flesh variety (75.64%) (Table 1). It may be due to the varietal character of dragon fruit by Parmar and Karetha (2020). Pre-harvest bagging with types of bagging significantly influenced the edible portion (%) of fruits. The fruits treated with the butter paper water resistance white bag significantly improved the edible rate (81.68%) of dragon fruit as compared to control (66.61%) (Table 1). Early bagging may increase edible rate (%) of fruits as the insect pest infestation remains low during that time which was supported by Tran *et al.*, (2015). These findings are in agreement with the results ofTuan *et al.*, (2017) in dragon fruit. Maximum edible portion (83.67%) were obtained from White Flesh variety bagged with butter paper water resistance white bag (Table 2).

Moisture content (%) and Dry matter content (%)

A perusal of data presented in Table 1 clearly indicated the significant variation was observed between two varieties on moisture content and dry matter content. The highest moisture content (85.70 %) and lowest dry

Table 2: Interaction effect between variety and type of bagging material on physical parameters and shelf life of dragon fruit.

Treatments	Fruit firmness with peel (kg cm^{-2})	Fruit firmness without peel (kg cm^{-2})	Specific gravity (w/v)	Edible portion (%)	Moisture content (%)	Dry matter content (%)	TSS (^{o}Brix)	Titratable acidity (%)	Reducing sugars (%)	Total sugars (%)	Non reducing sugars (%)	Ascorbic acid (mg 100 g^{-1})	Shelf life (Days)
V_1B_1	8.35	0.07	1.03	67.80	78.09	18.26	12.26	0.30	6.32	9.08	2.77	9.09	9.13
V_1B_2	8.56	0.17	1.08	71.31	79.61	16.99	13.18	0.31	6.45	9.23	2.78	9.20	9.55
V_1B_3	9.36	0.64	1.17	78.41	84.83	12.77	13.90	0.38	6.94	9.78	2.83	9.66	10.45
V_1B_4	8.77	0.22	1.11	74.65	81.40	15.32	13.24	0.31	6.57	9.36	2.78	9.33	9.62
V_1B_5	9.45	0.71	1.17	79.12	86.01	11.80	14.01	0.38	6.97	9.81	2.84	9.79	10.55
V_1B_6	9.21	0.50	1.13	77.88	84.00	13.56	13.87	0.34	6.86	9.65	2.79	9.57	9.68
V_1B_7	8.87	0.36	1.12	76.24	82.71	14.65	13.46	0.34	6.74	9.49	2.78	9.44	9.68
V_1B_8	9.49	0.74	1.18	79.70	86.78	11.05	14.47	0.40	7.02	9.86	2.84	9.89	10.80
V_2B_1	8.10	0.02	1.09	65.42	81.74	21.91	11.96	0.31	5.48	8.67	3.19	9.48	7.22
V_2B_2	8.33	0.12	1.12	70.26	83.01	20.39	12.88	0.31	5.63	8.82	3.19	9.58	8.28
V_2B_3	9.14	0.53	1.19	81.13	87.22	15.17	13.52	0.39	6.10	9.37	3.27	10.03	9.92
V_2B_4	8.54	0.29	1.15	75.33	84.68	18.60	12.92	0.32	5.72	8.95	3.26	9.71	9.04
V_2B_5	9.26	0.64	1.19	82.36	88.20	13.99	13.53	0.40	6.13	9.40	3.27	10.15	10.32
V_2B_6	8.98	0.12	1.17	80.37	86.44	16.00	13.43	0.35	5.99	9.24	3.25	9.94	9.82
V_2B_7	8.64	0.24	1.19	77.16	85.35	17.29	13.12	0.34	5.79	9.08	3.26	9.81	9.44
V_2B_8	9.30	0.69	1.21	83.67	88.95	13.22	13.90	0.41	6.14	9.45	3.31	10.25	10.58
SEm±	0.21	0.014	0.03	1.01	2.04	0.44	0.38	0.010	0.22	0.23	0.08	0.25	0.29
C.D. at 5 %	NS	0.04	NS	2.89	NS	NS	NS	NS	NS	NS	NS	NS	0.83
C.V. %	4.21	6.75	5.01	2.30	4.19	4.87	4.97	4.98	6.27	4.44	4.83	4.60	5.22

matter content (14.30 %) were obtained from Red Flesh variety. It may be due to the varietal character of dragon fruit. Highest moisture content (87.87 %) and lowest dry matter content (12.14 %) was attained from fruits bagged with butter paper water resistance white bag (B_8) than control (Table 1). Bagging of fruits was found effective for increased moisture content of dragon fruit. It might be due to bagging assist to retain moisture content in fruits by inhibiting water loss from surface thus increase moisture content percentage in fruits by (Dutta and Majumdar, 2012). The combined effect between variety and type of bagging material was found non- significant impact on moisture content and dry matter content of dragon fruit.

TSS content (^{o}Brix)

Total soluble solids (TSS) contribute significantly to the flavor, sweetness and consumer preference. The data presented in Table 1 clearly indicated that the TSS (^{o}Brix) significantly different between Red Flesh (13.55 ^{o}Brix) and White Flesh (13.16 ^{o}Brix) variety. It may be due to the varietal character of dragon fruit by Parmar and Karetha (2020). The result presented in Table 1 clearly indicated that the maximum TSS (14.18 (^{o}Brix) in butter paper water resistance white bag might be due to during the climacteric stage, the accumulated polysaccharide is rapidly degraded and most of it is converted into soluble sugars which form a large proportion of TSS (Paradva *et al.*, 2021). The present positive result of non-woven bag is coincided with findings of Mallik *et al.*, (2018), Chowdhury *et al.*, (2020), Parmar and Karetha (2020) and Hossain *et al.*, (2021) in dragon fruit. Interaction effect of variety and type of bagging material was found non-significant on TSS content (^{o}Brix) of fruit.

Titratable acidity (%)

Data presented in (Table 1) clearly revealed that, the maximum titrable acidity (0.36 %) was found in White Flesh variety than Red Flesh variety (0.34). It may be due to the varietal character of dragon fruit by Parmar and Karetha (2020) and maximum titratable acidity (0.41%) in butter paper water resistance white bag. This might be due to utilization of organic acids in metabolic activity like respiration process and reactions by (Singh *et al.*, 2017). The interaction effect of variety and type of bagging material was found non-significant on titratable acidity of fruit.

Reducing sugars (%)

There was a significant difference observed between two varieties on reducing sugar (%). The highest (6.73 %) was recorded from Red Flesh variety while the lowest reducing (5.87 %) was recorded from White Flesh variety in (Table 1). The maximum reducing sugars content (6.58 %) of fruit was recorded butter paper water resistance white bag (B_8), which was statistically at par with all the treatment B_5, B_3, B_6, B_7, B_4 and B_2 except control. This might be due to the fact that temperature and solar radiation are the environmental factors which give variation in sugar accumulations. The increased reducing sugars content may be due to conversion of sucrose into glucose inside the bags. It is due to more sucrose syntheses and sucrose phosphate syntheses activity inside the bags (Kumar, 2020). (Meena *et al.*, 2016) and Sushravya (2022) also reported improvement in reducing sugars content in guava fruit bagging. The combined effect of variety and type of bagging material on reducing sugars (%) of fruit was found non-significant.

Non reducing sugars (%)

A perusal of data presented in Table 1 clearly indicated the significant difference were found on non-reducing sugar (%). The highest non-reducing sugars (3.25%) was recorded from White Flesh variety (V_2), while minimum non-reducing sugars (2.80%) was found in Red Flesh variety (V_1). It may be due to the varietal character of dragon fruit by Parmar and Karetha (2020) and the data shows that there was non-significant effect on non-reducing sugars (%) of fruit by type of bagging materials. The combined effect of variety and type of bagging materials on non-reducing sugars (%) of fruit was found non-significant.

Total sugars (%)

It is evident from the data presented in (Table 1) that total sugars of dragon fruits significantly varied between two varieties. The highest total sugar (9.53%) was noticed in Red Flesh variety and lowest total sugar (9.12%) was obtained from White Flesh variety. It may be due to the varietal character of dragon fruit. Maximum total sugars (9.65%) were observed in butter paper water resistance white bag (B_8) which was statistically at par with non-woven red bag (B_5) (9.61%). It might be due to significantly positive association with temperature. The covered fruits had more total sugars content, probably higher temperature inside the bag which is favourable for conversion of starch in to sugar (Paradva *et al.*, 2021). A similar result was reported by Parmar and Karetha (2020) in dragon fruit.

Ascorbic acid (mg 100 g^{-1})

The data presented in Table 1 clearly indicated that the ascorbic acid (mg 100 g^{-1}) significantly different between both varieties. It may be due to the varietal character of dragon fruit by Parmar and Karetha (2020). Maximum ascorbic acid (10.07 mg 100 g^{-1}) of fruit was noted in butter paper water resistance white bag (B_8), which was statistically at par with the treatment B_5 (non-woven red bag) and B_3 (butter paper white bag) *i.e.*, 9.97 and 9.85 mg 100 g^{-1} respectively. Whereas lowest ascorbic acid (9.29 mg 100 g^{-1}) was recorded in B_1 (control) (Table 1). Among different type of bagging, ascorbic acid content was found maximum in butter paper water resistance white bag which was at par with and butter paper white bag. Ascorbic acid is the heat labile phyto-nutrients (Borochov-Neori *et al.*, 2011). The interaction effect of variety and type of bagging material on ascorbic acid (mg 100 g^{-1}) of fruit was found non-significant (Table 2).

Shelf Life (Days)

The data presented in (Table 1) clearly indicated that the shelf life (9.53 days) and minimum edible portion (75.64%) was observed in Red Flesh variety. The minimum fruit shelf life (9.33 days) was noticed in White Flesh variety. The result presented in (Table1) clearly indicated that the maximum shelf life (10.69 days) was observed in fruits bagged with butter paper water resistance white bag and the minimum shelf life (8.17 days) was noticed fruits not bagged (control). This might be due to reduced water loss in the fruits bagged with these bags whereas, increased or rapid water loss in fruits bagged with other bags and also in control. Bagging modified the microenvironment near fruit especially in respect to temperature and humidity (Haldankar *et al.*, 2015). The interaction effect of variety and type of bagging material on shelf life (days) of fruit was found significant. It is evident from the data presented in (Table 2) that the maximum shelf life (10.80 days) was observed in Red Flesh variety fruit bagged with butter paper water resistance white bag.

Conclusion

In the present study, the fruit bagging with white paper water resistant bag having water resistance could decrease thickness of peel, increase edible portion and shelf life. Moreover, fruit bagging has also benefited to checked incidence of pest and diseases, bird damage *etc*. Since the bagging improves the overall physical parameter traits, owing this study suggested that fruit bagging can effectively be used to improve fruit physico-quality and shelf life of dragon fruit varieties.

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