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Orange-cantaloupe Seed Beverage: Nutritive Value, Effect of Storage Time and Condition on Chemical, Sensory and Microbial Properties

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Abstract: Cantaloupe seed milk and orange concentrate were prepared from cantaloupe (*Cucumis melo* L.) seed and orange (*Citrus sinensis*) fruit, respectively. Orange concentrate (17%, v/v) was used to replace melon milk seed to produce an orange-cantaloupe seed beverage. The beverage was pasteurized at 85°C for 10 min. The moisture, fat, protein, ash and carbohydrate values were found to be 80.8, 2.25, 1.75, 0.298 and 14.9% respectively. This beverage was a good source of phosphorus and potassium. Storage stability of orange-cantaloupe seed beverage at refrigerator (4°C) and freezer (-18°C) was evaluated by analyzing changes in the chemical, microbial and sensory properties of the stored beverage for 42 days (Refrigerated Samples, RSs) and 84 days (Frozen Samples, FSs). The results showed that at both storage temperatures no changes occurred in soluble solids and microbial properties. Molds and yeasts were not found in the beverage at these conditions. The results of the consumer panel test showed that the beverage was liked much (3.67 on a 5-point hedonic scale). During storage time, pH and taste changes in both sample, but body and total acceptance changes were only significant in RSs ($p<0.05$). These changes were ignorable from technological aspects. The color of the beverage was not significantly affected by the storage time ($p>0.05$). The RSs had higher sensory ratings for taste and total acceptability, so was preferred respect to FSs.

Key words: Orange-cantaloupe seed beverage · storage stability · sensory properties · cantaloupe seed · nsutritive value

INTRODUCTION

In developing countries, the cost of milk and milk products are prohibitive [1]. An inexpensive substitute in the form of a beverage made from locally available plant foods, high in protein, with satisfactory quality could play an important role to improve protein malnutrition in these countries. Only soybeans have been extensively investigated while other oil seeds, such as melons, have not been studied comprehensively [2].

Cantaloupe (*Cucumis melo* L.) belongs to *Cucurbitaceae* family and is native to Africa and Asia. The records indicate that cultivation of melons as early as 2400 years B.C. Cantaloupe is cultivated for its tasty fruit, which may be used as an appetizer, a dessert or as salad [3]. Iran is one of the most important countries in melons cultivating [4]. The seeds of cantaloupe, however, are not much consumed. In some countries, their kernels are used as a dressing for breads, cakes, confectionery and snack foods, often instead of almonds and pistachios [5].

In recent years, the seed kernels have been used as the basis for a number of soups and stews [2] where act as a thickening, emulsifying, fat binding and flavoring agents [6]. The oil is also used and is highly valued [6]. Although several items of food have been made from melon seeds, no special food for infants and pre-school children has been formulated [7]. It is thought that melon seeds could be processed into a milk-like product, similar to soybean drinks [2].

In this study, it was shown that melon seeds can be substituted as an alternative to soybean for milk preparation [7]. The extract from melon seeds includes 3.6% protein, 4% fat and 2.5% carbohydrate which are comparable with those of soymilk. It is expected that the milk would improve the protein supply in developing countries and alleviate some of the nutritional problems caused by inadequate protein intake [2]. S.de Melo *et al.* [8] analyzed *Cucumis melo* var. saccharinus for their proximate composition. They found the concentrations of individual fatty acids varied from trace (less than 0.06%)

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quantities to about 51%. Linoleic, oleic, palmitic and stearic acids were the principal fatty acids of the total fatty acids which had a relatively high percentage (82.76%) of unsaturated fatty acids. Seed proteins were deficient in the essential amino acids methionine, lysine, threonine and valine. Methionine and lysine were the first and second limiting amino acids, while arginine, aspartic and glutamic acids were presented in good quantities [8]. However, the widespread utilization of melon seed milk has not been successful, perhaps because of its undesirable off-flavor, odor [1] and short stability shelf-life [7]. Apart from manipulation of soybean processing conditions, masking of soymilk with flavor additives such as fruit juice, coffee and vanilla or coconut cream has been reported to improve the flavor of soymilk [1]. Similarly, in this work, orange concentrate incorporated into cantaloupe seed milk at 17% (v/v) significantly improved acceptability of the beverage. Therefore, the objective of this study was evaluation of melon seeds, as a nutritive beverage and a source of protein.

MATERIALS AND METHODS

Materials: Cantaloupe (*Cucumis melo* L. var. til) seeds and sugar were purchased from a local market in Mashhad, Khorasan provinces, Iran. Orange concentrate was prepared through Shahd-Iran Company. Extraneous materials were separated from seeds. The seeds washed with water containing 5% Benzo alkoniumcloride, then sun-dried (36-48 hour) and were kept in jute-bags. The seeds were stored in a refrigerator at 4°C until used. Concentrate were kept in a freezer at -18°C. CMC was purchased from CP Celko Company.

Preparation of cantaloupe seed milk: The sun-dried cantaloupe seeds were soaked in water at 80-90°C for 30 min. The seeds were passed through sieve and ground by hammer miller to turn into paste. The paste blended with boiled water at 1:8 (paste/water) ratios, 17% sugar and 0.15% CMC (according to the results obtained from pre-treatments) in a Kenwood food processor (model 49074, UK) at high speed for 2 min. The resulting slurry was filtered through a double folded muslin cloth [1, 2, 6, 7]. By this way, cantaloupe seed milk was obtained.

Production of orange-cantaloupe seed beverage: Orange concentrate (17%, v/v) was used to mix with cantaloupe seed milk. This amount of concentrate decreased pH to 4.7. For setting pH on 4.15, some lime juice was added (In pH=4.15, any bacteria specially *Bacillus* spp. cannot growing). The mixture was blended in a mixture-homogenizer (model Ultra-Turrak, T25) [9, 10] at 8000^{rpm} for 2 min. The obtained beverage was pasteurized at 85°C for 10 min and hot filled into sterile bottles (about 6% head space).

Table 1: Composition of the cantaloupe seed and orange-cantaloupe seed beverage

	Cantaloupe seed (gr/100 gr dry material)		Orange-cantaloupe seed beverage
Constituent	Seed kernel	Whole seed	(gr/100gr beverage)
Moisture	3.900±0.05	4.500±0.08	80.800±0.50
Carbohydrate	13.000±0.00	33.900±0.00	14.900±0.00
Protein	28.620±0.50	21.110±0.45	1.750±0.11
Fat	49.700±0.75	36.720±0.59	2.250±0.09
Ash	4.812±0.10	3.821±0.09	0.298±0.02

Means of 3 replicates ±standard deviation

Table 2: Micro-nutrient contents of the cantaloupe seed and orange-cantaloupe seed beverage

	Cantaloupe seed (ppm)		Orange-cantaloupe
Micro-nutrient	Seed kernel	Whole seed	seed beverage (*ppm*)
Sodium	46.820±3.22	34.130±3.01	8.000±1.09
Potassium	25.330±1.25	25.530±1.02	14.000±1.9
Magnesium	0.832±0.01	0.751±0.02	-
Iron	2.407±0.02	2.439±0.03	0.612±0.02
Copper	0.315±0.01	0.540±0.02	0.062±0.01
Calcium	-	-	13.900±1.23
Phosphorus	-	-	60.500±2.11

Means of 3 replicates ±standard deviation

Production of FSs is similar, with only one difference. In preparation of cantaloupe seed milk, the paste was blended with boiled water at 1:4 (seed: water) ratio. So, the final brix is twice as much as RSs. at consumption time, the required water was added.

Storage stability: Beverage samples were stored in sterile bottles in 3 replicates at refrigerator (4°C) temperature for 42 days and freezer (-18°C) temperature for 84 days. For RSs at 7 days intervals and for FSs at 14 days intervals, the beverage samples were withdrawn and analyzed for pH, soluble solids, mold and yeast counts and sensory characteristics.

Analytical methods: Moisture, proteins (N×6.25), fat, ash, mineral content, pH and soluble solids were determined according to AOAC [11]. For analyzing cantaloupe seed kernels, the seeds were dehulled manually and then

ground but for whole cantaloupe seeds, they were just ground. The protein content was determined by Kjeldahl method [5, 7]. The fat content in seeds were determined by Soxhlet method and in the beverage after homogenizing, was measured using the Gerber method [5]. Carbohydrates were calculated by differences [7]. Sodium and potassium were measured by Flame photometer (JENWAY, Clinical PFP7 model). Other mineral contents (phosphorus, magnesium, iron, copper and calcium) were determined using Atomic Absorption Spectrophotometer method. pH was measured with a digital pH meter (Metrohm 691). Soluble solids were determined using an Abbe refractometer (RG, 701, Officine, Gathled) and the result expressed as degree brix. Mold and yeast counts were conducted with Sabouraud Dextrose Agar. Plates were incubated at 30°C and colonies were counted at 5-7 days intervals [12].

Sensory evaluation: The beverage samples were evaluated in a sensory laboratory under white light for attributes of taste, color, body and total acceptability by a preference method [13] on a 5-point hedonic scale where 5= excellent and 1= very poor. A panel team of ten trained-judges (ages ranging between 20 and 40) was used. Coded samples were presented in white glass cups and were evaluated at daily intervals between 10:00 a.m.–12:00 a.m. The judges were told to rinse their mouths with tap water between drinking beverage samples [14].

Statistical analysis: The experiments were conducted as a factorial with completely randomized design [15]. Analysis of variance and Duncan Multiple Range Test [16] were used to analyze data for significant differences between means ($p<0.05$).

RESULTS AND DISCUSSION

Cantaloupe seed and orange-cantaloupe seed beverage composition: The chemical analysis results of cantaloupe seed and orange-cantaloupe seed beverage are presented in Table 1. The moisture content of whole cantaloupe seed was 4.5% and in beverage was 80.8%. It is obvious that the dilution of the ground seeds with water and thus an increase in the moisture content would cause a decrease in the amount of other nutrients [5]. The fat content of the beverage was found to be 2.25%, lower than the value of the whole seed which is 36.7% on a dry weight basis. This loss could be explained by the process applied in obtaining the beverage since some fat particles might remain in the residue over the sieve [5]. The same results could be applied for protein content which was found to be 1.75%, since the protein content of cantaloupe seed is 21.1% on a dry weight basis. Karakaya and *et al.* (1995) found that musk-melon (*Cucumis-melo* L.) seed beverage has 86.36% moisture, 1.92% fat, 1.28% protein, 0.27% ash and 10.17% carbohydrate [5]. Akubor (1998) reported that the values of moisture, fat, protein, ash, carbohydrate and crude fiber in melon seed is 8, 53, 29.2, 3.5, 4.3, 2.0% and in melon seed milk is 87.0, 4.0, 3.67, 0.90, 3.4 and 1.0% respectively [7]. S.de Melo and *et al.* (2000) analyzed *Cucumis melo* var. saccharinus for their proximate composition. They found that the seeds contained high percentage of lipids (32.3%) and proteins (19.3%) [8].

Micro-nutrient contents of seed and beverage are shown in Table 2. The phosphorus (60.50 *ppm*) and potassium (14.00 *ppm*) content of the beverage is very high, therefore orange-cantaloupe seed beverage could be considered as a good source of phosphorus and potassium. Also, cantaloupe seeds have valuable amounts of sodium (34.13 *ppm* in whole seeds). As shown in Table 2, the beverage contains substantial amounts of sodium and calcium. El-Adawy and Taha [17] found that paprika seed and seed kernels of pumpkin and watermelon contained considerable amounts of phosphorus, potassium, magnesium, manganese and calcium [17].

Chemical properties: Chemical, sensory and microbial attribute changes of the formulated beverage during storage time are shown in Table 3. According to variance analysis, at both 4°C and -18°C, storage time have significant effect on pH ($p<0.05$). In the first 28 days of storage, pH increased. These increases were higher at 4°C than at -18°C. Because in freezing temperature, reactions intensity and resulting changes are lower. After 28 days, pH in RSs decrease which is probably due to the activity of acid-producing bacteria. In FSs throughout the period of storage, any of microorganisms couldn't grow, thus the pH constantly increased. Overall, the pH values of RSs (4.31) were higher than FSs (4.16) (Table 4). In spite of significant changes in pH for both samples, pH just moved from 4.15 to 4.31 (for RSs) and 4.15 to 4.30 (for FSs) finally.

The regression relationship between pH and sensory parameters of orange-cantaloupe seed beverage showed that only taste was highly correlated with pH ($p=0.022<0.05$). Other parameters include color ($p=0.877$), body ($p=0.617$) and total acceptability ($p=0.754$) have no significant effects on pH. The obtained equation is:

Table 3: Influence of storage time on chemical, microbial and sensory properties of orange-cantaloupe seed beverage stored at 4°C (Refrigerated) and -18°C (Frozen)

	Storage period (days)												
Attribute	Sample	1	7	14	21	28	35	42	49	56	63	70	77	84
pH	Refrigerated	4.161^{bc}	4.207^{bc}	4.260^{b}	4.339^{ab}	4.416^{a}	4.387^{a}	4.329^{ab}						
	Frozen	4.129^{c}		4.138^{c}		4.201^{bc}		4.199^{bc}		4.214^{b}		4.246^{ab}		4.303^{a}
Brix	Refrigerated	17.00^{a}	17.00^{a}	17.00^{a}	17.00^{a}	17.00^{a}	17.00^{a}	17.00^{a}						
	Frozen	34.00^{a}		34.00^{a}		34.00^{a}		34.00^{a}		34.00^{a}		34.00^{a}		34.00^{a}
Taste	Refrigerated	3.481^{b}	3.519^{b}	3.849^{a}	3.875^{a}	3.842^{a}	3.762^{a}	3.576^{b}						
	Frozen	3.384^{bc}		3.444^{b}		3.453^{b}		3.466^{b}		3.722^{a}		3.725^{a}		3.741^{a}
Color	Refrigerated	3.531^{a}	3.852^{a}	3.891^{a}	3.920^{a}	3.910^{a}	3.915^{a}	3.950^{a}						
	Frozen	3.650^{a}		3.704^{a}		3.796^{a}		3.833^{a}		3.813^{a}		3.886^{a}		3.920^{a}
Body	Refrigerated	3.222^{c}	3.519^{b}	3.74^{a}	3.750a	3.597^{ab}	3.571^{ab}	3.448^{b}						
	Frozen	3.511^{a}		3.463^{a}		3.489^{a}		3.466^{a}		3.537^{a}		3.531^{a}		3.501^{a}
Total acceptance	Refrigerated	3.167^{c}	3.426^{b}	3.653^{a}	3.774^{a}	3.712^{a}	3.500^{b}	3.386^{b}						
	Frozen	3.370^{b}		3.470^{ab}		3.482^{ab}		3.490^{ab}		3.650^{a}		3.560^{a}		3.570^{a}
Molds, yeasts	Refrigerated	X	X	X	X	X	X	X						
	Frozen	X		X		X		X		X		X		X

X, no growth, Means within a column with the same superscript were not significantly different (p>0.05)

$$y = 4.44 + 0.037 \text{ x r} = 0.68^{*}$$

Where, y is pH and x is the taste of the orange-cantaloupe seed beverage.

There were no appreciable changes in the values for soluble solids content of the refrigerated and frozen orange-cantaloupe seed beverage throughout the period of storage. These findings indicate that there wasn't important microbial activity and spoilage in the beverage. Akubor and *et al.* (2002) noted during 7-days storage of melon milk (pH=6.36) at room (30±2 °C) and refrigeration (10±2°C) temperatures, soluble solids and pH of the milk decreased while titratable acidity increased [2].

Sensory evaluation: The panel test results showed at initial days, the beverage was rated nearly well for taste (RSs, 3.48, FSs, 3.38), perhaps because of being new and not testing before. After that, taste score increased until 28 days. For Fss, it increased to 3.87 and then decreased to 3.58. It can be contributed to acid production and sour flavor that had deteriorated markedly. The Rss had a significant higher rating for taste than the FSs (Table 4).

According to variance analysis, there were no significant color changes among the samples during storage time (p>0.05). The color score of FSs (3.78) evaluated better than RSs (3.71) (Table 4). Orange-cantaloupe seed beverage is near to orange color.

Table 4: Effect of storage temperature on chemical, microbial and sensory properties of orange-cantaloupe seed beverage stored at 4°C (Refrigerated) and -18°C (Frozen)

	Sample	
Attribute	Refrigerated	Frozen
pH	4.314^{a}	4.165^{b}
Brix	17.00^{a}	34.00^{a}
Taste	3.669^{a}	3.398^{b}
Color	3.707^{a}	3.782^{b}
Body	3.475^{a}	3.505^{a}
Total acceptability	3.442^{a}	3.384^{a}
Molds and yeasts	X	X

X, no growth

Means within a column with the same superscript were not significantly different (p> 0.05)

Body rating of the RSs during shelf life was evaluated significant (p<0.05) and in FSs insignificant (p>0.05). At first day, FSs reached higher scores because of firmness. In these samples, 50% of formulation water was added just before using, so that water has no interaction with surrounding liquid and beverages seemed thinner. After 1 week, body of the RSs was rated better and obtained higher score than RSs. This was maintained until 25 days. After that body rating decreased. Increasing rating due to the chemical and biochemical reactions and occurred interactions in beverage that made it weaker. Bys the storage time, beverage structure was deteriorated.

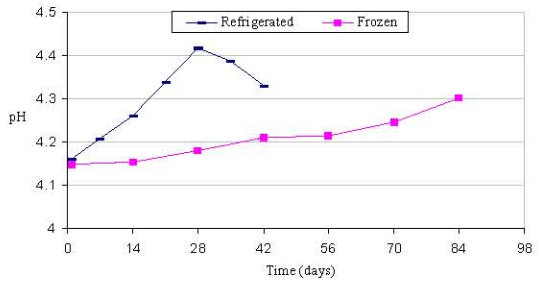

Fig. 1: pH changes during storage time of orange-cantaloupe seed beverage

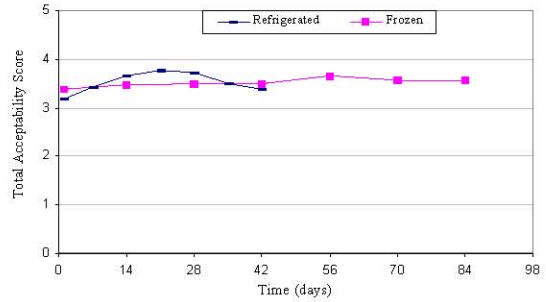

Fig. 2: Total acceptability score changes during storage time of orange-cantaloupe seed beverage

Considering, storage temperature has no significant effect on body scores (p>0.05, Table 4).

Variance analysis results of the consumer panel test showed that the total acceptability was significant only for RSs during storage (p<0.05). This was due to the storage temperature which was more appropriate to reactions. By the 21st day of storage, total acceptability score of RSs increased, but thereafter it decreased (Fig. 2). It might be the results of relating most portion of overall acceptability to body and taste. Since these parameters have the same trend, total acceptability followed them. By the way, the more important issue is that panelists evaluation of this beverage was 3.67 (good score), which is a considering rating for a new beverage. Karakaya [5] obtained that the consumer panel test results of musk-melon seed beverage was liked very much (4.9 on a 5-point hedonic scale) [5].

All the values make a data base that was used for defining mathematical methods. When applying the regression analysis method to the data, evaluated that color has no significant effect (p=0.07>0.05) on total acceptability, so eliminated. Thus, this equation obtained:

$$y = 0.036 + 0.715\ x_1 + 0.645\ x_2\ r = 0.712^*$$

Where, y is total acceptability, x_1 is body and x_2 is the taste of the orange-cantaloupe seed beverage.

On the other hand, Backward Stepwise indicated that total acceptability is significantly correlated with body (r= 0.705) and taste has little portion. The final equation obtained:

$$y = 0.286 + 0.811\ x\ r = 0.705^*$$

Where, y is total acceptability and x is the body of the orange-cantaloupe seed beverage.

Microbial attribute: No microbial (molds and yeasts) growth occurred in the orange-cantaloupe seed beverage during the 42 and 84 days storage at 4°C and -18°C respectively. This suggested that processing (85°C/ 10min) was efficient and post contamination had not occurred [2]. Thus, no potential microbial hazard was associated with storage conditions. However, some microorganisms might be resistance to the thermal treatment [18].

CONCLUSIONS

The extension of dairy substitutes in developing countries must be given greater emphasis. From the analysis performed in this study, orange-cantaloupe seed beverage can be considered as a good source of protein, phosphorus, potassium and sodium. Adding orange concentrate to cantaloupe seed milk decrease pH from 6.83 (pure cantaloupe seed milk) to 4.15 (orange-cantaloupe seed beverage). It seems that a combination of orange concentrate and heat treatment (85°C/10 min) provided a beverage which is chemically, microbially and sensorily stable for at least 6 weeks in refrigerated samples and 84 days for frozen samples. The consumers were more satisfied with refrigerated beverage.

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