

CHANGES IN CHEMICAL AND NUTRITIONAL QUALITY DURING COLD STORAGE OF SOME FRUIT AND VEGETABLE JUICE BLENDS.

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ABSTRACT

Fresh juice blends are a popular food daily consumed by all people with different age and standard living for their low prices and pleasant flavor. In spite of the cheap price of these juices; they have high nutritive value for their high content of β -carotene, minerals as calcium, potassium, magnesium and iron. So, the main target of such manuscript was to follow up main components changes in untraditional fruit and vegetable juice blends during cold storage (5-7°C) for three months. Obtained results showed that, the moisture, total sugar, non-reducing sugar, β -carotene, total soluble solids contents and pH value of fruit and vegetable juice blends decreased while, total solids, reducing sugar contents and total bacterial counts increased after three months of cold storage. Juice blend No.(4) (50% apricot + 50% carrot) had the highest value of β -carotene (1000 $\mu\text{g}/100\text{ml}$). Finally, it could be concluded that fruit and vegetable juice blends under study were acceptable and in a good agreement with their Egyptian standard specifications as well as the high content of β -carotene.

Keywords: Juice refrigeration, β -carotene, reducing sugar and pH.

INTRODUCTION

Vegetables and fruits are rich sources of vitamins C and E, folic acid, and the vitamin A precursor β -carotene. Epidemiologic studies often report an inverse association between these specific vitamins, as well as vegetable and fruit intake, and disease risk (Steinmetz and Potter, 1996 & Serdula, *et al.*, 1996).

Hung, *et al.*, (2004) reported that total consumption of fruits and vegetables among nurses and other health professionals in the United States is associated with reduced risk of cardiovascular disease but not cancer is very interesting.

Individuals who consumed more fruits, vegetables, and whole-grain foods were less likely to develop elevated blood pressure, defined as >135 mmHg systolic and 85 mmHg diastolic, over 15 years (Steffen *et al.*, 2005).

The US dietary guidelines recommended that all people over 2 years of age eat 5 to 9 servings of fruits and vegetables every day (USDA, 2000).

Fruits generally have lower provitamin A levels than leafy vegetables. However, they are usually better accepted by both children and adults and their provitamin A are believed to be more bioavailable. Popular tropical fruits, such as mango and papaya, are considered important provitamin A sources in developing countries (Olson, 1996 ; De Pee *et al.*, 1996).

To preserve food, it is necessary either to destroy all spoilage microorganisms that contaminate it or to bring about conditions that prevent microbes from carrying out their ordinary life processes. Although preservation is not aimed mainly at microbial spoilage it must be remembered that there are other types of spoilage factors such as oxidation, sometimes

chemicals are used together with other processes such as holding at refrigerator temperatures above freezing (Louis and Ernest, 1996).

Retention of provitamin A during storage of processed foods is favored by low storage temperature, protection from light, exclusion of oxygen by vacuum or hot filling, modified atmosphere packaging, or oxygen-impermeable packaging and the presence of a natural or added antioxidant. In general, salt treatment and sulfating also increase retention. Provitamin A in canned or bottled products are generally well retained for at least a year. Carotenoids in dehydrated products are more likely to undergo degradation during storage because the greater surface area and porosity increase their exposure to oxygen and light. Blanched products generally resist carotenoids decomposition during storage better than unbalanced foods (Delia, 1997).

Cooking, processing, and storing generally reduce the amount of vitamins and minerals available from fruits and vegetables, except for tomatoes, for which cooking increases the bioavailability of lycopene, intake of which is associated with reduced risk of prostate cancer (Etminan *et al.*, 2004).

Currently, refrigerated juices which are not obtained from concentrates and have been subjected to mild pasteurization partly satisfy the requirements of higher quality demanded by consumers. The shelf life of these juices ranges between 28 and 45 days in refrigeration and their quality approaches that of freshly squeezed juices (Esteve *et al.*, 2005).

Ramadan, (2006), found that, the moisture, total sugar, non-reducing sugar, carotenoids (β -carotene), total soluble solids contents and pH value of pasteurized fruit and vegetable juice blends decreased while, total solids, reducing sugar contents and total bacterial counts increased after six months of storage.

A comparative study was made for evaluation and modification of various carotenoids and vitamin A in untreated orange juice, pasteurized orange juice (90°C, 20 Sec.), and orange juice processed with high-intensity pulsed electric fields (HIPEF) (30 KV/cm, 100 μ s), during 7 weeks of storage at 2 and 10 °C. The concentration of total carotenoids in the untreated juice decreased by 12.6% when the juice was pasteurized, whereas the decrease was only 6.7% when the juice was treated with HIPEF. Vitamin A was greatest in the untreated orange juice, followed by orange juice treated with HIPEF (decrease of 7.52%) and, last, pasteurized orange juice (decrease of 15.62%). The decrease in the concentrations of total carotenoids and vitamin A during storage in refrigeration was greater in the untreated orange juice and the pasteurized juice than in the juice treated with HIPEF (Clara, *et al.*, 2006).

Because vitamin A deficiency remains a serious public health problem in developing countries, dietary sources and adequacy of provitamin A continue to be the major concern.

In view of absence of data for the characterization of refrigerated fruit and vegetable juice blends obtained from fresh juices with mild pasteurization, the main target of such manuscript is to follow up main components changes like, total sugar, reducing sugar, non-reducing sugar, pH, TSS and especially, β -carotene contents in untraditional fruit and vegetable juice blends during cold storage (5-7°C) for three months.

MATERIALS AND METHODS

Materials:

Raw Fruits and vegetables:

Mango (*Mangifera indica L.*), Apricot (*Prunus armeniaca L.*), Carrot (*Daucus carota L.*) and Pumpkin (*Cucurbita moschata*) were obtained from local market in EL-Mansoura city, EL-Dakahlia, Egypt.

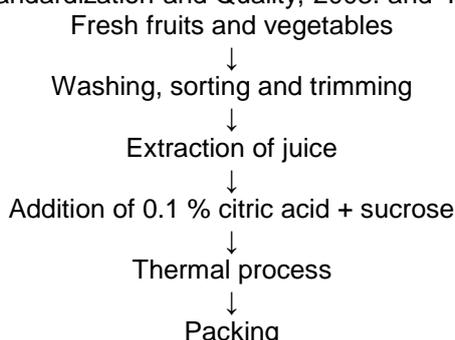
Glass bottles:

Transparent glass bottles were purchased from local market in EL-Mansoura city, EL-Dakahlia, Egypt.

Methods:

Preparation of juice blends:

The following procedures were carried out as a preliminary step, towards preparing the formulated juice blends shown in Table (1) as described by El-Sayed, (1966) and also, in accordance of Egyptian Organization for Standardization and Quality, 2003. and FAO/WHO, 2003.



Washing: Manual washing with 2% citric acid solution.

Sorting: Visual sorting to discard defected fruits or vegetables.

Trimming: Manual trimming by knife.

Extraction of juice: Mango, pumpkin and apricot juices were extracted using a high speed blender. Carrot juice was extracted using a kitchen machine.

Thermal process: Pasteurization at 88°C for one minute followed by cooling to 5°C .

Packing: Juice blends were packed in Transparent glass bottles.

Storage treatment: Packed juices were stored at 5°C for three months.

Prepared formulated fruit and vegetable juice blends were shown in Table (1).

Table (1): Formulated fruit and vegetable juice blends.

| Blends | Ingredients % | | | |
|---------|---------------|-----------|-----------|----------|
| | Mango % | Apricot % | Pumpkin % | Carrot % |
| No. (1) | 80 | 0 | 20 | 0 |
| No. (2) | 80 | 0 | 0 | 20 |
| No. (3) | 0 | 60 | 0 | 40 |
| No. (4) | 0 | 50 | 0 | 50 |
| No. (5) | 50 | 0 | 25 | 25 |
| No. (6) | 40 | 40 | 20 | 0 |

Then the previous six fruit and vegetable juice blends were stored at 5-7°C for three months.

Chemical analysis:

Total, reducing and non-reducing sugars were determined according to the methods of (AOAC, 2000).

Total soluble solid was determined using pocket refractometer, Japan and pH value was determined using pH meter, calibrated using standard buffers to pH = 4 and 7 (Hanna Instruments, Germany) according to (AOAC, 2000).

Determination of β -carotene (HPLC):

Extraction of yellow carotenoids:

Yellow carotenoids were extracted using acetone and petroleum ether solvents. To measure total carotenoids, 5ml of petroleum ether extract of the sample was pipetted to a 100ml volumetric flask containing 3ml acetone and diluted to mark with petroleum ether (Rangana 1979).

Then, β -carotene was determined according to the method described by (Weissenberg, *et al.*, 1997) at Food Technology Research Institute, Agricultural Researches Centre, Giza, Egypt.

HPLC conditions:

An Agilent 1100 series liquid chromatograph (Agilent Technologies, Waldbronn, Germany). Chromatogram were monitored at 450nm; the mobile phase was acetonitrile : 2-propanol : ethyl acetate(40:40:20, v.v.v.) ; the flow rate was 0.8 ml/min.

The extracts obtained as described above were dissolved in mobile phase (1 ml), filtered through a 0.45 μ m membrane disc and injected into the chromatograph (injection volume, 10 μ l). The column was regenerated by washing with 2-propanol after analysis, and then equilibrated with the mobile phase (Weissenberg, *et al.*, 1997).

Microbiological examination:

Total plate counts were carried out by applying the method of (Hareedy, 2003).

RESULTS AND DICSSIONS

Effect of cold storage period on fruit and vegetable juice blends:

Total soluble solids (TSS):

Data illustrated in Fig. (1) showed that total soluble solids in investigated juice blends gradually decreased from 15.50% to 14.50% in blend No.(2) after three months of storage. Blend No.(2) had the highest value of TSS and all other blends showed the same trend as blend No.(2) after 3 months of refrigerated storage. TSS values ranged from 14.50 to 15.50 at zero time of cold storage of all juice blends while, it ranged from 13.00 to 14.50 after three months of cold storage. This note may be explained that solids solubility decrease during storage and thus, TSS values were lower at the end of storage.

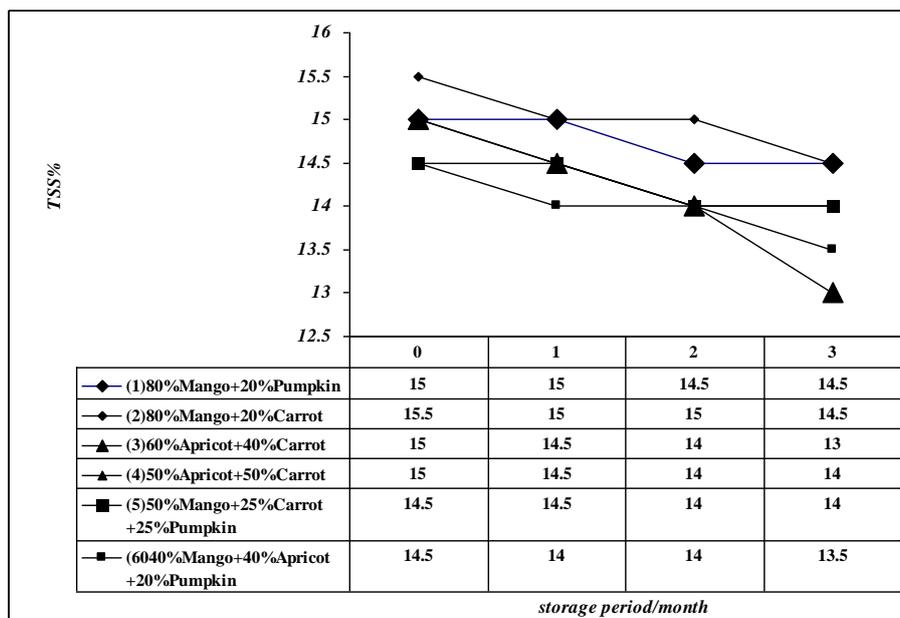


Fig. (1): Effect of cold storage on total soluble solids content in fruit and vegetable juice blends.

pH value:

Curves in Fig. (2) revealed a decrease of pH value with the progressively of storage time for juice blends from 4.35% to 4.01% in blend No. (1) after 3 months of cold storage. Blend No. (1) had the highest value of pH while, both blend No.(5) and No.(6) had the least value of pH (3.95). The same trend was observed for all other blends as No.(1). pH values decreased from the maximum value at zero time until it reached the minimum value at the end of storage period (three months) for every blend. However, it ranged from 3.95 to 4.35 and from 3.44 to 4.01 at zero time and at the end of storage period, respectively. These decreases in pH may be due to activity of some microorganisms and conversion of sugar to little alcohols and acids or some electrolytes sedimentation during storage. Total bacterial count results will explain the first probability. These results were in good agreement with those reported by Sukker, (2001).

Total, reducing and non-reducing sugars:

As shown in Figures (3,4 and 5), blend No.(2) (80% mango + 20% carrot) had the highest value of total sugar (16.00%) while, blend No.(5) (50% mango + 25% carrot + 25% pumpkin) had the highest value of reducing sugars (7.24%) and blend No.(3) had the highest value in non-reducing sugars (12.3%). In Fig. (4), it could easily observed that reducing sugar content ranged from 3.67% to 7.24% in all juice blends at zero time. These values slowly increased until reached the maximum value for each at the end of storage (4.70% – 7.55%). All juice blends showed the same previous trend

after three months of cold storage and of course, these increases may be attributed to acidic conversion of non-reducing sugar (sucrose) to reducing sugars (glucose + fructose). On the other hand, Fig. (5) and Fig. (3) showed decreases in non-reducing and total sugars from 11.40% to 10.50% and from 16.00 % to 15.50 % after three months of cold storage in blend No.(2), respectively. The same trend was observed for all other juice blends as blend No.2. The least total sugar value was in juice blend No. 6 after three months of cold storage where, it represented 14.25% while, the highest value was in juice blend No. 2 at zero time. As non-reducing sugars, the least value was in juice blend No. 6 and represented 7.41% at the end of cold storage period but, the highest value was 12.30% in juice blend No. 3 (60% apricot + 40% carrot) at zero time. These results showed that some of non-reducing turned into reducing sugars, this may be due to activity of some microorganism and this will be clear when discussion of microbiology results or acidic conversion. These results go in parallel with those reported by Sukker, (2001) and Ramadan, (2006).

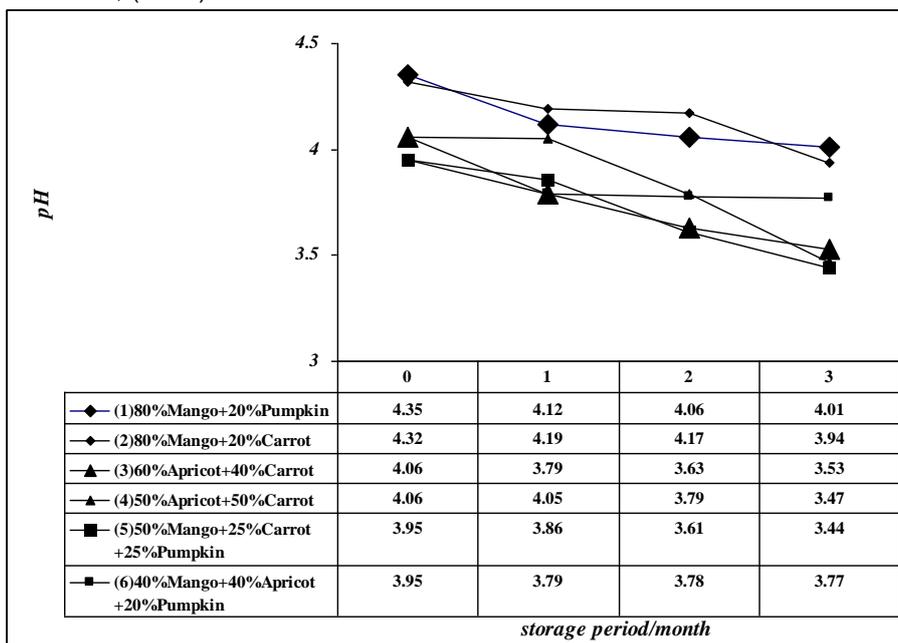


Fig. (2): Effect of cold storage on pH value in fruit and vegetable juice blends.

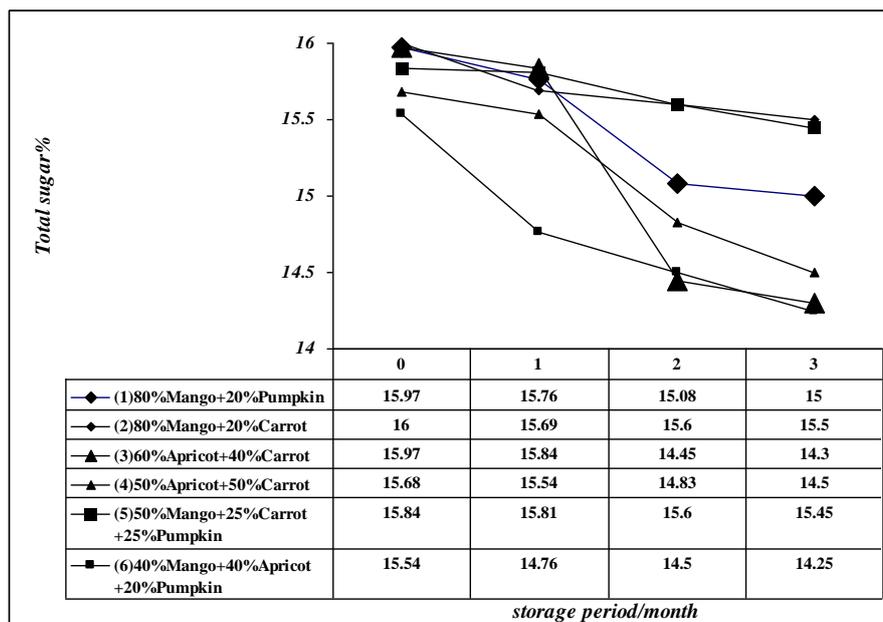


Fig. (3): Effect of cold storage on total sugar content in fruit and vegetable juice blends.

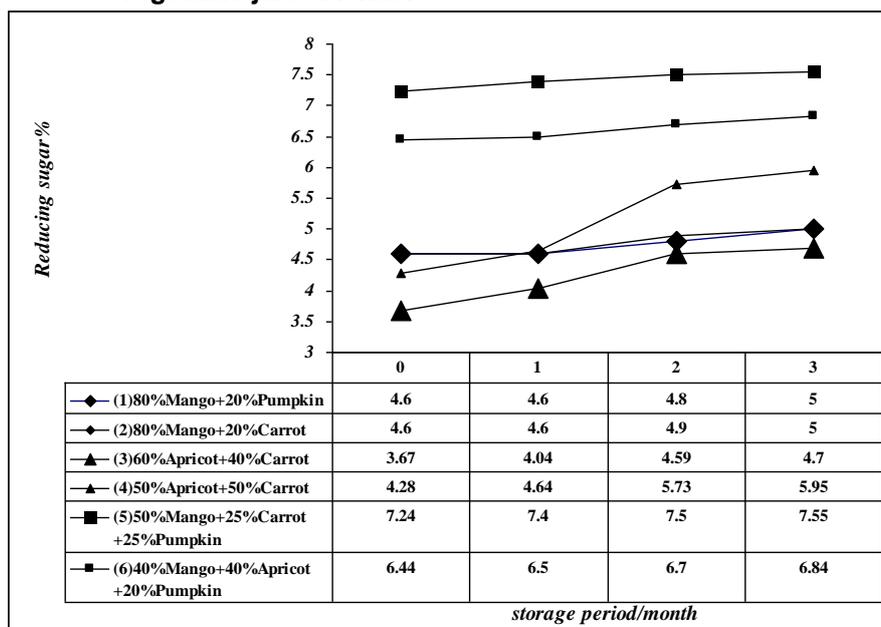


Fig. (4): Effect of cold storage on reducing sugar content in fruit and vegetable juice blends.

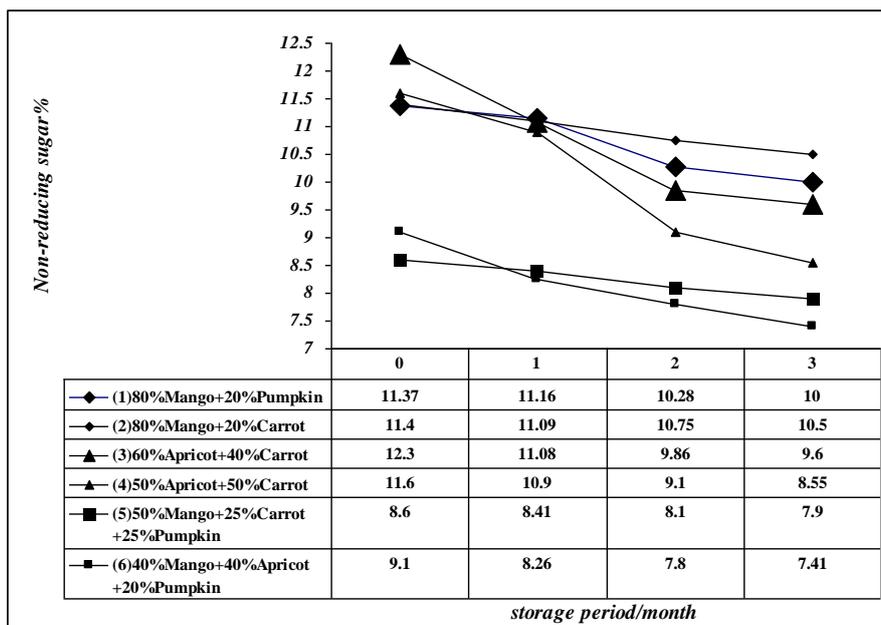


Fig. (5): Effect of cold storage on non-reducing sugar content in fruit and vegetable juice blends.

β-carotene:

Data tabulated in Table (2) showed that juice blend No.(4) (50% apricot + 50% carrot) had the highest value of β-carotene and it decreased for the same blend from 1000 to 950 μg/100ml after three months of cold storage. Other blends showed the same trend seen in blend No.(4) which followed by blend No. 2, 3, 5, 6 and No.1 as follows: (675 to 600), (625 to 550), (525 to 325), (500 to 375) and (250 to 216) μg/100ml from zero time and after three months of cold storage, respectively. Reduction percentages of β-carotene ranged from 5% to 38.09% in juice blend No. 4 and No. 5, respectively. This β-carotene reduction during cold storage may be due to not protection from light and there is no added antioxidants (Delia, 1997). These results go in parallel with those found by Etminan *et al.*, 2004 and Clara, *et al.*, 2006.

Table (2): Effect of cold storage on β-carotene content (μg/100ml) of fruit and vegetable juice blends.

| No. | Juice blends No. | | | | Storage period/month | | Change % |
|-----|------------------|-----------|-----------|----------|----------------------|-------|----------|
| | Mango % | Apricot % | Pumpkin % | Carrot % | Zero | Three | |
| 1 | 80 | 0 | 20 | 0 | 250 | 216 | -13.60 |
| 2 | 80 | 0 | 0 | 20 | 675 | 600 | -11.11 |
| 3 | 0 | 60 | 0 | 40 | 625 | 550 | -12.00 |
| 4 | 0 | 50 | 0 | 50 | 1000 | 950 | -5.00 |
| 5 | 50 | 0 | 25 | 25 | 525 | 325 | -38.09 |
| 6 | 40 | 40 | 20 | 0 | 500 | 375 | -25.00 |

Total viable bacterial counts (colony forming units/ml) of juice blends:

Data tabulated in Table (3) showed effect of cold storage period on total viable bacterial counts (CFU/ml) of juice blends at zero time and after three months of cooling storage. Data recorded that total viable bacterial count ranged from 20 CFU/ml to 40 CFU/ml for all blends at zero time but, it ranged from 30 CFU/ml to 50 CFU/ml at the end of storage period. Total bacterial count increased after three months of cold storage in juice blends No. 1, 2, 3, 4, 5 and 6 as follows from (20 to 30), (20 to 50), (30 to 40), (30 to 40), (40 to 50) and (20 to 40) CFU/ml, respectively.

The highest total bacterial count was obtained in juice blend No. 5 (50% mango + 25% pumpkin + 25% carrot) and No. 2 (80% mango + 20% carrot) after three months of storage where, it represented 50 CFU/ml in each blend. Total bacterial count increase percentage were 50%, 150%, 33.33%, 33.33%, 25% and 100% in juice blends No. 1, 2, 3, 4, 5 and 6 respectively.

The previous notices may be explained that preservation conditions (sugar %, pasteurization and vacuum) were not sufficient enough to inhibit all spoilage factors especially microbial one.

Table (3): Effect of cold storage on total viable bacterial counts (CFU/ml) of juice blends.

| Juice blends No. | | | | | Storage period/month | | Change % |
|------------------|---------|-----------|-----------|----------|----------------------|-------|----------|
| No. | Mango % | Apricot % | Pumpkin % | Carrot % | Zero | Three | |
| 1 | 80 | 0 | 20 | 0 | 20 | 30 | + 50 |
| 2 | 80 | 0 | 0 | 20 | 20 | 50 | + 150 |
| 3 | 0 | 60 | 0 | 40 | 30 | 40 | + 33.33 |
| 4 | 0 | 50 | 0 | 50 | 30 | 40 | + 33.33 |
| 5 | 50 | 0 | 25 | 25 | 40 | 50 | + 25 |
| 6 | 40 | 40 | 20 | 0 | 20 | 40 | + 100 |

Conclusion

So, it could be easily concluded that cold storage of tested fruit and vegetable juice blends had no clear effect on some chemical properties but had an negative action on β -carotene content and total viable bacterial counts. Any way, the presented fruit and vegetable juice blends were acceptable and in a good agreement with its Egyptian standard specifications.

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تغيرات صفات الجودة الكيميائية و التغذوية أثناء التخزين المبرد لبعض خلطات عصائر الفاكهة و الخضر.

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تعد العصائر الطازجة غذاءً شعبياً لجميع فئات المجتمع لانخفاض سعرها وحلاوة نكهتها. وبالرغم من السعر المنخفض لهذه العصائر إلا أنها ذات قيمة غذائية عالية لاحتوائها على تركيزات عالية من البيتاكاروتين و فيتامين ج و المركبات الفينولية و الكالسيوم و البوتاسيوم و المغنسيوم و الحديد. لذا يهدف هذا البحث إلى تتبع التغيرات الخاصة بالمكونات الرئيسية لخلطات غير تقليدية من عصائر الفاكهة و الخضر أثناء التخزين المبرد (٥ - ٧°م) لمدة ثلاثة أشهر. أظهرت النتائج أن الرطوبة ، و السكريات الكلية ، و السكريات غير المختزلة ، و البيتاكاروتين ، المواد الصلبة الذائبة الكلية و قيمة الرقم الهيدروجيني انخفضت في خليط عصائر الفاكهة و الخضر بينما يلاحظ وجود زيادة طفيفة في المواد الصلبة الكلية ، و السكريات المختزلة و العد الكلي للبكتريا و ذلك بعد ثلاثة أشهر من التخزين المبرد. و كان محتوى خليط العصير رقم ٤ (٥٠% مشمش + ٥٠% جزر) الأعلى في البيتا كاروتين حيث وصل إلى ١٠٠٠ ميكروجرام/١٠٠ مل عصير. و بالتالي تعتبر هذه الخلطات من عصائر الفاكهة و الخضر مقبولة للمستهلك و مطابقة للمواصفة القياسية المصرية الخاصة بها بالإضافة إلى أنها غنية في محتواها من البيتا كاروتين.

قام بتحكيم البحث

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