Research Article

Comparative study of five different squashes stored at room temperature

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Abstract

The aim of the study was to prepare squash from different fruits and to investigate the effect of Potassium metabisulphite (0.1%), storage time and temperature on the physiochemical and organoleptic properties of samples. During this study total five samples were prepared utilizing five different fruits which were peach, apple, guava, mango and lime such as X₁, X₂, X₃, X₄ and X₅ and were preserved with 0.1% Potassium metabisulphite. The purpose of utilizing these fruits to prevent post-harvest loss in the peak season which is due to lack of proper post-harvest handling and preserving facility. These samples were randomly analyzed physiochemically (pH, acidity, ascorbic acid content and total soluble solids) and organoleptically (taste, color and odor) with the storage interval of 15 days during one month storage. A decrease was observed in pH and ascorbic acid content while acidity and total soluble solids were found increased at α value less than 0.05 during storage. From this study it was concluded that X₄ [(25% mango pulp + 25% distilled water + 50% Sugar + Citric acid (0.75%) + 0.1% Potassium metabisulphite (0.075%)] stayed very much acceptable as compared to others because of minimum changes in sensory evaluation score and physicochemical characteristics. Fruit based beverages are very important food products; further study is suggested on the refrigerated temperature to know the effect of temperature. Study on effect of other preservatives in different concentration is also recommended in future.

Keywords: Acidity; Ascorbic acid; Citric acid; Interval; pH; Sensory; Total soluble solids

Introduction

Squash is a beverage that is made from the combination of fruit pulp and sugar with the addition of water. Sugar is responsible for its sweet flavour [1]. Fruits and vegetables are good source of phytochemicals which are essential for many body functions many of them are antioxidants such as flavonoids and quercetin [2]. Peach (*Prunus persica* L.) is one among the four local fruits of China. It belongs to Northwest China between the Tarim Basin and the slopes of

Kunlun mountains, the place where it was first domesticated and cultivated [3]. According to statistics of FAO, in 2000 the total planting area of peach in China was 908 000 hectares and the yield was 3 830 000 tonnes. It is considered the leading country for peach production. In Northern areas of Pakistan peaches said to be the traditional crop where it occupies the area of 4543 hectares with the production of 48284 tonnes. Peach is an essential money-making fruit tree of Balochistan, with an

area under cultivation of 60.22 hectares and production of 30.31 tonnes [4]. In respect to composition a medium peach contain 465 IU of vitamin A to compete the causing of aging and its β -carotene also helps to form a strong immune system to prohibit damage from free radicals, also to preclude many skin maladies [5]. Furthermore, peaches contain high amount of potassium, which is helpful for the maintenance of heart health and anticipation or regulation of high blood pressure [6]. Apple (*Malus sylvestris*) is one among well-known cultivated fruits. Production of apple throughout the World in 2008 was 64,255,520 tonnes and China ranked first with production of 27,507,000 tonnes. The total area, reported under apple in Pakistan is about 45875 hectares with total production of 589281 tonnes (1998-99) per annum. It is mainly grown in hilly areas of Punjab, KPK and Balochistan. Important varieties are Kashmiri, Kandhari, Amri, Qalat Special, Golden delicious, Red delicious and Kulu. Apple also helps to handle dysentery [7]. Apple has the ability to stop the occurrence of Alzheimer's and Parkinson's diseases. Apart from these benefits, it also helps in dental care and skin care. The factors which affect the shelf-life of apple are the primary contamination by post-harvest pathogens and the condition in which it is kept. Due to their reasonable high metabolic activity, apple loss their quality during storage [8]. They are collected over a limited period of time; that is why it is very important to arrange storage for the fruits to alter marketing and preserve high quality. Cold storage is mainly used to minimize the rate of respiration and ethylene production and also to increase the shelf-life of fruits. Long post-harvest life in cool storage is highly dependent on fruit quality [9]. Guava (*Psidium guajava*) family Myrtaceae is extensively grown all over the tropics and sub-tropics. Tropical America is the origin of guava but it has been in cultivation since early 17th century in the sub-continent [10]. Depending on the species guava fruits are usually 4 to 12 cm (1.6 to 4.7 in) elongated,

are round or oval [11]. This fruit is liked both in fresh and processed forms, which is the major cause of their production all over the world [12]. According to Sindh Board of Investment, Pakistan produces around 560,000 tonnes guava yearly with 58,500 hectares of land under its cultivation. Larkana district is the largest supplier in guava production accounting for 45% of Sindh's produce per year. Like other fruits and vegetables, Guava is also rich in antioxidants that aids in minimizing the occurrence of progressive abnormalities such as arthritis, arteriosclerosis, cancer, heart diseases, inflammation and brain dysfunction. Furthermore, antioxidants were described to delay ageing [13, 14] by inhibiting or deferring oxidative injury of lipids, proteins and nucleic acids. Guava leaves contain both carotenoids and polyphenols like (+)-gallicocatechin and leucocyanidin [15].

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae, is known to be one of the main cultivated fruit throughout the world. The mango is inherent to South Asia [16] from where it has been circulated all over the world to become one of the most cultivated fruits in the tropics. *Mangifera indica* the "common mango" or "Indian mango" is the only mango tree generally cultivated in many tropical and subtropical areas [17]. World production of mangoes was nearly 43 million tonnes in 2013, with India accounting for 42% (18 million tons) of the total. China and Thailand were the next leading producers. Mango is the second major fruit cultivated in Pakistan which covers 14 percent of the total area (734.6 thousand hectares). In Punjab, Multan and Bahawalpur divisions while Hyderabad and Mirpur Khas in Sindh are the leading mango growing districts in the country [18]. Mango is the most delicious fruit. It is liked not only due to its pleasant taste, aroma but also for its nutritional contribution to our diet. It is a vital source of energy and provides vitamins A, C and minerals like iron and phosphorus. Juicy varieties of mango are favoured for

manufacturing of squash. Squashes are sweetened juices containing some pulp. The term “cordial” is often used interchangeably with squash. Fruit squashes have a minimum of 25% by volume of a strong iron-rich diet with juicy mangoes [19]. Lime (*Citrus aurantifolia*) belongs to the family of Rutaceae and is grown almost in every home garden. Lime is a hybridized citrus fruit, which is usually round, lime green, 3–6 centimetres (1.2–2.4 in) in diameter, and having acidic juice vesicles. The total world production of lemons and limes was 15.42 million tonnes, with India top production of 2.52 million tonnes in 2013 [20]. Limes are brilliant source of vitamin C, and are frequently used to improve the flavours of foods and beverages. They are grown year-round. Plants with fruit called “limes” have diverse genetic origins; limes do not form a monophyletic group [21]. From the nutrient database [22], raw lime contains 88% water, 10% carbohydrates and less than 1% each of fat and protein. Only vitamin C content at 35% of the Daily Value (DV) per 100 g serving is important for nourishment, with other nutrients existing in low DV amounts. Lime flesh and peel have diverse phytochemicals, containing polyphenols and terpenes [23] a lot of which are under basic research for their potential properties in humans [24]. The foremost coumarins in limes is limettin which has multiple higher content in peels than in pulp. Drinking lime juice with salt reduces the stomach pain. It helps in digestion of foods. Fruit juices and fruit juice beverages are becoming popular

due to their pleasant flavour and nutritional characteristics. Beverages are consumed by people of all age group to quench the thirst as a social drink and for good health and medicinal values [25, 26].

In Pakistan peach, apple, guava, lime and mangoes are eaten in fresh form but during peak season when their production is high, post-harvest losses occur because of lacking proper handling and storage facilities. Keeping in view their nutritional significance and nutritionists suggestion to increase consumption of fruits and vegetables to decrease chances of obesity and cardiovascular diseases in population and to prevent post-harvest losses by product development, the present study was designed.

Materials and methods

Best quality fresh, mature and juicy fruits of peach, apple, guava, mango and lime were selected and bought from local fruit market of Peshawar and brought to Food processing lab of Nuclear Institute for Food and Agriculture Peshawar, KPK Pakistan. All the fruits were washed with water, after washing of fruits these fruits were peeled off and the seeds were been removed and then juice was extracted with the help of a juice extractor. The five samples were prepared by mixing the juice with sugar and distilled water in ratio of (2:2:4). Citric acid and Potassium metabisulphite was also added at the last. And were transferred to plastic bottles and kept at room temperature and labelled as X₁, X₂, X₃, X₄ and X₅ (Table 1).

Table 1. Proposed plan of study

Treatments	%Juice	%Water	%Sugar	%Citric Acid	%Potassium Metabisulphite
X ₁ (Peach)	25	25	50	0.75	0.075
X ₂ (Apple)	25	25	50	0.75	0.075
X ₃ (Guava)	25	25	50	0.75	0.075
X ₄ (Mango)	25	25	50	0.75	0.075
X ₅ (Lime)	25	25	50	0.75	0.075

Physicochemical analysis

All sample were phsiochemically analyzed for different parameters by using the

standard methods as described by [27] for pH values of all the samples were determined by method no 2005.02 for TSS

by using a digital refractive meter, for Acidity using method no 920.183 and for Ascorbic Acid method no 920.183.

Statistical analysis

All the data regarding storage interval and treatments were statistically analyzed by CRD 2 factorial design as recommended by [29]. And the means were separated by applying least significant difference (LSD) test 5% probability level as defined by [30].

Results and discussion

(%) Acidity value of samples

On first day Acidity value of all samples was calculated as X_1 (1.23), X_2 (1.81), X_3 (1.92), X_4 (1.96) and X_5 (1.03) percent and on final day results were noted as X_1 (1.44), X_2 (2.01), X_3 (2.12), X_4 (2.16) and X_5 (1.23) percent respectively. The average

value was found increased from 1.59 to 1.79% at α value less than 0.05. In samples highest percent increase was observed in X_5 (16.26%) second was X_1 (14.58%) and lowest increase in percent was observed in percent X_4 (9.25%) next was X_3 (9.43%) while highest mean value was noted in X_4 (2.06) second by X_3 (2.02) and lowest mean value was observed in X_5 (1.13) next was X_1 (1.33) (Table 2). It is clear from statistical analysis that storage time strongly affect all the sample equally. These results are in similarity with the findings of [31] who noticed the increasing trend of acidity in kinnow juice and with the findings of [32] during studies on fruit juices.

Table 2. Effect of storage on the %acidity of different squashes

Treatments	Storage Interval			%Increase	Mean
	Initial	15	30		
X_1	1.23	1.33	1.44	14.58	1.3300d
X_2	1.81	1.91	2.01	9.95	1.9100c
X_3	1.92	2.02	2.12	9.43	2.0200b
X_4	1.96	2.06	2.16	9.25	2.0600a
X_5	1.03	1.13	1.23	16.26	1.1300e
Mean	1.59c	1.69b	1.792a		

Ascorbic Acid (mg/100g) content of samples

On first day Ascorbic acid value of all samples was calculated as X_1 (26.19), X_2 (20.37), X_3 (33.46), X_4 (36.37) and X_5 (23.28) percent and on final day results were noted as X_1 (25.99), X_2 (20.17), X_3 (33.26), X_4 (36.17) and X_5 (23.07) percent respectively. The average value was found decreased from 27.93 to 27.72 % at α value less than 0.05. In samples highest percent decrease was observed in X_5 (0.90%) second was X_1 (0.76%) and lowest decrease in percent was observed in percent X_4 (0.54%) next was X_3 (0.59%) while highest mean value was noted in X_4 (36.270) second by X_3 (33.360) and lowest mean value was observed in X_2 (20.27) next was X_5 (23.17) (Table 3). It is clear from statistical analysis that storage time strongly affect all the sample equally.

These results are in similarity with the findings of [33] while working on mango leather. The results achieved in the work of [34] also showed decrease in ascorbic acid content. And stated that decrease in ascorbic acid content is due to presence of oxygen product and other cause is head space in the product packaging.

pH value of samples

On first day pH value of all samples was calculated as X_1 (3.61), X_2 (3.75), X_3 (3.68), X_4 (3.81) and X_5 (3.63) percent and on final day results were noted as X_1 (3.57), X_2 (3.65), X_3 (3.61), X_4 (3.76) and X_5 (3.40) percent respectively. The average value was found decreased from 3.69 to 3.59% at α value less than 0.05. In samples highest percent decrease was observed in X_2 (2.78%) second was X_2 (2.66%) and lowest decrease in percent was observed in X_1 (1.10%) next was X_4 (1.31%) while highest

mean value was noted in X₄ (3.78) second by X₂ (3.71) and lowest mean value was observed in X₅(3.51) next was X₁(3.58) (Table 4). It is clear from statistical analysis that storage time strongly affect all the

sample equally. These results are in similarity with the findings of [35] who observed a decrease in pH of ready to serve mandarin drink.

Table 3. Effect of storage on the ascorbic acid content of different squashes

Treatments	Storage Interval			%Decrease	Mean
	Initial	15	30		
X ₁	26.19	26.09	25.99	0.76	26.090c
X ₂	20.37	20.27	20.17	0.98	20.270e
X ₃	33.46	33.36	33.26	0.59	33.360b
X ₄	36.37	36.27	36.17	0.54	36.270a
X ₅	23.28	23.17	23.07	0.90	23.173d
Mean	27.934a	27.832b	27.723c		

Table 4. Effect of storage on the pH of different squashes

Treatments	Storage Interval			%Decrease	Mean
	Initial	15	30		
X ₁	3.61	3.58	3.57	1.10	3.5867cd
X ₂	3.75	3.72	3.65	2.66	3.7100b
X ₃	3.68	3.66	3.61	1.90	3.6500bc
X ₄	3.81	3.79	3.76	1.31	3.7867a
X ₅	3.63	3.51	3.40	2.78	3.5133d
Mean	3.6880a	3.6540ab	3.5980b		

Total soluble solids (°brix) of samples

On first day Ascorbic acid value of all samples was calculated as X₁ (54), X₂ (58), X₃ (50), X₄ (53) and X₅ (53) °brix and on final day results were noted as X₁ (60), X₂ (60), X₃ (53), X₄ (54) and X₅ (56) and degree °brix respectively. The average value was found decreased from 53.6 to 56.80 °brix respectively at α value less than 0.05. In samples highest percent decrease was observed in X₁ (10%) second was X₃

(7.40%) and lowest decrease in percent was observed in percent X₄ (1.88%) next was X₂ (3.33%) (Table no. 04) while highest mean value was noted in X₂ (59) second by X₁(57) and lowest mean value was observed in X₃ (52) next was X₄ (53.33) (Table 5). It is clear from statistical analysis that storage time strongly affect all the sample equally. These results are in similarity with the findings of [36] in their studies on lime juice.

Table 5. Effect of storage on the total soluble solids of different squashes

Treatments	Storage Interval			%Increase	Mean
	Initial	15	30		
X ₁	54	57	60	10.0	57.00b
X ₂	58	59	60	3.33	59.00a
X ₃	50	52	54	7.40	52.00d
X ₄	53	53	54	1.88	53.33cd
X ₅	53	56	56	5.35	55.00c
Mean	53.60b	55.40a	56.80a		

Color score of samples

On the first day judges score for color of all samples was calculated as X_1 (8.0), X_2 (7.6), X_3 (7.3), X_4 (9.0) and X_5 (6.5) percent and on final day results were noted as X_1 (7.5), X_2 (7.0), X_3 (6.5), X_4 (8.5) and X_5 (6.0) percent respectively. The average value was found decreased from 7.68 to 7.10% at α value less than 0.05. In samples highest mean score of judges was observed

in X_4 (8.73%) second was X_1 (7.83%) and lowest decrease in mean score of judges was observed in X_5 (6.30%) next was X_3 (6.93%) (Table 6). It is clear from statistical analysis that storage time strongly affect all the sample equally. These results are in similarity with the findings of [37] they observed a gradual decrease in score of judges for color in Jamun squash, in Chinese orange squash by [38].

Table 6. Effect of storage on the color of different squashes

Treatments	Storage Interval			Mean
	Initial	15	30	
X_1	8	8	7.5	7.83b
X_2	7.6	7.3	7	7.3c
X_3	7.3	7	6.5	6.93d
X_4	9	8.7	8.5	8.73a
X_5	6.5	6.5	6	6.30e
Mean	7.68a	7.50b	7.10c	

Odour score of samples

On first day judges score for odour all samples was calculated as X_1 (8.7), X_2 (8.0), X_3 (8.5), X_4 (9.0) and X_5 (6.5) percent and on final day results were noted as X_1 (7.0), X_2 (6.5), X_3 (5.7), X_4 (8.0) and X_5 (2.00) percent respectively. The average value was found decreased from 8.14 to 6.90% at α value less than 0.05. Maximum mean score of judges for flavor was obtained by X_4 (8.50) followed by X_1 (7.73) and minimum mean score was obtained X_5 (6.16) next was X_2 (7.16).

Maximum decrease in judges score was found in X_1 (19.54) and next was X_2 (18.75) and minimum decrease was found in X_5 (7.69) and next was X_4 (11.11) (Table 7). It is clear from statistical analysis that storage time strongly affect all the samples equally. These results are in similarity with the findings of [39] who during his work on Vitamin C enrichment of fruit juice and [40] also reported the declining in scores in the stored juice product because of production of off flavor substances.

Table 7. Effect of storage on the odor of different squashes

Treatments	Storage Interval			Mean
	Initial	15	30	
X_1	8.7	7.5	7	7.73b
X_2	8	7	6.5	7.16c
X_3	8.5	7.5	7	7.66bc
X_4	9	8.5	8	8.5a
X_5	6.5	6	6	6.16d
Mean	8.14a	7.30b	6.90c	

Taste score of samples

On first day judges score for taste value of all samples was calculated as X_1 (8.0), X_2 (7.5), X_3 (7.0), X_4 (9.0) and X_5 (8.0)

percent and on final day results were noted as X_1 (7.3), X_2 (6.5), X_3 (6.0), X_4 (8.5) and X_5 (6.5) percent respectively. The average value was found decreased from 7.90 to

6.96 % at α value less than 0.05. Highest mean value was noted in X₄ (8.66) second was X₁ (7.6) and lowest mean value was observed in X₃ (6.66) next was X₂ (7.0) (Table 8). It is clear from statistical analysis that storage time strongly affect all the sample equally. These results are in similarity with the findings of [41] while

their work one effect of sugar levels and storage period of physiochemical and sensory characteristics of Chinese orange squash [42] reported that during the storage time and temperature taste of the product is adversely affected while studying the physiochemical and sensory properties of orange.

Table 8. Effect of storage on the taste of different squashes

Treatments	Storage Interval			Mean
	Initial	15	30	
X ₁	8	7.5	7.3	7.6b
X ₂	7.5	7	6.5	7cd
X ₃	7	7	6	6.66bc
X ₄	9	8.5	8.5	8.66a
X ₅	8	7.5	6.5	7.3bc
Mean	7.9a	7.5b	6.96c	

Conclusions and recommendations

From this study it was concluded that the potassium metabisulphite alongwith citric acid and sugars has strong effect on the overall quality of mango squash. It was concluded that X₄ (25% mango pulp + 25% distilled water + 50% Sugar + Citric acid (0.75%) + 0.1% Potassium Meta-Bisulphite stayed very much acceptable during 30 days of storage. In future the same study is recommended at low temperature. Moreover microbial evaluation is also recommended. Packaging influence on the product quality is also suggested to study in future. Study on effect of other preservatives in different concentration is also recommended in future.

Authors' contributions

Conceived and designed the experiments: S Rani, Performed the experiments: H Wahab & U Shahni, Analyzed the data: H Wahab & AS Shah, Contributed materials/ analysis/ tools: B Saeed, H Wahab & U Shahni, Wrote the paper: S Rani & H Wahab

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