

Research Article

Quality evaluation of mandarin and strawberry mixed fruit juice for total period of 90 days at room temperature

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Citation

Sumayya Rani, Alam Zeb, Muhammad Ayub and Uzma Shahni. Quality evaluation of mandarin and strawberry mixed fruit juice for total period of 90 days at room temperature. Pure and Applied Biology. Vol. 7, Issue 1, pp174-183. <http://dx.doi.org/10.19045/bspab.2018.70021>

Received: 25/10/2017

Revised: 29/12/2017

Accepted: 31/12/2017

Online First: 20/01/2018

Abstract

The present study was designed to find the best mixing ratio of mandarin and strawberry juice, and to study the individual and combined effect of sodium benzoate and potassium sorbate on physiochemical and organoleptic characteristics of the product during storage. The juices from both fruits were mixed in different ratios (1:1, 1:2, 1:3, 2:1, 3:1) and were analyzed organoleptically. The product having both fruit juices in (1:1) was taken for further study. Total six samples (S₁, S₂, S₃, S₄, S₅ and S₆) were preserved with different concentrations of sodium benzoate and potassium sorbate and were analyzed for their physiochemical (pH, total soluble solids, % acidity, ascorbic acid, reducing and non-reducing sugar) and organoleptic characteristics (color, flavor, taste and overall acceptability) for 90 days at 15 days interval at room temperature. The average value for pH, ascorbic acid and non-reducing sugars were decreased at α value (< 0.05) while the average value for total soluble solids, percent acidity and reducing sugars were increased at α value (< 0.05). The average judges score for color, flavor, taste and overall acceptability of all samples was decreased at α value (< 0.05). S₄ [(1:1) + 0.075% Sodium benzoate + 0.025 Potassium sorbate] stayed more acceptable while S₆ [controlled] showed unsatisfactory results both physiochemically and organoleptically.

Keywords: Fruit juice; Mandarin; Preservatives; Quality evaluation; Strawberry; Temperature

Introduction

From past, man has been using fruits and vegetables as source of vitamins and minerals. These are utilized in fresh form as well as in the form of various products such as jelly, squash, jam and vegetable based beverages. [1]. The blending and mixing terms refers to addition and mixing of ingredients to form a homogenous product rich with many essential nutrients [2]. The

work of [3] has explained the methods of mixing different products. For the first time the methodology for quality analysis of mixed fruit products such as juices, squashes developed by [4]. The mixing of different juices leads to high quality product to consumer [5]. In order to get best thirst quenching beverages [6], coconut water was added to lemon juice, which was not only able to satisfy consumer demands but was

found rich in terms of nutritional significance. In a health conscious society the demands for low caloric, high fiber rich in vitamins and minerals beverages is increasing day by day. The simple solution for this is to blend different juices to get enriched product. [7].

Mandarin (*Citrus reticulata*) is among the most famous citrus fruits which has shiny color, attractive taste and aroma. In Pakistan, nearly 60% of gross citrus production consists of mandarin which is locally known as “Kinnow”. Mandarin juice is very beneficial because it contains good amount of minerals and ascorbic acid [8]. It is a rich source of vitamin C (130%), retinol(3%), carotenes, pectin, citric acid and some minerals such as iron(4%), phosphorus (3%) and calcium (4%). Ascorbic acid (vitamin C) plays a significant role in protecting health in various ways by absorbing iron from plant foods and formation and retention of collagen which keeps the body together by repairing and supporting bones, muscles and skin [9]. Generally this fruit is consumed in fresh as well as in processed forms such as ready to serve, juices based soft drinks, jelly, jam as well as marmalade. It is widely grown in Pakistan in many districts such as Lahore, Multan, Sargodha, Mianwali, Gujranwala, Jhang, Sahiwal etc while in KPK it is mainly grown in Peshawar, Swabi, Mardan, Swat, Hazara and Nowshera. In Pakistan the total area under cultivation of citrus was 199.4 thousand hectares and its gross production was 2294.5 thousand tonnes during the year 2007-08[10].

Strawberry (*Fragaria ananassa*) belongs to kingdom plantae and family rosaceae. It is cultivated in several parts of world but is widely grown in Japan, USA, Lebanon, Italy and Mexico [11]. In Pakistan it is cultivated in particular areas of Punjab (Narowal, Lahore and Islamabad), KPK (Mardan, Swat, Charsadda) and Balochistan (Ziarat). Strawberry is a freshly introduced crop in

Pakistan so its production is very low [12]. It is a tiny and fleshy red colored sweet fruit. Anthocyanin is responsible for its red color. Approximately 50% of sugars content consist of glucose. Strawberry is a good source of ascorbic acid (vitamin C) and flavonoids. Ascorbic acid is important for normal healthy skin, bones formation in infants and children [13]. The average sized strawberry fruit contains water (91.75g), carbohydrates (7.02g), fat (0.37g), protein (0.6g), vitamin c (60mg), fiber (2.3g), potassium (0.2g), calcium (21mg), magnesium (15mg), iron (0.5mg) and zinc (0.15mg). The outstanding flavor is due to some organic acids such as citric and maleic acid.

Titrateable acidity range is 0.58-1.35g/100g and pH is 3.27-3.86 that helps in stabilization of color. The range of total soluble solids is 8.0-11.5% which are ideal for concentrates of juice desired in market. Strawberry is generally utilized in fresh as well as in processed forms [14]. The fruit sugar is an instant source of energy that improves its taste and attracts children to consume the product happily. It provides fluids which prevents body from dehydration in hot weather, allergic reactions and in case of diseases. Fruits and vegetables can be 100% replaced by their juices [15].

Research work all around the world is exploring the importance of phytochemicals to the world. Strawberry is rich in anthocyanins and flavonoids which have strong capability to fight against cancer and mandarin is rich in vitamin C and citric acid which are strong antioxidants [16]. Mandarin is produced abundantly In Pakistan. Lack of proper storage facility causes loss of this fruit. About 30-50% of fruits and vegetables losses occur in developing countries including Pakistan [17]. Citrus fruits ranked first amongst them. The strawberry is very delicious but is very perishable fruit.

According to the survey, about 10 million liters of fruit juices are consumed per year in

Pakistan. Citrus fruit and strawberry juices make a larger portion of beverages and food industry [18]. Keeping in view the nutritional significance, market demands and recommendations of health professionals the present study was designed. It will help to produce the fruit juice to overcome market demands and help the population to enjoy them throughout the year. It can help the dietitian to plan the diet for patients suffering from cancer, skin and bones diseases.

Materials and methods

Fresh and good quality mandarin and strawberries were purchased from local market of Peshawar and brought to the Food Processing Laboratories of Pakistan Council of Scientific and Industrial Research (PCSIR), Peshawar where research work was carried out. Mandarin and strawberries were washed with tap water. Mandarins were peeled and cut into halves with the help of pre sterilized stainless steel knife. Juice was then extracted by using Rose Head machine and filtered with the help of muslin cloth. Leaves were detached manually from strawberries. Juice was extracted with the help of mechanical pulper, filtered through muslin cloth and were mixed in different ratios as shown in Table 1.

Table 1. Mixing ratios of mandarin and strawberry juice

	R ₁	R ₂	R ₃	R ₄	R ₅
Mandarin	1	1	1	2	3
Strawberry	1	2	3	1	1

All The mixing ratios were presented to a panel of judges selected from members of PCSIR. Using Grading points of Larmond one ratio, R₁ (1:1) got maximum score. Further six treatments were made from the selected ratio of mixed fruit juice:

$$S_1 = (1:1) + 0.1\% \text{ Sodium Benzoate}$$

$$S_2 = (1:1) + \text{Potassium Sorbate}$$

$$S_3 = (1:1) + 0.05\% \text{ Sodium Benzoate} + 0.05\% \text{ Potassium Sorbate}$$

$$S_4 = (1:1) + 0.075\% \text{ Sodium Benzoate} + 0.025\% \text{ Potassium Sorbate}$$

$$S_5 = (1:1) + 0.025\% \text{ Sodium Benzoate} + 0.075\% \text{ Potassium Sorbate}$$

$$S_6 = \text{control}$$

All the samples were kept in 250 ml bottles and were stored at room temperature for total periods of 90 days. They were analyzed both physiochemically and organoleptically at fifteen days interval.

Physiochemical analysis

All the samples were analyzed at room temperature physiochemically for pH, total soluble solids (TSS), % acidity, ascorbic acid, reducing and non-reducing sugar using standard method as explained by [19].

Organoleptic evaluation

All the samples were analyzed by a group of ten judges for color, flavor, taste and overall acceptability and score was given to them using 9-points hedonic scale according to the method described by [20].

Statistical analysis

All the results were computed using statistics two-way ANOVA as recommended by [21]. Means were separated using LSD test as described by [22].

Results and discussion

pH of Mandarin and strawberry mixed fruit juice samples

The average value of pH was decreased from 3.63 to 2.78 at α value (< 0.05). For treatments highest average value was observed in S₄ (3.40) followed by S₅ (3.34) and minimum in S₆ (3.03) followed by S₂ (3.09). The highest percent decrease was observed in S₆ (31.2) followed by S₂ (29.7) and minimum in S₄ (15.62) followed by S₅ (17.35) (Table 2). Same results were obtained by [23] who showed that pH during storage decreases due to production of different acidic radicals. The results are also in agreements with the findings of [24] who

showed that the decrease in pH is due to production of acidic components by

degradation of reducing sugars and production of pectinic acid in the product.

Table2. pH value of Mandarin and Strawberry mixed fruit juice samples

Treatments	Storage intervals (Days)							% decrease	Average
	1 st	15 th	30 th	45 th	60 th	75 th	90 th		
S ₁	3.66	3.55	3.45	3.34	3.21	3.02	2.99	18.30	3.32a
S ₂	3.60	3.51	3.32	3.03	2.98	2.70	2.53	29.70	3.09bc
S ₃	3.62	3.42	3.12	3.02	2.88	2.68	2.49	29.20	3.19b
S ₄	3.60	3.51	3.32	3.03	2.98	2.70	2.53	15.62	3.40a
S ₅	3.63	3.53	3.52	3.42	3.21	3.10	3.00	17.35	3.34a
S ₆	3.62	3.42	3.12	3.02	2.88	2.68	2.49	31.21	3.03c
Average	3.63a	3.54a	3.39b	3.24c	3.10d	2.93e	2.78f		

Total soluble solids (TSS) of Mandarin and Strawberry mixed fruit juice samples

The average value of total soluble solids was increased from 10.20 to 11.33⁰brix at α value (< 0.05). The highest average value was observed in S₆ (11.13) followed by S₅ (10.95) and lowest average value was observed in S₁ (10.46) followed by S₄ (10.53). The highest percent increase was recorded in sample S₆ (17.75) followed by S₅ (16.10) and minimum in S₄ (6.56) followed by S₂ (6.96) and S₁ (7.84) (Table 3). The same slow increase in total soluble solids content was shown by [25] in their spinach orange carrot juice samples. The work of [26] on lime juice samples also showed the increase in total soluble solids.

Acidity (%) of Mandarin and Strawberry mixed fruit juice samples

The average value of acidity was increased from 1.15 to 1.88 at α value (< 0.05). Highest average value was observed in S₅ (1.67) followed by S₁ (1.63) and minimum in S₃ (1.37) followed by S₄ (1.38). Highest percent increase was observed in S₆ (72.03%) followed by S₂ (67.65%) and minimum percent increase was observed in S₃ (55.5%) followed by S₁ (57.14%) (Table 4). The production of carboxylic acid is responsible for increased acidity in the product. The same increasing trend in acidity was found in the work of [27]. The increasing trend in acidity

was also reported by [28]. They observed an increase in acidity of pomegranate syrup samples and stated that the increase in acidity was due to oxidation of reducing sugars. Formation of pectinic acid in product is another cause of increase in acidity.

Ascorbic Acid (mg/100g) of Mandarin and Strawberry mixed fruit juice samples

The average value of ascorbic acid content of all samples was decreased from 40.30 to 28.09 at α value (< 0.05). Among treatments highest average value was observed in S₄ (36.60) followed by S₃ (34.87) and minimum in S₆ (28.55) followed by S₅ (32.94). Highest percent decrease was observed in S₆ (57.01%) followed by S₂ (44.95%) and minimum in S₄ (20.33%) followed by S₃ (27.95%) (Table 5). The results are in similarity with the findings of [29] while working on mango leather. The work of [30] also showed the decrease in ascorbic acid content in kinnow juice samples. The results obtained from the work of [31] also showed decrease in ascorbic acid content who stated that decrease in its content was due to the presence of oxygen in the product.

Reducing Sugars of Mandarin and Strawberry mixed fruit juice samples

The average value of reducing sugars of all samples was increased from 4.41 to 6.59 at α value (< 0.05). Among treatments highest average value was observed in S₄ (5.96)

followed by S₂ (5.72) and minimum in S₁ (5.02) followed by S₅ (5.26). Highest percent increase was observed in S₆ (64.8%) followed by S₅ (58.4%) and minimum in S₁ (27.3%) followed by S₃ (43.1%) (Table 6). The same results were shown by [32] his work on

strawberry juice and stated that inversion of sucrose is responsible for increase amount of monosaccharides in the product. The work of [33] on dehydrated mango slices also showed increase in reducing sugar amount.

Table 3. Total soluble solids content of Mandarin and Strawberry mixed fruit juice samples

Treatments	Storage intervals (Days)							% Increase	Average
	1 st	15 th	30 th	45 th	60 th	75 th	90 th		
S ₁	10.20	10.32	10.51	10.72	10.85	10.90	11.0	7.84	10.46b
S ₂	10.20	10.31	10.42	10.54	10.63	10.72	10.91	6.96	10.64bc
S ₃	10.20	10.41	10.52	10.76	10.81	11.0	11.32	10.98	10.72b
S ₄	10.20	10.25	10.32	10.42	10.53	10.64	10.87	6.56	10.53bc
S ₅	10.20	10.42	10.75	10.93	11.05	11.47	11.84	16.10	10.95 a
S ₆	10.20	10.57	10.79	11.02	11.52	11.82	12.01	17.75	11.13a
Average	10.23a	10.28b	10.40b	10.5b	10.61 c	10.76 c	10.91 d		

Table 4. Acidity content of Mandarin and Strawberry mixed fruit juice samples

Treatments	Storage intervals (Days)							% Increase	Average
	1 st	15 th	30 th	45 th	60 th	75 th	90 th		
S ₁	1.26	1.35	1.59	1.61	1.75	1.89	1.98	57.14	1.63ab
S ₂	1.02	1.19	1.29	1.42	1.53	1.62	1.71	67.65	1.39c
S ₃	1.08	1.15	1.24	1.33	1.42	1.58	1.68	55.5	1.37c
S ₄	1.07	1.20	1.28	1.38	1.50	1.53	1.72	60.74	1.38c
S ₅	1.30	1.40	1.50	1.64	1.75	1.96	2.17	66.92	1.67a
S ₆	1.18	1.28	1.33	1.46	1.76	1.98	2.03	72.03	1.57b
Average	1.15a	1.26b	1.37c	1.47d	1.62e	1.78f	1.88g		

Table 5. Ascorbic acid (mg/100g) content of Mandarin and Strawberry mixed fruit juice samples

Treatments	Storage intervals (Days)							%Decrease	Average
	1 st	15 th	30 th	45 th	60 th	75 th	90 th		
S ₁	40.18	39.54	36.56	34.89	31.29	29.76	27.25	32.18	34.21b
S ₂	40.42	38.70	37.83	35.35	31.20	27.28	22.25	44.95	33.29 b
S ₃	40.25	39.15	37.03	35.21	33.18	30.26	29.00	27.95	34.87ab
S ₄	40.18	39.01	38.92	36.89	35.84	33.34	32.01	20.33	36.60 a
S ₅	40.58	38.48	36.30	33.12	30.67	27.21	24.25	40.24	32.94cd
S ₆	40.20	35.20	31.12	29.67	25.61	20.72	17.28	57.01	28.55c
Average	40.30a	38.68ab	36.96b	34.52c	31.83d	28.93e	26.01f		

Table 6. Reducing Sugar content of Mandarin and Strawberry mixed fruit juice samples

Treatments	Storage intervals (Days)							% Increase	Average
	1 st	15 th	30 th	45 th	60 th	75 th	90 th		
S ₁	4.50	4.65	4.76	4.86	5.17	5.49	5.73	27.3	5.02d
S ₂	4.50	4.85	5.10	5.56	6.33	6.78	6.95	54.4	5.72ab
S ₃	4.33	4.51	5.73	5.91	6.02	6.18	6.20	43.1	5.55bc
S ₄	4.80	5.00	5.21	5.88	6.66	6.95	7.21	49.2	5.96a
S ₅	4.09	4.85	5.00	5.15	5.32	5.90	6.48	58.4	5.26cd
S ₆	4.21	4.74	5.05	5.26	5.50	6.81	6.94	64.8	5.50bc
Average	4.41d	4.77cd	5.14cd	5.44bcd	5.83abc	6.35ab	6.59a		

Non-Reducing Sugars of Mandarin and Strawberry mixed fruit juice samples

The value of non-reducing sugar of all samples was decreased from 3.34 to 1.53 at α value (<0.05). Among treatments highest average value was observed in S₁ (2.68) followed by S₄ (2.64) and minimum in S₆ (1.64) followed by S₂ (2.16). Highest percent decrease was observed in S₆ (79.39%) followed by S₂ (64.81%) and minimum in S₅ (30.33) followed by S₁ (40%) (Table 7). The same decreasing trend in non-reducing sugar content was shown by [34] in melon cube samples treated with non-caloric sweeteners and stated that non reducing sugar convert to reducing sugar that cause decrease in their content. The results obtained from the work

of [35] are also supporting the results obtained from our work.

Color score of Mandarin and Strawberry mixed fruit juice samples

The average color score for all samples was decreased from 8.38 to 3.71 at α value (<0.05). Among treatments highest average score was obtained by S₄ (7.20) followed by S₃ (6.23) and minimum by S₆ (2.69) followed by S₂ (5.29) (Table 8). The same results were shown by [36] on their work on Indian gooseberry juice. The work of [37] showed the decrease in color score of fruit leather. The results obtained in the work of [38] are also in agreement with the results obtained in our work.

Table 7. Non reducing sugar content of Mandarin and Strawberry mixed fruit juice samples

Treatments	Storage intervals (Days)							%Decrease	Average
	1 st	15 th	30 th	45 th	60 th	75 th	90 th		
S ₁	3.30	3.28	3.16	2.46	2.46	2.14	1.98	40	2.68a
S ₂	3.38	3.21	2.53	1.86	1.73	1.25	1.19	64.81	2.16cd
S ₃	3.36	3.26	3.06	2.70	1.19	1.44	1.31	61.38	2.33bc
S ₄	3.37	3.27	3.00	2.79	2.59	1.81	1.67	50.45	2.64ab
S ₅	3.33	3.11	3.09	2.86	2.61	2.51	2.32	30.33	2.83a
S ₆	3.30	2.85	2.51	1.62	1.43	1.20	0.68	79.39	1.94d
Average	3.34a	3.16ab	2.89b	2.38c	2.00d	1.73de	1.53e		

Table 8. Color score of mandarin and strawberry mixed fruit juice samples

Treatments	Storage intervals (Days)							Average
	1 st	15 th	30 th	45 th	60 th	75 th	90 th	
S ₁	7.78	6.60	6.28	6.23	5.46	4.00	3.17	5.65bc
S ₂	8.86	6.67	5.56	5.00	4.38	3.58	2.98	5.29c
S ₃	8.51	6.89	6.53	6.00	5.53	5.13	5.00	6.23b
S ₄	8.76	7.78	7.32	7.00	6.98	6.53	6.00	7.20a
S ₅	8.81	6.89	6.22	5.89	5.78	5.00	4.12	6.10b
S ₆	7.58	4.78	3.26	1.20	1.00	1.00	1.00	2.69d
Average	8.38a	6.44b	5.86bc	5.22cd	4.89de	4.21ef	3.71f	

Flavor score of Mandarin and Strawberry mixed fruit samples

The judges score for flavor of all samples was decreased from 8.63 to 3.70 at α value (<0.05). Among treatments highest average score was received by S₄ (7.83) followed by S₃ (6.95) and minimum by S₆ (2.95) followed by S₅ (4.86) (Table 9). The same decrease in flavor score was observed by [39] on orange juice. The work of [40] are also supporting our results who observed loss in flavoring compounds during storage.

Taste score of Mandarin and Strawberry mixed fruit juice samples

The judges score for taste of all samples was decreased from 8.52 to 3.91 at α value (<0.05). Among treatments highest average score was achieved by S₄ (7.51) followed by S₃ (7.00) and minimum by S₆ (2.97) followed

by S₂ (5.01) (Table 10). The same declining trend in the score of judges for taste was shown by [41, 42] who observed the production of different chemical compounds that gives bitter taste to product and cause the decline in their acceptability rates.

Overall Acceptability score of Mandarin and Strawberry mixed fruit juice samples

The overall acceptability score of all samples was decreased from 8.58 to 4.13 at α value (<0.05). Among treatments highest average score was obtained by S₄ (8.01) followed by S₃ (7.41) and minimum by S₆ (4.72) followed by S₅ (5.69) (Table 11). The same declining trend was shown by [43] in their work on apricot fruit bar. The results of [44] are also supporting our results. They found the decline in the sensory properties of orange juice stored in glass bottles.

Table 9. Flavor score of Mandarin and Strawberry mixed fruit juice samples

Treatments	Storage interval (Days)							Average
	1 st	15 th	30 th	45 th	60 th	75 th	90 th	
S ₁	8.56	7.23	6.58	5.67	4.08	3.98	2.87	5.59 cd
S ₂	8.44	6.89	6.11	5.87	5.67	4.87	4.43	6.04c
S ₃	8.89	7.89	7.67	7.00	6.00	5.78	5.29	6.93b
S ₄	9.0	8.72	8.13	8.00	7.49	7.00	6.49	7.83a
S ₅	7.33	6.00	5.20	5.00	4.14	3.44	2.00	4.86d
S ₆	8.67	4.34	2.67	2.00	1.00	1.00	1.00	2.95e
Average	8.63a	6.84b	6.06bc	5.59cd	4.73de	4.35ef	3.70f	

Table 10. Taste score of Mandarin and Strawberry mixed fruit juice samples

Treatments	Storage intervals (Days)							Average
	1 st	15 th	30 th	45 th	60 th	75 th	90 th	
S ₁	8.44	7.33	6.32	6.00	5.87	5.00	4.01	6.14b
S ₂	8.32	6.67	6.45	4.31	3.54	3.00	2.81	5.01c
S ₃	8.80	8.00	7.58	7.00	6.56	6.23	5.85	7.00a
S ₄	8.85	8.33	8.00	7.84	7.10	6.45	6.00	7.51a
S ₅	8.42	6.67	5.46	5.00	4.46	4.00	3.76	5.39bc
S ₆	8.28	4.53	2.00	1.00	1.00	1.00	1.00	2.97d
Average	8.52a	6.92b	6.14bc	5.36cd	4.59de	4.28e	3.91ef m	

Table 11. Overall acceptability score of Mandarin and Strawberry mixed fruit juice samples

Treatments	Storage intervals (Days)							Average
	1 st	15 th	30 th	45 th	60 th	75 th	90 th	
S ₁	8.89	7.89	6.00	5.28	5.00	4.88	3.98	5.76b
S ₂	8.00	6.43	5.44	4.15	3.01	2.47	2.00	6.08b
S ₃	8.54	7.33	7.11	6.33	6.00	5.87	5.00	7.41a
S ₄	8.61	7.14	7.00	6.20	5.89	5.00	4.89	8.01a
S ₅	8.67	6.67	5.44	5.00	4.89	4.00	3.89	5.69b
S ₆	8.78	4.00	3.00	2.00	1.00	1.00	1.00	4.72c
Average	8.58a	7.07b	6.17bc	5.55cd	5.00cde	4.48de	4.13e	

Conclusion and recommendations

From this study it was concluded that the mixing of fruit juice and addition of preservatives strongly affect the products shelf life and consumer acceptability. During this study we found S₄ [(1:1) + 0.075% Sodium Benzoate Sodium Benzoate + 0.025 Potassium Sorbate] more acceptable while S₆ [controlled] showed unsatisfactory results both physiochemically and organoleptically during storage. Further study is recommended on refrigeration and mixing of more than two fruits is recommended to make the product more nutritious. Nutritional assessment and packaging effect study is also recommended for future work.

Authors' contributions

Conceived and designed the experiments: A Zeb & S Rani, Performed the experiments: S Rani, Analyzed the data: U Shahni, Contributed materials/ analysis/ tools: S Rani, U shahni & M Ayub, Wrote the paper: S Rani.

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