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Studies on preparation of aonla candy with different brix concentration and steeping time

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Abstract
An experiment entitled "Studies on preparation of aonla candy with different brix concentration and steeping time" was carried out during year 2020-2021 at Post Harvest Technology Laboratory, Department of Horticulture, College of Agriculture, Nagpur with the experiment was laid out in Factorial Completely Randomized Design (FCRD), with two factors, as factor A Brix concentration of aonla candy *viz.*, T_1 (50^0 B Sugar concentration), T_2 (55^0B Sugar concentration), T_3 (60^0 B Sugar concentration) and factor B steeping time of aonla candy *viz.*, S_1 (4 Days of steeping time), S_2 (8 Days of steeping time), S_3 (12 Days of steeping time) with 9 treatment combinations and replicated in thrice. The observations in respect of physical analysis of fresh aonla fruits, chemical analysis were recorded from periodically at an interval of 30 days. From the finding, it was observed that, there was gradual increase in TSS, Protein, reducing sugars, total sugars content of aonla candy irrespective of steeping time and brix concentration used in experimentation. However moisture, titratable acidity, ascorbic acid, fiber and non- reducing sugars content of aonla candy found to decreased with advancement of storage period.

Keywords: Aonla, candy, *Phyllanthus emblica*, physicochemical properties, Indian gooseberry

Introduction
Aonla (*Phyllanthus emblica*), the king of arid fruits, popularly known as Indian Gooseberry is a minor Sub-tropical deciduous tree indigenous to Indian sub-continents. India ranks first in the world in aonla area and production volume. The tree belongs to the family of Euphorbiaceae botanically known as *Phyllanthus Emblica.* It is known by different names like Amla, Amalakki, Nelli, Indian Gooseberry etc. The main varieties of aonla are Banarasi, Chakaiya, Hathijhool, Bansi Red, Pink- tinged and NA-7. The aonla gets ready for harvesting during November-December. However, the fruit may be allowed to remain on the tree till February without much fruit drops. A fully mature aonla tree may yield 250-300 kg of fruit annually.

Aonla is the one of the oldest Indian fruits and considered as "Wonder fruit for health" because of its unique qualities. It has played an important therapeutic role from time immemorial and is frequently recommended for its synergistic effects in both the ayurvedic and unani systems of medicine. It is the highest source of vitamin C (478.56 mg/100 ml). In addition to Vitamin C, it also contains calcium, iron, protein and tannic acids, sugars, phosphorous, carbohydrates etc. Aonla primarily contains tannins, alkaloids, phenolics compounds, amino acids and carbohydrates. The fruit is highly perishable in nature. Its storage life in atmospheric conditions after harvesting is only 5-6 days. The fresh fruits are generally not consumed due to their high astringency but it has got great potential in processed forms. Hence attention has been focused on the preparation of different value added products from aonla. Candy is a sweet food prepared from fruits or vegetables by impregnating them with sugar syrup followed by draining of excessive syrup and then drying the product to a shelf stable state. White sugar is the usual sweetening agent used in preparation of candies. Such sugar contains sucrose (99.7%). Aonla candies are becoming more and more popular because of high acceptability, minimum volume, higher nutritionally value and longer storage life. These have additional advantages of being least thirst provoking and ready to eat snacks (Vikram *et al.* 2014) [21]. The dried products save energy, money and space in packaging, storage and transportation (Nayak *et al.* 2012) [11]. Aonla is presently an underutilized fruit, but has enormous potential in the world market. It is almost entirely unknown in the world market and needs to be popularized. In view of the health benefits, there is need to make the fruits more and more amenable to value added products. Among the unique products of aonla, the candy has much demand in domestic as well as export point of view.

To strengthen market, storability and superior quality of aonla candy is of prime importance. Hence, the attempt to processing aonla to various value added products like aonla candies will be helpful in alleviating distress sale of the aonla fruits often observed in the market when the harvesting reaches the peak. Therefore, the present work has been attempted to investigate the effects of sucrose concentration on the physicochemical properties of aonla candy.

Materials and Methods

Well matured, healthy and uniform size fruits variety Kanchan were carefully harvested from Regional Fruit Reasearch Station, Katol and brought to the laboratory for further experimentation. The selected fruit were thoroughly washed with clean tap water to remove the dirt and dust particles adhered to pericarp of the fruit. Healthy and good quality matured fruits were selected for candy preparation and fruit boil in water till it become soft. For experimentation then seed were removed and segments were separated. The product was prepared by dipping the segments in successive increasing concentration of sugar syrup at room temperature till equilibrium at 50, 55, 60^0 Brix was reached as per the method described by Tondon *et al.* (2003) [18].

Firstly 50^0Brix sugar syrup was prepared to which pre-treatment segments were transferred. After soaking for 24 hours, the segments were taken out and syrup were drained and their concentration were shifted 50, 55, 60^0Brix concentration by adding sugar at proper proportion. The required quantity of sugar were added subsequently to obtained the required 50, 55, 60^0Brix strength of syrup. The syrup concentration was increased by 5^0 Brix every time until the concentration reached up to 50, 55, 60^0Brix. Finally the fruit segments was kept in 50, 55, 60^0Brix syrup solution of sugar according to the treatment for three different steeping period *viz.* 4,8,12 days respectively until the equilibrium was reached between segments and the sugar syrup concentration. Finally, the segments impregnated in each treatment was drained free of syrup and rinse immediately with the tap water to remove the adhere sugar solution and dried in shade till the moisture content noticed up to 12%. After drying, the candy was packed in 250 guage polythene bags and stored under ambient condition. The chemical observations were recorded at every 30 days interval up to 120 days until the candy remains acceptable and record maximum consumer acceptability. Changes in nutritional composition in terms of moisture, protein and fiber contents of aonla candy was determined as per method mentioned by the Association of official Analytical Chemists (2000). Oven drying method (at 105^0 C for 6 hours) was used to determine the moisture content of the samples. The protein (N x 6.25) content of the samples was determined by the Kjeldhal method. Meanwhile, Total solids of candy were determined by subtracting the moisture content from 100 whereas titratable acidity; reducing and total sugars were estimated as described by Ranganna (1986) [13]. Vitamin C content was determined by the titration method described by Srivastava and Kumar (1994) [22]. Each experiment was repeated in triplicate. The statistical analysis of the data was done by the method described by Panse and Sukhatme (1967) [12] using C.R.D. factorial experiment.

Result and Discussions

Physical characteristics of fresh aonla fruits (At the time of preparation of candy)

The data pertaining to physical characteristics of fresh aonla fruits have been presented in Table 1 Full matured, diseased free fruits of fresh aonla physical properties recorded the fruits were medium to large conical at apex. Skin smooth apricot yellow in colour with pink blush. The average weight, volume, length and specific gravity, 35.5 g, 31.91 cm^3, 3.2 cm, 1.16 g/cc respectively.

Chemical characteristics of fresh aonla fruits.

The fresh aonla fruits were evaluated for various chemical characteristics and the results recorded presented in Table 2. From the table it is recorded that, the average moisture percent were recorded as 83.36 percent. As regards to chemical composition, the fully matured diseased free aonla fruit recorded 14.20^0 Brix TSS, 11.59 percent acidity, 392 g/100 g fruits ascorbic acid, 17.04 percent fiber, 2.66 percent protein, 18.19 percent reducing sugars, 10.65 percent non-reducing sugars, 28.84 percent total sugars, respectively

Changes in proximate composition of aonla candy during storage

Moisture content

The data regarding chemical composition of final product are presented in table 3. All samples were analyzed five times, for 4 months with an interval of 1 month, Table 3 showed a trend of gradual decreased of moisture content were found decreased throughout the storage period irrespective of steeping time. Whereas freshly prepared candy with 50^0 B sugar solution were shown to contain 11.96% moisture, after 1 month the moisture content were showed to decrease to 11.85% and nutrient content was decreased. Similarly, after 4 month, the moisture content was decreased to 11.38% and nutrient content was moderately decreased compare to initial month. Candy with 55^0B and 60^0B sugar solution was followed with similar trend of having moderately decreased nutrient content during storage. The decrease in moisture content in aonla candy with an increase in storage period might be due to the evaporation of moisture from the stored candy. Decreased in moisture with storage of candies were also reported by Tripathi and Singh (1988) [19] in aonla candy, Mehta *et al.* (2005) [8] in galgal peel candy. Rani and Bhatia (1985) [14] reported maximum loss in moisture content in pear candy. The similar results were also reported by Lathar *et al.* (2007) [6] in aonla candy.

Total soluble solids (^{O}B)

The data pertaining to the interaction effect in respect of total soluble solids content of aonla candy as influenced by different brix concentration and steeping time at ambient storage condition was recorded up to 120 days of storage and presented in Table 3. At 0 days of storage maximum TSS was recorded by T_3S_3 (62.51^0B) were as minimum TSS were recorded in treatment combinations T_1S_1 (50.33^0B) followed by similar trend and recorded at 30, 60, 90,120 days. At 120 days maximum TSS was recorded by T_3S_3 (62.93^0B) and was found significantly higher than all other treatments were minimum TSS was registered in treatment combinations T_1S_1 (50.72^0B). This might be due to conversion of polysaccharides into sugars during hydrolysis process. Increase in TSS might also be attributed to the reduction in moisture contents of the product with the advancement of storage. Increase in TSS with storage period was also reported by Tripathi *et al.* (1988) [19] in aonla products, Manivasagan *et al.* (2006) [7] in Karonda candy and Rani and Bhatia (1985) [14] in pear candy were recorded similar trend.

Titratable acidity (%)

The data regarding the interaction effects of brix concentration and steeping time on titratable acidity (%) of aonla candy was presented in Table 3. An interaction effects of brix concentration and steeping time on titratable acidity (%) of aonla candy was found non- significant between 0 to 120 days except 30 days of storage. At 30 days of storage maximum acidity was recorded T_1S_1 (0.78%) and was found significant higher than all other treatment. The decrease in titratable acidity during storage might be happened due to the co-polymerization of organic acids with sugars and amino acids and loss of volatile acids during storage. Similar findings were also reported by Tripathi *et al*. (1988) [19] and showed decrease in titratable acidity with advancement of storage. The reduction in acidity from 0.17 to 0.07 percent during storage in pear candy was observed when stored at room temperature Rani and Bhatia (1985). Similar results were also reported in aonla candy by tripathi *et al.* (1988) [19]; in apple candy and Sharma *et al.* (1998) [16] also in Citrus peel candy Mehta and Bajaj (1984) [9].

Ascorbic acid (mg/100g)

The data pertaining the interaction effects of different brix concentration and steeping time on ascorbic acids content of aonla candy are presented in Table 3. An interaction effect of brix concentrations and steeping time on ascorbic acid content of aonla candy was found to be significant at all stages at 0 to 120 days of storage. At 0 days of storage, maximum ascorbic acid was found in treatment T_1S_1 (360.54 mg/100 g) and found significantly superior to all other treatment. At the end of 120 days of storage maximum ascorbic acid was found in treatment T_1S_1 (326.27 mg/100 g) and minimum ascorbic acids was recorded in T_3S_3 (113.16 mg/100 g).The vitamin C content were found to be decrease with the advancement of storage of candy. Reduction in vitamin C might be due to oxidation trapped by oxygen in polythene pouch which results to in formation of dehydroascorbic acid. Loss in ascorbic acid content was also observed by Sethi (1980) [15] in aonla preserve, Tripathi *et al.* (1988) in aonla products, Rani and Bhatia (1985) [14] in Pear candy and Kumar Singh (2001) [5] in different aonla products. Manivasagan *et al.* (2006) [7].

Fiber content (%)

The representing interaction effects of different brix concentration and steeping time on fiber content of aonla candy are presented in Table 4. An interaction effects of different brix concentration and steeping time on fiber content of aonla candy was found to be significant 30, 60, 90,120 days except 0 days. At 0 days non- significant differences was recorded. At 30 days of storage maximum fiber content was recorded in T_1S_1 (1.18%). At 120 day storage, maximum fiber content was recorded in treatment T_1S_1 (1.11%) and was found significantly superior to all other treatment and minimum in treatment T_3S_3 (0.80%). The decrease in fiber content in aonla candy with an increase in storage period might be due to the existence of fiber content comes from the aonla itself, however there was a tendency that the higher network of the cell wall changes which increase the progressive dissolution of pectin substances due to the enzyme activity. In ginger candy same result was observed by Alam *et al.* (2018) [1]. Loss in fiber content of aonla candy decrease with progressive increase in storage period was also reported by Patel *et al.* (2013) [23] and Mondal *et al.* (2017) [10].

Protein content (%)

The data regarding the interaction effect of different brix concentration and steeping time on protein content % of aonla candy are presented in Table 4. An interaction effects of different brix concentration and steeping time on protein content of aonla candy was found to be significant at all stages of observation. At 0 days of storage maximum protein content was recorded in treatment T_1S_1 (2.60%) and minimum protein content in treatment T_3S_3 (2.36%). After 120 days of storage, protein content aonla candy was ranged from (2.90%) to (2.50%) being maximum in treatment T_1S_1 (2.90%) and minimum in treatment T_3S_3 (2.50%). The protein content in aonla candy increased significantly with progressive increase in storage period. These results are in conformity with the results obtained by Mondal *et al.* (2017) [10].

Reducing Sugars (%)

The data regarding the interaction effects of different brix concentration and steeping time on reducing sugars of aonla candy was presented in Table 4. An interaction effect of different brix concentration and steeping time on reducing sugars % of aonla candy was found to be significant at 0 to 120 days of storage. At 0 days of storage maximum reducing sugars are found in treatment combination T_3S_3 (36.49%) whereas minimum reducing sugars was found in treatment combinations T_1S_1 (24.30%)on the processing day while at the end of 120 days of storage, maximum reducing sugar was in treatment T_3S_3 (43.07%) and minimum in treatment T_1S_1 (28.74%). The increase in reducing sugars with advancement of storage might be because of increased degree of inversion of sugars. These findings are in conformity with the results reported by Rani and Bhatia (1985) [14] in pear candy, Mehta *et al.* (2005) [8] in galgal candy and Verma *et al.* (2006) [20] in citrus peel candy.

Non-reducing sugars (%)

The data regarding the interaction effect of different brix concentration and steeping time on non-reducing sugars of aonla candy was presented in Table 4. In general there was decreased in non-reducing sugars % with advancement of storage period. An interaction effect of different brix concentration and steeping time of aonla candy was found significant at 0 to 120 days of storage days. At 0 days of storage maximum non-reducing sugars was found in treatment combination T_3S_3 (38.03%) whereas minimum non-reducing sugars was recorded in treatment combination T_1S_1 (26.66%). Similar trend was also recorded at 30, 60, 90 and 120 days of storage whereas treatment T_3 was found significantly superior over to other treatments. The non-reducing sugars was found to be decreased with the advancement of storage period. This might be due to decrease in non-reducing sugars to inversion of non-reducing sugars to reducing is caused by acid present in products result reported by Nayak *et al*. (2012) [11] in aonla candy.

Total sugars (%)

The data presenting to Table 4 in respect of total sugars as influenced by different brix concentration and steeping time on total sugars % of aonla candy are presented in Table 4. The total sugars of aonla candy increased significantly with increased in storage period. At 0 days of storage period

maximum total sugars was recorded in treatment combination T_3S_3 (74.51%) and minimum was recorded in treatment T_1S_1 (50.96%). Similar trend was recorded at 30, 60, 90 and 120 days of storage period. At 120 days of storage maximum total sugars was recorded in treatment T_3S_3 (77.95%) and minimum total sugars was recorded in treatment T_1S_1 (51.54%). Increase in total sugars content was found increased during storage of aonla candy which could be due to the hydrolysis of polysaccharides resulting in conversion of soluble compounds like sugars. Total sugar content of products was dependent on the total soluble solids. Increase in total sugars throughout the storage might be because of increased degree of inversion of sugars. These results are in conformity with the results reported by Rani and Bhatia (1985) [14] in pear candy, Mehta *et al.* (2005) [8] in galgal peel candy.

Table 1: Physical characteristics of fresh aonla fruit.

Physical parameters	Weight(g)	Volume(cm^3)	Length(cm)	Specific gravity(g/cc)
Observations	35.5 g	31.91 cm^3	3.2 cm	1.16g/cc

Table 2: Chemical characteristics of fresh aonla fruit

Chemical parameters	Moisture (%)	TSS (^{0}B)	Acidity (%)	Ascorbic Acid (mg/100g)	Fiber (%)	Protein (%)	Reducing sugars (%)	Non- reducing sugars (%)	Total sugars (%)
Observations	83.36%	14.2 (^{0}B)	11.59 (%)	392 (mg/ 100 g)	17.04(%)	2.66 (%)	18.19 (%)	10.65 (%)	28.84 (%)

Table 3: Interaction effects of different brix concentration and steeping time on chemical characters of prepared aonla candy during storage

Treatments	Moisture (%) Storage (days)					TSS (^{0}B) Storage (days)					Acidity (%) Storage (days)					Ascorbic acid (mg/100 g) Storage (days)				
	0	30	60	90	120	0	30	60	90	120	0	30	60	90	120	0	30	60	90	120
T_1S_1	11.96	11.85	11.70	11.40	11.38	50.33	50.43	50.55	50.67	50.72	0.79	0.78	0.77	0.76	0.75	360.54	352.04	346.12	335.36	326.27
T_1S_2	11.80	11.75	11.59	11.28	10.93	51.42	51.53	51.63	51.75	51.83	0.70	0.66	0.68	0.67	0.66	275.35	255.26	252.24	241.24	234.17
T_1S_3	11.68	11.63	11.47	11.18	10.63	52.51	52.62	52.70	52.83	52.95	0.61	0.60	0.59	0.58	0.57	157.38	147.29	138.25	127.36	122.19
T_2S_1	11.95	11.84	11.69	11.38	11.37	55.31	55.41	55.53	55.61	55.75	0.77	0.76	0.75	0.73	0.73	359.55	350.25	345.12	335.29	325.25
T_2S_2	11.77	11.75	11.58	11.27	10.52	56.42	56.51	56.61	56.71	56.87	0.68	0.67	0.66	0.65	0.64	253.23	241.22	232.99	226.03	218.26
T_2S_3	11.67	11.62	11.47	11.18	10.62	57.51	57.61	57.73	57.84	57.91	0.60	0.58	0.58	0.58	0.55	156.34	146.26	137.25	126.29	120.19
T_3S_1	11.94	11.83	11.69	11.37	11.36	60.31	60.42	60.51	60.61	60.71	0.75	0.74	0.73	0.72	0.70	358.54	350.25	344.35	344.32	325.17
T_3S_2	11.76	11.74	11.56	11.26	10.91	61.42	61.51	61.62	61.73	61.82	0.66	0.65	0.64	0.63	0.62	231.19	255.12	214.32	202.23	118.27
T_3S_3	11.66	11.58	11.46	11.17	10.61	62.51	62.61	62.72	62.81	62.93	0.57	0.56	0.55	0.54	0.53	155.35	144.25	136.15	127.01	113.16
CD (5%)	-	-	-	-	0.205	0.020	0.035	0.020	0.029	0.020	-	0.017	-	-	-	1.732	1.732	1.851	1.731	1.730

All values are mean± SEM of three replicates

The test values along the same column carrying different superscripts for each composition contents are significantly different (p<0.05) within days.

T_1S_1-50^{0}B concentration+ 4 days of steeping time, T_1S_2- 50^{0}B concentration+ 8 days of steeping time, T_1S_3- 50^{0}B concentration +12 days of steeping time, T_2S_1- 55^{0}B concentration + 4 days of steeping time, T_2S_2- 55^{0}B concentration+ 8 days of steeping time, T_2S_3- 55^{0}B concentration+ 12 days of steeping time,T_3S_1- 60^{0}B concentration+ 4 days of steeping time, T_3S_2- 60^{0}B concentration + 8 days 0f steeping time, T_3S_3- 60^{0}B concentration + 12 days of steeping time.

Table 4: Interaction effects of different brix concentration and steeping time on chemical characters of prepared aonla candy during storage

Treatments	Fiber (%) Storage(days)					Protein (%) Storage(days)					Reducing sugars (%)					Non-reducing sugars (%)					Total sugars (%)				
	0	30	60	90	120	0	30	60	90	120	0	30	60	90	120	0	30	60	90	120	0	30	60	90	120
T_1S_1	1.22	1.18	1.13	1.12	1.11	2.60	2.68	2.75	2.84	2.90	24.30	25.45	26.57	26.67	28.74	26.66	25.67	24.76	23.73	22.81	50.96	51.12	51.33	51.40	51.54
T_1S_2	1.14	1.11	1.08	1.06	1.05	2.57	2.62	2.69	2.78	2.80	29.27	30.46	31.55	32.63	33.77	28.69	27.66	26.68	25.72	24.80	57.96	58.12	58.23	58.35	58.57
T_1S_3	0.97	0.92	0.88	0.84	0.82	2.39	2.47	2.52	2.64	2.68	34.25	35.61	36.40	37.53	38.61	30.75	29.72	29.70	28.71	26.76	65.02	65.32	66.02	66.24	66.38
T_2S_1	1.21	1.17	1.12	1.10	1.08	2.59	2.66	2.74	2.81	2.88	24.31	24.46	26.58	27.67	28.75	26.78	25.68	24.75	23.74	22.81	51.08	51.13	51.32	51.42	51.55
T_2S_2	1.12	1.08	1.04	1.02	1.00	2.53	2.63	2.66	2.73	2.78	30.43	31.61	32.67	33.73	34.80	32.39	30.74	30.71	29.77	29.74	62.82	63.35	63.37	63.51	65.54
T_2S_3	0.95	0.91	0.87	0.85	0.84	2.37	2.43	2.51	2.57	2.65	35.27	36.47	37.43	38.51	39.66	31.92	31.69	31.66	30.63	30.46	67.19	68.16	69.08	69.15	70.12
T_3S_1	1.20	1.16	1.11	1.10	1.06	2.57	2.65	2.73	2.80	2.85	24.50	25.47	26.59	27.69	28.76	26.68	25.79	24.75	23.75	22.82	51.18	51.25	51.34	51.40	51.57
T_3S_2	1.09	1.05	0.02	0.84	0.82	2.46	2.51	2.56	2.63	2.67	32.55	33.67	34.71	35.76	36.81	37.26	36.21	36.04	35.17	34.30	69.81	70.85	70.75	70.94	71.11
T_3S_3	0.94	0.92	0.86	0.83	0.80	2.36	2.39	2.42	2.47	2.50	36.49	39.55	40.34	41.75	43.07	38.03	36.93	36.69	35.94	34.88	74.51	76.47	77.03	77.69	77.95
CD (5%)	-	0.017	0.020	0.019	0.021	0.039	0.029	0.022	0.020	0.019	1.729	1.732	1.729	1.731	1.734	1.724	1.729	1.731	1.722	1.735	1.729	1.727	1.735	1.735	1.731

All values are mean± SEM of three replicates

The test values along the same column carrying different superscripts for each composition contents are significantly different (p<0.05) within days.

T_1S_1-50^{0}B concentration+ 4 days of steeping time, T_1S_2- 50^{0}B concentration+ 8 days of steeping time, T_1S_3- 50^{0}B concentration +12 days of steeping time, T_2S_1- 55^{0}B concentration + 4 days of steeping time, T_2S_2- 55^{0}B concentration+ 8 days of steeping time, T_2S_3- 55^{0}B concentration+ 12 days of steeping time,T_3S_1- 60^{0}B concentration+ 4 days of steeping time, T_3S_2- 60^{0}B concentration + 8 days 0f steeping time, T_3S_3- 60^{0}B concentration + 12 days of steeping time.

Conclusion

From the above investigation the result obtained from the study that there was continuous increase in the TSS, protein, reducing sugars and total sugars content in aonla candy with the advancement of storage period. The best quality of aonla candy was found 50^{0}B sugar concentration and 4 days of steeping time. Maximum protein content were observed in 50^0 B concentration and 4 days of steeping time whereas minimum TSS, reducing sugars and total sugars were observed in 50^0 B concentration and 4 days of steeping time as compared to 8 and 12 days of steeping time. The total sugars content of candy with 50^{0}B sugar concentration was

lower than candy with 55^0B and 60^0B sugar concentration and higher sugar content is not desirable for children and diabetic patients. On the other hand moisture content, titratable acidity, ascorbic acid, fiber content, non-reducing sugars were minimum at 8 and 12 days of steeping time as compared to 4 days of steeping time. Although the present research tried to maintain a sound methodology and analysis of data, it is not free from limitations as we used only sugar syrup. Therefore, the present study paved the way for further research supplemented with others treatments to improve the quality of aonla candy during storage at different steeping time.

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