

Effect of Paclobutrazol and GA₄₊₇ on post-harvest storage of dragon fruit [*Hylocereus costaricensis* (Web.) Britton and Rose]

Abstract

Dragon fruit undergoes rapid senescence during storage. This study identified the synergistic effect of Paclobutrazol and GA₄₊₇ with different concentrations on the postharvest quality and shelf life of dragon fruits stored at ambient conditions. This study was conducted in completely randomized design. Dragon fruits were treated with different concentration of Paclobutrazol and GA₄₊₇ and stored at ambient temperature for 13 days. Changes in fruit's physiological loss of weight, firmness, total soluble solid, titrable acidity, and ascorbic acid were periodically recorded. The results indicated that the Paclobutrazol treated with 200mg significantly reduced the decrease of physiological loss of weight, firmness, total soluble solids, titrable acidity and ascorbic acid content. The results showed that Paclobutrazol treated with 200mg is the most effective treatment than GA₄₊₇ for improving the postharvest quality and prolong the shelf life of dragon fruits when stored at ambient condition.

Key words: Dragon fruit, Paclobutrazol, GA₄₊₇, Ambient condition

Introduction

The dragon fruit (*Hylocereus sp.*) is a perennial and long day plant (Jiang *et al.*, 2012) and belongs to cactaceae family. Dragon fruit is also known by many other names like Pitaya, Night blooming cereus, Strawberry pear, Belle of the night and Cinderella plant (Perweenet *al.*, 2018). It ~~is~~ originated in tropical & sub-tropical region of Mexico, Central America and Northern South America (Kakade *et al.*, 2020). Mostly three types of Dragon fruits cultivated in different zones of countries namely *Hylocereus undatus*, *Hylocereus costaricensis* and *Hylocereus megalanthus* according to Hunt, 2006 and Hamidah *et al.*, 2017. According to Harithpriya K. & Jeychandran R., (2019) the leading producer of dragon fruit is the Vietnam where it was introduced 100 years ago where it accounts for more than half (51.1%) of global production across an area of 55, 419 hectares. China is the second-largest producer of dragon fruit. According to Wakchaure *et al.*, (2020), dragon fruit productivity in India is estimated to be between 8.0 and 10.5 (MT/ha). The top three states in India for dragon fruit production are Gujarat, Karnataka, and Maharashtra, accounting for over 70% of total production. The dragon fruit ~~contain~~ contains the water (80-90g), Ascorbic acid (4-25mg), Ash (0.4-0.7g), Calcium (6-10mg), Calories (35-50) and Carbohydrates (9-14g) etc. The dragon fruit is

beneficial for ~~promotes~~promoting the healing of wounds and cuts, ~~improve~~improving appetite, ~~improve~~improving eye sight and aid in weight reduction etc. (Rao and Sasanka, 2015). In the present experiment, two chemicals ~~was~~were used that is ~~the~~ Paclobutrazol and GA₄₊₇. Khader, (1990) reported that application of paclobutrazol at the rate of 2000mg and 3000mg per litre of water attained better quality as judged from the total soluble solids, total acidity, ascorbic acid content from harvest to 12 days of storage at ambient conditions. According to Jawandhaet *al.*, (2012), applying growth regulators such gibberellin influences the physicochemical characteristics of ber fruits and is known to extend their shelf life. Hence, the present study is conducted on the Effect of Paclobutrazol and GA₄₊₇ on ~~post-harvest~~post-harvest storage of dragon fruit [*Hylocereus costaricensis* (Web.) Britton and Rose]”

Comment [UA1]: There is no statement that why the researcher was doing this experiment in first place.

Materials and methods

The present experiment entitled ~~that~~ “Effect of Paclobutrazol and GA₄₊₇ on storage of dragon fruit [*Hylocereus costaricensis* (Web.) Britton and Rose]” was carried out during the period 2022-23 to 2023-24 at Main Experimental Station of Fruit Science and analysis of fruit of each parameters was done in the PG laboratory of fruit Science, College of Horticulture and Forestry, A.N.D.U.A. & T., Kumarganj, Ayodhya 224229 (UP). Paclobutrazol and GA₄₊₇ were applied in the field where Paclobutrazol was applied as soil drench and GA₄₊₇ as foliar spray (after sun set) through Randomized Block Design. To determine the weight loss of the fruit during storage, both treated and control fruit were weighed at different sampling intervals of 0, 3, 5, 7, 9, 11 and 13 days after harvesting of fruit. The percentage of weight loss was calculated as the difference between initial fruit weight and the fruit weight at the time of measurement and expressed in percentage.

Comment [UA2]: What was the concentration of stock and applied solution of chemical? How many treatments were there and how did you apply the treatments to fruit?

Comment [UA3]: Where did you get the fruit? What was the average size of fruit, and how many fruit per treatment was taken? How many replications used? How many fruits were used to measure PLW? What was the room condition of the experimental room; and temperature and humidity?

Comment [UA4]: What are sources and commercial name and % constituents when purchased?

$$PLW (\%) = \frac{\text{Initial fruit weight} - \text{weight of fruit on observation day}}{\text{Initial fruit weight}} \times 100$$

Fruit firmness was measured with the help of Penetrometer by using a 5/16 plunger in kgcm⁻². Total soluble solids of three randomly selected fruits from each replication in each treatment was measured by the using digital hand Refractometer and expressed in ° Brix. To determine the titratable acidity, 10g known quantity of fruit pulp was macerated, diluted, and filtered through muscling cloth using just a small amount of distilled water. The volume ~~had been~~was raised to 100 ml, after which a 5-ml aliquot was taken and titrated using phenolphthalein indicator against a 0.1 N sodium hydroxide solution. The end point was noted when pink colour appeared and sustained for 15 seconds. The result was expressed in percent.

Comment [UA5]: Name and company of the refractometer?

Comment [UA6]: Any reference for this method of analysis?

$$\text{Titration Acidity \%} = \frac{\text{Titre value} \times \text{Normality of alkali} \times 64 \times \text{Volume made up}}{\text{Aliquot taken} \times \text{Weight of Sample} \times 1000} \times 100$$

Ascorbic acid content of the fruits was measured by volumetric method using 2,6-dichlorophenol indophenols dye according to [the](#) procedure suggested by Rangana (1977) and expressed in mg/100g pulp.

$$\text{Vitamin - C (mg/100g)} = \frac{\text{Titre value} \times \text{Dye factor} \times \text{Volume made up}}{\text{Weight of aliquot taken} \times \text{weight of the sample taken}}$$

Statistical analysis

The data recorded from the experiment were analyzed by SAS 9.1 statistical software for each treatment.

Result and discussion

Physiological loss of weight (%)

A perusal data of Table no. - 1 revealed that physiological loss [inf](#) weight increased with the increases day of the storage during both the years (2022-23 and 2023-24). Minimum physiological loss of weight (1.36% and 1.39%) was observed in treatment T2 (Paclobutrazol @ 200mg) and T5 (GA₄₊₇@ 200mg) respectively, on the 3rd day of storage. However, maximum physiological loss of weight (14.99%) was observed in treatment T1 (control) followed by the T7 (GA₄₊₇@ 600mg) 14.28% and T4 (Paclobutrazol @ 600mg) 13.54% respectively, on 11th day of storage during the year 2022-23. Similarly, during 2023-24 minimum physiological loss of weight (1.35% and 1.36%) was observed in treatment T2 (Paclobutrazol @ 200mg) and T5 (GA₄₊₇@ 200mg) respectively, on the 3rd day of storage. However, maximum physiological loss of weight (14.18%) was observed in treatment T1 (control) followed by the T7 (GA₄₊₇@ 600mg) 13.47% and T6 (GA₄₊₇@ 400mg) 12.81% respectively, on 11th day of storage during the year 2023-24. Patel *et al.*, (2020) observed that paclobutrazol applied at the rate of 100mg per litre significantly increased the shelf life (days) in mango. Purohit *et al.*, (2003) reported that physiological loss in weight (PLW) and rotting were lowest in fruits treated with PBZ during twelve days of storage.

Table No. 1: Effect of Paclobutrazol and GA4+7 on physiological losses [line#](#) weight of dragon fruit during storage at ambient condition.

Comment [UA7]: Looking at table I can not assume at which level the p value were significant. It has to be tested for each day of measurement and ANOVA need to be down.

2022-23									2023-24								
Treatment	1 st Day	3 rd Day	5 th Day	7 th Day	9 th Day	11 th Day	13 th Day	Mean	Treatment	1 st Day	3 rd Day	5 th Day	7 th Day	9 th Day	11 th Day	13 th Day	Mean
T1(control)	0	3.31	5.74	8.29	11.11	14.99	*	8.68a	T1(control)	0	3.29	5.78	8.36	11.16	14.18	*	8.55a
T2(PBZ@ 200mg)	0	1.36	3.16	5.26	7.42	10.22	11.98	6.56d	T2(PBZ@ 200mg)	0	1.35	3.13	5.19	7.34	9.58	11.09	6.28d
T3(PBZ@ 400mg)	0	1.76	3.91	6.26	8.76	11.74	*	6.48f	T3(PBZ@ 400mg)	0	2.07	4.17	6.53	9.06	11.74	*	6.71e
T4(PBZ@ 600mg)	0	2.67	5.05	7.56	10.27	13.54	*	7.81d	T4(PBZ@ 600mg)	0	1.79	3.81	6.11	8.51	11.12	*	6.26f
T5(GA4+7@ 200mg)	0	1.39	3.34	5.59	7.90	11.05	12.27	6.92c	T5(GA4+7@ 200mg)	0	1.36	2.28	5.46	7.73	10.23	11.71	6.46c
T6(GA4+7@ 400mg)	0	2.09	4.27	6.70	9.32	12.50	*	6.97e	T6(GA4+7@ 400mg)	0	2.70	4.89	7.35	10.01	12.81	*	7.55d
T7(GA4+7@ 600mg)	0	3.10	5.51	8.18	10.96	14.28	*	8.40b	T7(GA4+7@ 600mg)	0	3.06	5.36	7.89	10.58	13.47	*	8.07b
Mean	0	2.24e	4.42d	6.83c	9.39b	12.61a	12.12f		Mean	0	2.23e	4.20d	6.69c	9.19b	11.87a	11.40f	
LSD (0.05%)	Days=0.071 Treatment=0.077								LSD (0.05%)	Days=0.085 Treatment= 0.092							

Table No. 2: Effect of Paclobutrazol and GA4+7 on firmness of dragon fruit during storage at ambient condition.

Comment [UA8]: Comment same as table no 1. Which method of mean comparison was used not known in Method section.

2022-23									2023-24								
Treatment	1 st Day	3 rd Day	5 th Day	7 th Day	9 th Day	11 th Day	13 th Day	Mean	Treatment	1 st Day	3 rd Day	5 th Day	7 th Day	9 th Day	11 th Day	13 th Day	Mean
T1(control)	4.79	4.61	4.30	3.87	3.49	3.07	*	4.02f	T1(control)	4.84	4.65	4.35	3.92	3.48	3.01	*	4.04f
T2(PBZ@ 200mg)	5.60	5.49	5.36	5.11	4.79	4.43	3.58	4.90a	T2(PBZ@ 200mg)	5.62	5.52	5.37	5.11	4.80	4.43	4.02	4.98a
T3(PBZ@ 400mg)	5.40	5.27	5.03	4.73	4.41	3.91	*	4.79c	T3(PBZ@ 400mg)	5.48	5.33	5.10	4.79	4.45	3.99	*	4.85c
T4(PBZ@ 600mg)	5.31	5.16	4.95	4.64	4.33	3.86	*	4.70d	T4(PBZ@ 600mg)	5.32	5.15	4.95	4.63	4.26	3.81	*	4.68d
T5(GA4+7@ 200mg)	5.53	5.43	5.28	5.10	4.71	4.38	3.55	4.85a	T5(GA4+7@ 200mg)	5.55	5.41	5.24	4.97	4.64	4.27	3.62	4.81b
T6(GA4+7@ 400mg)	5.44	5.32	5.17	4.93	4.52	3.98	*	4.89b	T6(GA4+7@ 400mg)	5.51	5.35	5.16	4.88	4.53	4.08	*	4.91c
T7(GA4+7@ 600mg)	5.14	4.98	4.70	4.37	3.99	3.56	*	4.45e	T7(GA4+7@ 600mg)	5.26	5.09	4.84	4.50	4.12	3.84	*	4.60e
Mean	5.31a	5.18b	4.97c	4.67d	4.32e	3.88f	3.56g		Mean	5.36a	5.21b	5.00c	4.68d	4.32e	3.91f	3.82g	
LSD (0.05%)	Days= 0.071 Treatment= 0.076								LSD (0.05%)	Days=0.072 Treatment=0.078							

Table No. 3: Effect of Paclobutrazol and GA4+7 on total soluble solids of dragon fruit during storage at ambient condition.

Comment [UA9]: Same as table 1 and 2

2022-23									2023-24								
Treatment	1 st Day	3 rd Day	5 th Day	7 th Day	9 th Day	11 th Day	13 th Day	Mean	Treatment	1 st Day	3 rd Day	5 th Day	7 th Day	9 th Day	11 th Day	13 th Day	Mean
T1(control)	13.15	13.29	13.72	14.65	13.55	11.92	*	13.38d	T1(control)	13.17	13.31	13.68	14.61	13.90	12.07	*	13.45d
T2(PBZ@ 200mg)	14.32	14.51	15.00	16.05	15.23	13.80	12.01	14.41a	T2(PBZ@ 200mg)	14.63	14.82	15.26	16.29	15.37	14.08	12.61	14.72a
T3(PBZ@ 400mg)	14.18	14.39	14.83	15.86	15.04	13.49	*	14.63ab	T3(PBZ@ 400mg)	14.48	14.65	15.09	16.04	15.06	13.68	*	14.83bc
T4(PBZ@ 600mg)	14.22	14.43	14.88	15.53	14.76	13.23	*	14.50b	T4(PBZ@ 600mg)	14.29	14.46	14.87	15.81	14.88	13.42	*	14.62c
T5(GA4+7@ 200mg)	14.24	14.50	14.91	15.97	15.30	13.83	12.15	14.41a	T5(GA4+7@ 200mg)	14.51	14.73	15.08	16.09	15.12	13.79	12.27	14.51ab
T6(GA4+7@ 400mg)	14.16	14.33	14.72	15.91	15.03	13.45	*	14.60b	T6(GA4+7@ 400mg)	14.42	14.63	14.96	15.96	15.01	13.61	*	14.76bc
T7(GA4+7@ 600mg)	13.76	14.02	14.35	14.93	13.96	12.33	*	13.89c	T7(GA4+7@ 600mg)	14.34	14.57	14.86	15.85	14.92	13.47	*	14.66c
Mean	14.00d	14.21c	14.63b	15.55a	14.69b	13.15e	12.08f		Mean	14.26c	14.45c	14.82b	15.80a	14.89b	13.44d	12.44e	
LSD (0.05%)	Days=0.174 Treatment=0.188								LSD (0.05%)	Days=0.199 Treatment= 0.215							

Table No. 4: Effect of Paclobutrazol and GA4+7 on titratable acidity of dragon fruit during storage at ambient condition.

Comment [UA10]: Same as table 1 and 2.

2022-23									2023-24								
Treatment	1 st Day	3 rd Day	5 th Day	7 th Day	9 th Day	11 th Day	13 th Day	Mean	Treatment	1 st Day	3 rd Day	5 th Day	7 th Day	9 th Day	11 th Day	13 th Day	Mean
T1(control)	0.255	0.239	0.220	0.194	0.150	0.062	*	0.186a	T1(control)	0.251	0.221	0.196	0.164	0.129	0.067	*	0.171a
T2(PBZ@ 200mg)	0.219	0.199	0.176	0.146	0.114	0.103	0.081	0.148e	T2(PBZ@ 200mg)	0.207	0.191	0.171	0.146	0.109	0.093	0.078	0.142b
T3(PBZ@ 400mg)	0.233	0.211	0.188	0.160	0.129	0.098	*	0.169c	T3(PBZ@ 400mg)	0.212	0.192	0.168	0.140	0.101	0.080	*	0.148c
T4(PBZ@ 600mg)	0.237	0.217	0.196	0.171	0.131	0.099	*	0.175b	T4(PBZ@ 600mg)	0.220	0.197	0.170	0.138	0.105	0.082	*	0.152b
T5(GA4+7@ 200mg)	0.221	0.202	0.180	0.151	0.117	0.085	0.064	0.145d	T5(GA4+7@ 200mg)	0.210	0.189	0.165	0.136	0.101	0.083	0.068	0.136c
T6(GA4+7@ 400mg)	0.234	0.215	0.192	0.164	0.134	0.101	*	0.173b	T6(GA4+7@ 400mg)	0.215	0.193	0.167	0.135	0.100	0.078	*	0.148c
T7(GA4+7@ 600mg)	0.243	0.221	0.194	0.162	0.129	0.091	*	0.173b	T7(GA4+7@ 600mg)	0.217	0.193	0.164	0.129	0.092	0.090	*	0.148d
Mean	0.234a	0.214b	0.192c	0.164d	0.130e	0.091f	0.072g		Mean	0.218a	0.196b	0.171c	0.141d	0.105e	0.081f	0.073g	
LSD (0.05%)	Days= 0.002 Treatment=0.003								LSD (0.05%)	Days=0.0028 Treatment=0.003							

Table No. 5: Effect of Paclobutrazol and GA4+7 on ascorbic acid of dragon fruit during storage at ambient condition.

Comment [UA11]: Same as table 1 and 2.

2022-23									2023-24								
Treatment	1 st Day	3 rd Day	5 th Day	7 th Day	9 th Day	11 th Day	13 th Day	Mean	Treatment	1 st Day	3 rd Day	5 th Day	7 th Day	9 th Day	11 th Day	13 th Day	Mean
T1(control)	12.04	11.78	11.44	11.02	10.38	9.41	*	11.01e	T1(control)	12.08	11.89	11.63	11.29	10.87	10.23	*	11.33e
T2(PBZ@ 200mg)	12.81	12.68	12.52	12.32	12.05	11.66	10.21	12.03a	T2(PBZ@ 200mg)	12.98	12.88	12.75	12.59	12.38	12.10	11.13	12.40a
T3(PBZ@ 400mg)	12.74	12.54	12.28	11.95	11.44	10.70	*	11.94bc	T3(PBZ@ 400mg)	12.91	12.78	12.61	12.39	12.09	11.63	*	12.40abc
T4(PBZ@ 600mg)	12.76	12.59	12.36	12.04	11.58	10.91	*	12.04bc	T4(PBZ@ 600mg)	12.78	12.61	12.38	12.08	11.69	11.09	*	12.10d
T5(GA4+7@ 200mg)	12.78	12.63	12.43	12.16	11.77	11.23	10.07	11.86ab	T5(GA4+7@ 200mg)	12.93	12.81	12.67	12.47	12.20	11.81	10.61	12.21ab
T6(GA4+7@ 400mg)	12.71	12.50	12.23	11.88	11.32	10.49	*	11.85c	T6(GA4+7@ 400mg)	12.87	12.73	12.53	12.27	11.94	11.43	*	12.29bcd
T7(GA4+7@ 600mg)	12.55	12.32	12.02	11.63	11.03	10.14	*	11.61d	T7(GA4+7@ 600mg)	12.83	12.67	12.46	12.19	11.84	11.28	*	12.21cd
Mean	12.62a	12.43a	12.18b	11.85c	11.36d	10.64e	10.14f		Mean	12.76a	12.62ab	12.43b	12.18c	11.85d	11.36e	10.87f	
LSD (0.05%)	Days= 0.209 Treatment= 0.225								LSD (0.05%)	Days=0.209 Treatment= 0.226							

Changes in firmness

A perusal data of Table No.- 2 revealed that firmness decreased with the increases day of the storage during both the years (2022-23 and 2023-24). On first day of storage, maximum firmness (5.60) was observed in the treatment T2 (Paclobutrazol @ 200mg) followed by the T5 (GA₄₊₇@ 200mg) 5.53 while, minimum firmness (4.79) was observed in the treatment T1 (control). However, minimum firmness (3.07) was observed on 11th day of storage followed by the T5 (GA₄₊₇@ 200mg) 3.55 during the year 2022-23. Similarly, during 2023-24 on first day of storage, maximum firmness (5.62) was observed in the treatment T2 (Paclobutrazol @ 200mg) followed by the T5 (GA₄₊₇@ 200mg) 5.55 while, minimum firmness (4.84) was observed in the treatment T1 (control). However, minimum firmness (3.01) was observed in the treatment T1 (control) on 11th day of the storage followed by the T5 (GA₄₊₇@ 200mg) 3.62 on 13th day of the storage. Bill *et al.*, (2012) observed that PBZ decreased fruit firmness and increased the percentage soft fruit at the end of the shelf-life period in persimmon.

Changes in TSS (° Brix)

A perusal data of Table No.- 3 revealed that total soluble solids increased with the increases day of the storage up to 7th day after that decreased during both the years (2022-23 and 2023-24). Maximum total soluble solids (16.05⁰ B and 15.97⁰ B) were observed in the treatment T2 (Paclobutrazol @ 200mg) and T5 (GA₄₊₇@ 200mg) respectively, on 7th day of the storage. However, minimum total soluble solids (11.92⁰ B) was observed in the treatment T1 (control) on 11th day of storage during the year 2022-23. Similarly, during 2023-24 maximum total soluble solids (16.29⁰ B and 16.09⁰ B) was observed in treatment T2 (Paclobutrazol @ 200mg) and T5 (GA₄₊₇@ 200mg) respectively, on the 7th day of storage. However, minimum total soluble solids (12.07⁰ B) was observed in treatment T1 (control) on 11th day of storage. Khader, (1990) reported that application of paclobutrazol at the rate of 2000mg and 3000mg per litre of water attained better quality as judged from the total soluble solids from harvest to 12 days of storage at ambient conditions.

Changes in titrable acidity (%)

A perusal data of Table No.- 4 revealed that titrable acidity decreased with the increases day of the storage during both the years (2022-23 and 2023-24). On 1st day of storage minimum titrable acidity (0.219%) was observed in the treatment T2 (Paclobutrazol @ 200mg) followed by the T5 (GA₄₊₇@ 200mg) 0.221% while, maximum titrable acidity (0.255%) was observed in the treatment T1 (control). However, minimum titrable acidity

(0.062%) was observed in the treatment T1 (control) on 11th day of storage followed by the T5 (GA₄₊₇@ 200mg) on 13th day of storage during 2022-23 year. Similarly, during 2023-24 on first day of storage minimum acidity (0.207%) was observed in the treatment T2 (Paclobutrazol @ 200mg) followed by the T5 (GA₄₊₇@ 200mg) 0.210% while, maximum titrable acidity (0.251%) was observed in the treatment T1 (control). However, minimum titrable acidity (0.067%) was observed in the treatment T1 (control) on 11th day of storage followed by the T5 (GA₄₊₇@ 200mg) 0.068% on 13th day of the storage. Purohit *et al.*, (2003) reported that acidity contents of the fruits decreased with the increases days of the storage fruits that treated by Paclobutrazol.

Changes in Ascorbic acid (mg/100g)

A perusal data of Table No.- 5 revealed that ascorbic acid decreased with the increases day of the storage during both the years (2022-23 and 2023-24). On first day of storage, maximum ascorbic acid (12.81mg) was observed in the treatment T2 (Paclobutrazol @ 200mg) followed by the T5 (GA₄₊₇@ 200mg) 12.78mg while, minimum ascorbic acid (12.04mg) was observed in the treatment T1 (control). However, minimum ascorbic acid (9.41mg) was observed on 11th day of storage followed by the T5 (GA₄₊₇@ 200mg) 10.07mg during the year 2022-23. Similarly, during 2023-24 on first day of storage, maximum ascorbic acid (12.98mg) was observed in the treatment T2 (Paclobutrazol @ 200mg) followed by the T5 (GA₄₊₇@ 200mg) 12.93mg while, minimum ascorbic acid (12.08mg) was observed in the treatment T1 (control). However, minimum ascorbic acid (10.23mg) was observed in the treatment T1 (control) on 11th day of the storage followed by the T5 (GA₄₊₇@ 200mg) 10.61mg on 13th day of the storage. Purohit *et al.*, (2003) reported that ascorbic acid contents of the fruits decreased with the increases days of the storage fruits that treated by Paclobutrazol.

Conclusion

It is concluded that the application of Paclobutrazol treated with 200mg noted significantly better results in terms of minimum physiological losses, highest firmness, and quality parameter such as total soluble solids, titrable acidity and ascorbic acid content. It was followed by T5 (GA₄₊₇@ 200mg) dragon fruits storage at ambient conditions.

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Comment [UA12]: This is actually result of the experiment but where is the conclusion of this study.

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