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Evaluation of Low Calorie Roselle Beverage

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Abstract

Roselle calyces contained 10.85, 6.75, 8.61, 1.10, 13.60 and 69.94% of moisture crude protein, ash, ether extract, crude fiber and available carbohydrates, respectively. The major minerals of roselle calyces were Ca, Mg, P, Fe and K which contained 688.34, 234.68, 34.88, 33.42 and 20.56 mg/100g, respectively (on dry weight basis). Dried roselle calyces contained 113.60, 46.50, 28.68, 76.26 and 8.32 mg/100g from ascorbic acid, total polyphenols, flavonoids, tannins and anthocyanin, respectively (on dry weight basis). With respect to roselle beverage storage for 6 months indicated that T.S.S, ash, total sugars, reducing sugars, non-reducing sugars and titratable acidity ranged from 3.19 to 15.63, 3.33 to 7.25, 30.31 to 81.45, 12.60 to 20.81, 9.03 to 65.41 and 0.59 to 0.77%, respectively.

It could be noticed that increasing storage period from 0 to 6 months was accompanied by significant decrease in total sugars, reducing sugars and titratable acidity of roselle beverage. pH value of roselle beverage ranged from 2.58 to 2.80. Total phenolic compounds, flavonoid components and the antioxidant activity ranged from 0.90 to 1.24, 0.34 to 0.83 mg/gm and 20.50 to 77.14 µmol/g, respectively. While, increasing storage period from 0 to 6 months led to significant decrease in total phenolic compounds, flavonoid components and the antioxidant activity. Also, organoleptic properties (color, odor, taste, appearance and overall acceptability) were decreased significantly during storage period of roselle beverage.

Key words: Roselle beverage, Low calorie, Stevioside, Sucralose.

Introduction

Roselle (*Hibiscus sabdariffa* L.) locally called "karkada" and at the same time for the mallow tea produced from the dried flowers or hibiscus tea. Roselle is in Egypt and Sudan a rather popular drink which is drunk hot and cold as a soft drink. Its thirst-quenching effect is especially welcome in hot areas. In Indonesia, the drink is called the Mesir "Egyptian tea". Meanwhile, it is common for special occasions, such as wedding celebrations, to serve roselle. It is used as a substitute for alcoholic beverages in a predominantly Islamic society.

Hibiscus sabdariffa commonly named as "red sorrel" or "roselle" belongs to the family Malvaceae. It is a medicinal plant with a worldwide fame and has more than three hundred species which are distributed in tropical and subtropical regions around the world. Roselle can adapt to a variety of soil in a warmer and more humid climate. Roselle is rich in organic acids including citric, malic, tartaric, and allohydroxy citric acids **(Singh *et al*., 2017)**.

Roselle, the safe medicinal plant having various medically important compounds called phytochemicalsis well known for delicacy and also for its nutritional and medicinal properties **(Arvind *et al*., 2011).**

Roselle tea is naturally low in calories and is caffeine-free. According to the USDA Nutrient Database, it has a good supply of minerals including calcium, iron, magnesium, phosphorus, potassium, sodium, and zinc. It also contains B-vitamins like niacin and folic acid. This tea is a good source of anthocyanins, which makes it beneficial for managing elevated blood pressure levels, the common cold, and urinary tract infections.

Mohamed *et al.* (2007) reported that the chemical analysis of dried roselle calyces for moisture, T.S.S., crude protein, crude fiber, crude fat, ash, and total available carbohydrate content were: 11.00, 5.00, 7.88, 13.20, 0.16, 10.60 and 57.16%, respectively (on wet weight basis). Also, ascorbic acid, Ca and Fe were 11.00, 60.00 and 25.00 mg/100g, respectively.

Diessana *et al.* (2015) showed that the use of crushed (rather than whole) dried calyces and a 1:5 w/w calyx-to-water soaking ratio resulted in maximal anthocyanin extraction after 30 min at 30°C. Meanwhile, studies of the thermal kinetic degradation of anthocyanins in water extracts of sun-dried roselle calyces uncovered that rate of degradation increases dramatically above 80°C, revealing the importance of using mild (rather than harsh) pasteurization conditions **(Cisse *et al*., 2009)**.

Cisse *et al.* (2012) used 100°C for 5 minutes and observed significant differences in anthocyanins, antioxidants and colour between pasteurized and unpasteurized samples. In all properties, pasteurized extracts had lower values. Whereas, **Perez-Ramirez *et al.* (2015)** pasteurized at 95°C for 15 minutes and observed a 6-7% loss in anthocyanins but no losses with total polyphenolic content or antioxidant capacity.

Fasoyiro *et al.* (2005) found that the chemical composition of roselle extract were 10.37% T.S., 3.47% protein, 12.63% ash, 10.99% fat, 2.31%

crude fiber and 70.49% available carbohydrate (on dry weight basis). Also, ascorbic acid Ca and Fe were 11.00, 60.00 and 25.00 mg/100 g, respectively Also, ascorbic acid, Ca, P and Na were 31.33, 2.30, 2.78 and 2.25 mg/100g, respectively. pH of roselle extract was 3.10, titratable acidity 2.40% and total soluble solids 3.20°Brix.

Pozos *et al*. (2020) found that the concentration of the polyphenols in calyx of roselle (*H. sabdariffa*) extracted (13.02 mg GAE/g dw) and flavonoids (4.981 mg CE/g dw), anthocyanins (1.855 mg Cya3GE/g dw), and tannins (0.745 CE/g dw) recoveries and an antioxidant activity (DPPH) of 74.58%.

Replacing sugar as the major sweetener in food and beverages has been a major industry objective since the latter part of the twentieth century. Roselle beverages are typically sweetened with industrial sweeteners such as sucrose (white sugar) or natural sweeteners e.g. honey, fruit juice, maple syrup, nectars, simple sugars (fructose or dextrose) and sugar alcohols. Although high in sweetening quality, these sweeteners fail in their ability to satisfy consumer's requirements health calorie reduction. Indeed, the use of sugar in roselle beverages seems counterintuitive to some of the documented natural benefits of roselle extracts. Therefore, intense sweeteners are purported to be the current healthy solution for sweetening beverages, of which only the stevia glycosides satisfy clean label conditions and are approved for use in the EU. Low-calorific sweeteners from the plant source stevia are becoming more popular although incorporation into beverages is limited. Extracts from the *Stevia rebaudiana* plant has been associated with off-flavours. In addition, **Perez-Ramirez *et al*. (2015)** demonstrated that stevia can add extra functionality to roselle beverages. 1.4-1.5% stevia used reduced the loss of antioxidants as well as the degradation of anthocyanins and total polyphenols in the beverage.

The present investigation was carried out to study evaluation of low calorie roselle beverage.

Materials and Methods

Materials:

The fully ripped edible dried red roselle calyces (*Hibiscus sabdariffa* L.) was procured from local market in Giza Government. Stevioside and sucralose (Fineprint company) imported by Rebat Company for Food Stuffs Trade, Egypt.

Methods:

2.1. Preparation of raw materials:

Roselle calyces sorted and cleaned to remove the defects and the undesirable particles. The crushed portion was stored at 5ºC in a refrigerator until processing and analysis.

2.1.1. Preparation of roselle calyces extracts.

Roselle calyces were soaked in distilled water at a ratio of 1:10 (w/v) at ambient temperature (25±2ºC) overnight then, boiled for 15 min. The extract was drained through one layer of cheese cloth and pressed by hand until obtaining the free running extract, then the obtained extract was filtered through a piece of cotton to remove fine particles. In order to prepare roselle beverage, many treatments were prepared for this study.

2.1.2. Preparation of the deferential treatments:

T1: Control: Extract without additives, **T2:** Control: Extract + sucrose (TSS ˜ 15.5%), **T3:** Extract + sucralose (0.0246 g/100 ml), **T4:** Extract + stevia (0.0590 g/100 ml) and **T5:** Extract from local syrup market. The treatments from T2 to T4 were mixed with 0.05% potassium sorbate, 0.25% sodium benzoate and 0.5% ascorbic acid.

2.1.3. Filling and storage:

The roselle beverages were filling in sterilized glass bottles (100 ml), sealing and heated at 80±2ºC/20 min, then cooled to 25°C **(Chumsri1 *et al*., 2008)**. All bottles were stored at refrigeration temperature 5±2°C (**Mgaya-Kilima *et al*., 2014)**.

Storage period for 6 months. Chemical, physical and sensory evaluations of the stored samples were carried out after 0, 3 and 6 months of storage.

3. Analytical methods:

Raw dried red roselle calyces and laboratory-made natural roselle beverages prepared according to the most optimum extraction, were analyzed directly for their sensory and chemical characteristics. Laboratory-made roselle beverages were prepared with special packed ingredients according to recipes derived from the native shops of beverages.

3.1. Organoleptic evaluation of roselle beverages:

Ten panelists evaluated the organoleptic characteristics for roselle extracts beverages. The organoleptic evaluation was carried according to method described by **Kotecha and Kadam (2003).**

3.2. Chemical analysis:

Moisture, total soluble solids (T.S.S.) and total ash content were determined according to **A.O.A.C. (2012)**. Total carbohydrates content was calculated by difference.

Phosphorus was determined by using the spectrophoto-meteric method as described by **(A.O.A.C., 2012)**.

Macro and micro-elements calcium, phosphorus, potassium, magnesium, and iron were determined using the atomic absorption spectroscopy technique (Pye Unicom Sp. 1900 England) as described by **A.O.A.C. (2012)**.

Total and reducing sugars were determined by Shaffer and Hartman method as described in the **A.O.A.C. (2012)** while non-reducing sugars were calculated by difference.

The pH of the samples was measured using a digital pH meter (Jenway 3510 pH Meter, Germany). Also, Titratable acidity was determined according to **A.O.A.C (2012)**.

3.3. Determination of color index (non-enzymatic browning) and total anthocyanins content:

Color index was determined by the method of **Meydov *et al.* (1977)**. Total anthocyanins were measured according to the method of **Skalski and Sistrunk (1973)**.

3.4. Determination of biochemical components:

Total phenolic content of each sample was determined using a Folin Ciocalteu assay according to the method of **Singleton and Rossi (1965).**

Total flavonoid content was measured by $AlCl_3$ colorimetric assay according to the method of **Tacouri *et al.* (2013).**

The radical scavenging ability of diets was tested on the basis of the radical scavenging effect on the DPPH free radical. Antioxidant assays are based on measurement of the loss of DPPH color at 515 nm after reaction with test compounds **(Brand-Williams *et al.,* 1995)**.

5. Statistical analysis:

The statistical analysis was carried out using two-way ANOVA using SPSS, ver. 22 **(IBM Corp. Released 2013).** Data were treated as a complete randomization design according to **Steel *et al.* (1997).** Multiple comparisons were carried out applying Duncun test the significance level was set at < 0.05.

Results and Discussion

1. Chemical composition of dried roselle calyces:

The results shown in Table (1) showed that moisture content of naturally dried roselle calyces was 10.85%. Chemical analysis also showed that roselle calyces contained 6.75, 1.10, 13.60 and 69.94% of crude protein, ether extract, crude fiber and available carbohydrate, respectively. Results given in the same table indicated that roselle calyces had high ash content which reached 8.61%. The composition of the roselle calyces was similar to referenced data, with some differences that may be due to genetic variety and type of soil **(Babalola *et al.,* 2001)**.

The results are in agreement with those reported by **(Adenipeku, 1998)** who showed that the calyces contain 11.33% moisture and 6.90% protein. The results indicate the nutritional content of calyces compared well literature value. Typical literature values are; carbohydrates (68.75 %), protein (6.71%) and fat 1.01%). This may be attributable to the source of calyces **(Ameh *et al.,* 2009)**.

Also, **El-Baily (2016)** noticed that dried roselle calyxes contains 89.20 total solid, 12.89 ash, 0.43 fat and 8.22% protein.

Besides the chemical composition, the content of some minerals dried roselle calyces was determined, as well. Results presented in Table (1) indicate the high content of the analyzed minerals in the dried roselle calyces form the obtained results it is evident that content of the major minerals Ca, Mg, P, Fe and K was 688.34, 234.68, 34.88, 33.42 and 20.56 mg/100g on dry weight basis, respectively.

Table 1. Chemical composition of dried roselle calyces (mean±SE).

Components	Dried roselle calyces
Proximate components (%):	
Moisture	**10.85±0.62**
Crude protein*	**6.75±0.48**
Ash*	**8.61±0.52**
Ether extract*	**1.10±0.04**
Crude fiber*	**13.60±1.24**
Available carbohydrate*@	**69.94±2.88**
Minerals (mg/100 g):	
Ca	**688.34±5.23**
P	**34.88±0.64**
K	**20.56±0.88**
Mg	**284.68±2.56**
Fe	**33.42±1.42**
Bioactive components (mg/100 g):	
Ascorbic acid	**113.60±2.36**
Total phenolic	**46.50±0.98**
Flavonoids	**28.68±0.68**
Tannins	**76.26±1.32**
Anthocyanin	**8.32±0.04**

* On dry weight basis @: available carbohydrate calculated by difference

Data in the same table show the content of bioactive components in dried roselle calyces, which contained ascorbic acid, total polyphenols, flavonoids, tannins and anthocyanin. Dried roselle calyces contained 113.60, 46.50, 28.68, 76.26 and 8.32 mg/100g on dry weight basis from ascorbic and, total polyphenols, flavonoids, tannins and anthocyanin, respectively. These results are lower

than those obtained by **(Ismail *et al*., 2008)** who reported that the dried roselle calyces contained 260–280 mg/100g. The results of total phenolic are higher than those obtained by **Luvonga (2011)** who found that total phenolic content of roselle was 6.06±0.18 mg/100 g. The results of anthocyanin are lower than those obtained by **Cisse *et al.* (2012)** who reported that the content of anthocyanins in roselle were reported to be in the range of 1.5 to 2.5 g/100 g (on dry weight).

2. Effect of storage period on chemical composition of roselle beverage:

Data in Table (2) shows the changes in chemical composition/ constituents [moisture, total soluble solids (T.S.S), ash, total sugars, reducing sugars, non reducing sugars, titratable acidity contents and pH value] during storage period of roselle beverage.

Statistical analysis indicated that there are more or less significant difference in moisture content of roselle beverage between the different treatments. Moisture content ranged from 82.62 to 95.40, which was significantly higher in T4, while it was significantly lower in T2.

Statistical analysis did not appear any significant difference in moisture content between T3 and T4. The lowest moisture content of T2 and T5 due to adding of sucrose during preparation of roselle beverage statistical analysis did not appear and significant difference in moisture content of all treatment during storage period. These results are in agreement with those obtained results by **Fasoyiro *et al*. (2005)**. With respect to T.S.S statistical analysis indicated that a significant difference between all treatments. T.S.S ranged from 3.19 to 15.63% which were significantly higher in T2, while were significantly lower in T1.

The significantly higher of T.S.S in T2 and T5 due to using of sugar during preparation roselle beverage, while the lowest significantly of T.S.S due to using of natural sweeteners, which contained sucralose in T3 and stevia in T4. These results agreement with those results obtained by **Fasoyiro *et al*. (2005)**.

Total ash content in roselle beverage ranged from 3.33 to 7.25% on dry weight basis, which was significantly higher in T4, while it was significantly lower in T5 the highest amount of ash in T4 due to using of stevia, while the lowest amount of ash in T5 may be due to using water and sugar in roselle beverage preparation. The results of anthocyanin are lower than those obtained by **Fasoyiro *et al*. (2005).**

Total sugars content ranged from 30.31 to 81.45% on dry weight basis, which was significantly higher in T2, while was significantly lower in T1. The lowest amount of total sugars in T1 due to no adding sugar, while the lowest amount of total sugars in T3 and T4 due to using of natural sweeteners, which contained sucralose in T3 and stevia in T4 the highest amount of total sugars in T2 and T5 due to adding of sucrose during preparation of roselle beverage. Reducing sugars content ranged from 12.60 to 20.81% on dry weight basis, which was significantly higher in T1, while it was significantly lower in T2.

Statistical analysis did not appear any significant differences of reducing sugars between T1 and T3 and between T3 and T4, respectively. Non reducing sugars content determined as sucrose ranged from 9.03 to 65.41%, which was significantly higher in T2, while it was significantly lower in T1.

The highest amount of non reducing sugars content in T2 and T5 due to adding sucrose during roselle beverage or syrup. The lowest amount of non reducing sugars content in T1 due to no adding sucrose, while the lowest amount of non reducing sugars content in T3 and T4 due to using natural sweeteners, which contained sucralose in T3 and stevia in T4.

It could be noticed that increasing storage period from 0 to 6 months was accompanied by significant decrease in total sugars of T1, T3, T4 and T5 from 31.58, 45.58, 45.73 and 74.42 to 29.09, 41.63, 43.06 and 71.41% on dry weight, respectively. Also increasing storage period from 0 to 6 months led to significant decrease in reducing sugars of T1, T4 and T5 from 21.91, 19.26 and 16.82 to 19.96, 17.45 and 14.99, respectively. Titratable acidity of roselle beverage ranged from 0.59 to 0.77%, which was significantly higher in T1, while it significantly lower in T4. Statistical analysis did not appear any significantly differences of titratable acidity between T3 and T5. From the obtained results, it could be noticed that increasing storage period from 0 to 6 months of roselle beverage was accompanied by significant decrease in titratable acidity in all treatment, which decreased from 0.79, 0.75, 0.69, 0.61 and 0.68 to 0.75, 0.68, 0.59, 0.56 and 0.61% in pH value of roselle beverage ranged from 2.58 to 2.80, which was significantly lower in T1, while it was significantly higher in T4. Statistical analysis did not appear any significantly differences of pH value between T2, T3, T4 and T5, which recorded 2.71, 2.76, 2.80 and 2.79, respectively. These results are in agreement with those obtained by **Bolade *et al*. (2009)** who reported that the pH of roselle beverage (*soborodo*) obtained from different dried was 2.69.

Table 2. Effect of storage period on chemical composition of roselle beverage (mean±SE).

Treatments	Beverage type after storage (month)							
	0	3	6	Mean	0	3	6	Mean
	Moisture				T.S.S.			
T1	94.32 ±0.05^{bA}	94.26 ±0.06^{bA}	94.28 ±0.07^{bA}	94.29 ±0.03^{b}	3.22 ±0.02^{eA}	3.17 ±0.03^{dA}	3.18 ±0.02^{eA}	3.19 ±0.01^{e}
T2	82.68 ±0.29^{dA}	82.58 ±0.08^{dA}	82.60 ±0.12^{dA}	82.62 ±0.10^{d}	15.67 ±0.02^{aA}	15.64 ±0.02^{aA}	15.60 ±0.03^{aA}	15.63 ±0.02^{a}
T3	95.36 ±0.07^{aA}	95.28 ±0.06^{aA}	95.34 ±0.04^{aA}	95.33 ±0.03^{a}	3.94 ±0.03^{dA}	3.90 ±0.01^{cA}	3.88 ±0.02^{dA}	3.91 ±0.02^{d}
T4	95.35 ±0.06^{aA}	95.51 ±0.14^{aA}	95.33 ±0.10^{aA}	95.40 ±0.06^{a}	4.18 ±0.01^{cA}	4.13 ±0.02^{bAB}	4.10 ±0.06^{cB}	4.14 ±0.02^{c}
T5	85.66 ±0.22^{cA}	85.53 ±0.10^{cA}	85.61 ±0.07^{cA}	85.60 ±0.07^{c}	12.52 ±0.04^{bAB}	12.55 ±0.04^{aA}	12.47 ±0.08^{bB}	12.51 ±0.03^{b}
	Ash*				Total sugars*			
T1	5.06 ±0.07^{bA}	4.98 ±0.08^{cA}	5.01 ±0.04^{cA}	5.02 ±0.03^{c}	31.58 ±1.56^{dA}	30.27 ±0.89^{eAB}	29.09 ±1.29^{dB}	30.31 ±0.73^{d}
T2	4.35 ±0.03^{cA}	4.30 ±0.06^{dA}	4.26 ±0.09^{dA}	4.30 ±0.04^{d}	82.42 ±1.47^{aA}	81.38 ±0.53^{aA}	80.56 ±1.19^{aA}	81.45 ±0.63^{a}
T3	6.88 ±0.12^{aA}	6.67 ±0.08^{bA}	6.82 ±0.09^{bA}	6.79 ±0.06^{b}	45.28 ±0.54^{cA}	41.98 ±0.47^{dB}	41.63 ±0.83^{cB}	42.96 ±0.66^{c}
T4	7.22 ±0.07^{aA}	7.29 ±0.37^{aA}	7.25 ±0.29^{aA}	7.25 ±0.14^{a}	45.73 ±0.82^{cA}	44.35 ±1.26^{cAB}	43.06 ±1.28^{cB}	44.38 ±0.76^{c}
T5	3.36 ±0.07^{dA}	3.31 ±0.02^{eA}	3.32 ±0.05^{eA}	3.33 ±0.03^{e}	74.42 ±1.97^{bA}	72.65 ±1.05^{bAB}	71.41 ±0.89^{bB}	72.83 ±0.82^{b}
	Reducing sugars*				Non-reducing sugars*			
T1	21.91 ±1.39^{aA}	20.57 ±0.88^{aAB}	19.96 ±1.31^{aB}	20.81 ±0.67^{a}	9.67 ±0.22^{dA}	9.69 ±0.14^{eA}	9.13 ±0.60^{eA}	9.5 ±0.21^{e}
T2	13.00 ±0.44^{dA}	12.48 ±0.24^{dA}	12.33 ±0.21^{dA}	12.60 ±0.19^{d}	69.42 ±1.10^{aA}	68.90 ±0.60^{aA}	68.23 ±0.98^{aA}	68.85 ±0.49^{a}
T3	20.89 ±0.42^{abA}	19.74 ±0.40^{aA}	19.72 ±0.27^{aA}	20.11 ±0.27^{ab}	24.40 ±0.30^{cA}	22.24 ±0.32^{dB}	21.91 ±0.74^{dB}	22.85 ±0.46^{d}
T4	19.26 ±0.44^{bA}	18.89 ±0.75^{bA}	17.45 ±0.30^{bB}	18.54 ±0.38^{b}	26.47 ±0.42^{cA}	25.46 ±0.51^{cA}	25.31 ±1.02^{cA}	25.74 ±0.44^{c}
T5	16.82 ±0.22^{cA}	15.79 ±0.21^{cAB}	14.99 ±0.15^{cB}	15.87 ±0.28^{c}	57.59 ±1.87^{bA}	56.86 ±1.18^{bA}	56.43 ±1.04^{bA}	56.96 ±0.72^{b}
	Titratable acidity				pH value			
T1	0.79 ±0.00^{aA}	0.76 ±0.02^{aAB}	0.75 ±0.01^{aB}	0.77 ±0.01^{a}	2.57 ±0.01^{cA}	2.57 ±0.01^{bA}	2.60 ±0.01^{bA}	2.58 ±0.01^{b}
T2	0.75 ±0.00^{aA}	0.72 ±0.01^{aA}	0.68 ±0.02^{bB}	0.72 ±0.01^{b}	2.63 ±0.17^{bcB}	2.72 ±0.01^{aAB}	2.79 ±0.01^{aA}	2.71 ±0.06^{a}
T3	0.69 ±0.01^{bA}	0.63 ±0.03^{bcB}	0.59 ±0.02^{cdC}	0.64 ±0.02^{c}	2.71 ±0.01^{abA}	2.77 ±0.01^{aA}	2.79 ±0.02^{aA}	2.76 ±0.01^{a}
T4	0.61 ±0.01^{cA}	0.59 ±0.01^{cAB}	0.56 ±0.04^{dB}	0.59 ±0.01^{d}	2.72 ±0.01^{abB}	2.82 ±0.02^{aA}	2.87 ±0.01^{aA}	2.80 ±0.02^{a}
T5	0.68 ±0.01^{bA}	0.66 ±0.02^{bA}	0.61 ±0.01^{cB}	0.65 ±0.01^{c}	2.75 ±0.01^{aA}	2.79 ±0.01^{aA}	2.82 ±0.02^{aA}	2.79 ±0.01^{a}

*: On dry weight basis.

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter for the same attribute.

A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter for the same attribute.

T1: Control: Extract without additives.

T2: Control: Extract + sucrose (TSS 15.5).

T3: Extract + sucrolose (0.0246 g/100 ml).

T4: Extract + stevia (0.0596 g/100 ml).

T5: Extract from local syrup market.

T1, T2, T3, T4 and T5, respectively. The obtained results agreement with those results by Fasoyiro *et al*. (2005).

3. Effect of storage period on bioactive components of roselle beverage:

Data in Table (3) shows the changes in bioactive component (phenolic compounds, flavonoid and antioxidant content) during storage period of roselle beverage.

Statistical analysis indicated that there are significant differences in total phenolic compounds content of roselle beverage between the different treatments. Total phenolic compounds (TPC) ranged from 0.90 to 1.2 mg/g (on wet weight) which were significantly higher in T2, while its significantly lower in T5 statistical analysis did not appear any significant differences in TPC between T1, T3 and T4, which contained 1.24, 1.22 and 1.21 mg/g, respectively. The flavonoid components content in roselle beverage ranged from 0.34 to 0.83 mg/g (on wet weight), which was significantly higher in T3, while it was significantly lower in T2, statistical analysis did not appear any significant differences between T3 and T4 and between T1 and T5 which contained 0.83 and 0.81, and 0.66 and0.61 mg/g, respectively. The highest amount of flavonoid components in T3 and T4 may be due to using sucralose and stevia in roselle beverage preparation.

From the obtained results, it could be noticed that increasing storage period from 0 to 6 months was accompanied by significant decrease in TPC of T1, T2, T3 and T5, which decreased from 1.37, 1.37, 1.25 and 1.02 mg/g at zero time of storage to 1.11, 1.27, 1.19 and 0.79 mg/g, respectively, at the end period of storage, which the insignificant decrease in TPC was found in T4, which decreased from 1.22 to 1.19 mg/g.

Table 3. Effect of storage period on bioactive components of roselle beverage (mean±SE).

Treatments	Beverage type after storage (month)							
	0	3	6	Mean	0	3	6	Mean
	Phenolic compounds content mg/g				Flavonoid components content mg/g			
T1	1.37 ±0.00^{aA}	1.23 ±0.02^{bB}	1.11 ±0.01^{cC}	1.24 ±0.04^{b}	0.81 ±0.01^{bA}	0.66 ±0.02^{bB}	0.51 ±0.04^{bC}	0.66 ±0.05^{b}
T2	1.37 ±0.00^{aA}	1.32 ±0.01^{aAB}	1.27 ±0.01^{aB}	1.32 ±0.01^{a}	0.42 ±0.01^{dA}	0.31 ±0.02^{cB}	0.30 ±0.02^{cB}	0.34 ±0.02^{c}
T3	1.25 ±0.01^{bA}	1.23 ±0.01^{bAB}	1.19 ±0.04^{bB}	1.22 ±0.02^{b}	0.97 ±0.02^{aA}	0.84 ±0.04^{aB}	0.68 ±0.01^{aC}	0.83 ±0.04^{a}
T4	1.22 ±0.01^{bA}	1.21 ±0.04^{bA}	1.19 ±0.01^{bA}	1.21 ±0.01^{b}	0.93 ±0.01^{aA}	0.80 ±0.02^{aB}	0.69 ±0.02^{aC}	0.81 ±0.03^{a}
T5	1.02 ±0.00^{cA}	0.90 ±0.04^{cB}	0.79 ±0.07^{dC}	0.90 ±0.04^{c}	0.67 ±0.02^{cA}	0.63 ±0.01^{bA}	0.54 ±0.01^{bB}	0.62 ±0.02^{b}
	Antioxidants activity µmol/g							
T1	70.65 ±0.87^{cA}	64.73 ±1.47^{cB}	59.96 ±1.24^{cC}	65.11 ±1.66^{b}				
T2	58.38 ±1.18^{dA}	49.24 ±0.59^{dB}	47.07 ±1.18^{dC}	51.56 ±1.81^{c}				
T3	75.33 ±0.97^{bA}	66.12 ±1.66^{bB}	60.59 ±0.46^{bC}	67.35 ±2.22^{b}				
T4	84.58 ±0.58^{aA}	78.09 ±1.48^{aB}	68.76 ±0.64^{aC}	77.14 ±2.35^{a}				
T5	25.49 ±1.61^{eA}	19.11 ±0.65^{eB}	16.88 ±0.73^{eC}	20.50 ±1.40^{d}				

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter for the same attribute.

A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter for the same attribute.

T1: Control : Extract without additives.

T2: Control : Extract + sucrose (TSS 15.5). T3: Extract + sucrolose (0.0246 g/100 ml).

T4: Extract + stevia (0.0596 g/100 ml). T5: Extract from local syrup market.

Flavonoid components in roselle beverage decreased significantly from 0.81, 0.42, 0.97, 0.93 and 0.67 mg/g at zero time of storage to 0.50, 0.30, 0.68, 0.81 and 0.62 mg/g at 6 months of storage in T1, T2, T3, T4 and T5, respectively. The antioxidant activity content ranged from 20.50 to 77.14 µmol/g, which was significantly higher in T4, while it was significantly lower in T5. Statistical analysis did not appear any significant difference in antioxidant activity content between T1and T3, which contained 65.11 and 67.35 µmol/g, respectively antioxidant activity content of roselle beverage decreased significantly from 70.65, 58.38, 75.33, 84.58 and 25.49 µmol/g at the end of storage in T1, T2, T3, T4 and T5 respectively. These results was high than obtained results by **Pozos *et al*. (2020).**

4. Effect of storage period on coloring of roselle beverage:

Data in table (4) shows the changes in anthocyanin content and color index during storage period of roselle beverage. Anthocyanin content ranged from 3.05 to 4.38 mg/100g which was significantly higher in T1, while it was significantly lower in T5. Statistical analysis did not appear any significant differences in anthocyanin content between T1, T3 and T4, which contained 4.48, 4.4 and 4.47 mg/100g, respectively.

The significantly higher content of anthocyanin in T1, T3 and T4 may be due to no adding sugar in and adding sucralose or stevia in roselle beverage preparation.

Anthocyanin content of roselle beverage decreased significantly from 4.90, 4.78, 4.77, 4.84 and 3.11 mg/100g at zero time of storage to 4.00, 3.78, 4.10, 4.12 and 2.99 mg/100g at 6 months of storage in T1, T2, T3, T4 and T5, respectively.

Data in The same table shows the changes of color index in roselle beverage during storage period. Color index ranged from 0.13 to 0.55 which was significantly higher in T1, while it was significantly lower in T5. Statistical analysis did not appear any significant differences in color index between T2, T3 and T4 which contained 0.48, 0.48 and 0.47 respectively. Color index of roselle beverage increased significantly from 0.47, 0.34, 0.36, 0.46 and 0.11 at zero time of storage to 0.63, 0.58, 0.57, 0.50 and 0.16 at the end of storage period in T1, T2, T3, T4 and T5, respectively.

Table 4. Effect of storage period on coloring of roselle beverage (mean±SE).

Treatments	Beverage type after storage (month)							
	0	3	6	Mean	0	3	6	Mean
	Anthocyanin content mg/100g				Color index			
T1	4.90 ±0.12^{aA}	4.55 ±0.15^{aB}	4.00 ±0.09^{abC}	4.48 ±0.15^{a}	0.47 ±0.00^{aC}	0.54 ±0.01^{aB}	0.63 ±0.00^{aA}	0.55 ±0.02^{a}
T2	4.78 ±0.01^{aA}	4.01 ±0.00^{bB}	3.78 ±0.19^{bC}	4.19 ±0.16^{b}	0.34 ±0.01^{bC}	0.51 ±0.00^{bB}	0.58 ±0.00^{bA}	0.48 ±0.04^{b}
T3	4.77 ±0.01^{aA}	4.51 ±0.01^{aB}	4.10 ±0.06^{aC}	4.46 ±0.10^{a}	0.36 ±0.00^{bC}	0.53 ±0.00^{abB}	0.57 ±0.01^{bA}	0.48 ±0.03^{b}
T4	4.84 ±0.00^{aA}	4.46 ±0.01^{aB}	4.12 ±0.02^{aC}	4.47 ±0.10^{a}	0.46 ±0.00^{aC}	0.45 ±0.00^{cB}	0.50 ±0.01^{cA}	0.47 ±0.01^{b}
T5	3.11 ±0.16^{bA}	3.05 ±0.01^{cA}	2.99 ±0.07^{cC}	3.05 ±0.05^{c}	0.11 ±0.00^{cC}	0.13 ±0.00^{dB}	0.16 ±0.01^{dA}	0.13 ±0.01^{c}

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter for the same attribute.

A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter for the same attribute.

T1: Control: Extract without additives.

T2: Control: Extract + sucrose (TSS 15.5).

T3: Extract + sucrolose (0.0246 g/100 ml).

T4: Extract + stevia (0.0596 g/100 ml).

T5: Extract from local syrup market.

5. Effect of storage period on organoleptic properties of roselle beverage:

Sensory evaluation of food product is an important criterion by which consumer acceptability can be assessed.

Data in Table (5) shows the changes in organoleptic properties (color, odor, taste, appearance and overall acceptability) during storage period of roselle beverage. Color property ranged from 7.17 to 7.87, which was significantly higher in T3, while it was significantly lower in T5.

Statistical analysis did not appear any significant difference in color between T1, T2 and T4 and also between T2, T4 and T5, which contained 7.50, 7.40 and 7.38 and 7.40, 7.38 and 7.17, respectively. color property in roselle beverage decreased significantly from 7.95, 7.60, 8.20, 7.80 and 7.40 at zero time of storage 7.05, 7.25, 7.5, 7.10 and 6.95 after 6 months of storage T1, T2, T3, T4 and T5, respectively.

Odor property ranged from 6.55 to 7.48, which was significantly higher in T3, while it was significantly lower in T5.statistical analysis did not appear any significant differences T1, T2 and T4, which container 6.88, 6.80 and 7.07, respectively. Odor of roselle beverage decreased significantly from 7.4, 7.15, 7.80, 7.35 and 7.15 at zero time of storage to 6.25, 6.30, 7.20, 6.80 and 6.15 after 6 months of storage in T1, T2, T3, T4 and T5, respectively.

The taste property of roselle beverage ranged from 5.58 to 7.38, which was significantly higher in T3, while it was significantly lower in T1.

Statistical analysis did not appear any significant differences in taste between T2 and T4 which contained 6.87 and 7.02, respectively. In general taste of roselle beverage decreased significantly from 6.10, 7, 15, 7.25 and 6.50 at zero time of storage to 5.58, 6.87, 7.02 and 6.18 at the end period of storage in T1, T2, T4, and T5, respectively, while the taste in T3 decreased insignificantly from

7.55 at zero time of storage to 7.35 at the end of storage period.

The appearance property of roselle beverage ranged from 6.70 to 7.45, which was significantly higher in T3, while it was significantly lower in T1. Statistical analysis did not appear any significant differences in appearance between T3 and T4, T2 and T4 and T1 and T5, which contained 7.45 and 7.38, 7.17 and 7.38 and 6.70 and 6.82, respectively. The appearance property of roselle beverage significantly from 7.25, 7.45, 7.75, 7.65 and 7.45 at zero time of storage to 5.85, 6.80, 7.15, 7.10 and 5.90 in T1, T2, T3, T4 and T5, respectively.

Table 5. Effect of storage period on organoleptic properties of roselle beverage (mean±SE).

Treatments	Beverage type after storage (month)							
	0	3	6	Mean	0	3	6	Mean
	Color				Odor			
T1	7.95 ±0.2^{abA}	7.50 ±0.17^{bcB}	7.05 ±0.23^{bC}	7.50 ±0.13^{b}	7.45 ±0.16^{bA}	6.95 ±0.20^{bB}	6.25 ±0.13^{cC}	6.88 ±0.13^{b}
T2	7.60 ±0.22^{cdA}	7.35 ±0.17^{cdB}	7.25 ±0.15^{abB}	7.40 ±0.11^{bc}	7.15 ±0.25^{bA}	6.95 ±0.20^{bA}	6.30 ±0.15^{cB}	6.80 ±0.13^{b}
T3	8.20 ±0.19^{aA}	7.90 ±0.16^{aB}	7.50 ±0.15^{aC}	7.87 ±0.11^{a}	7.80 ±0.20^{aA}	7.45 ±0.14^{aB}	7.20 ±0.15^{aC}	7.48 ±0.10^{a}
T4	7.80 ±0.20^{bcA}	7.25 ±0.25^{cdB}	7.10 ±0.15^{bB}	7.38 ±0.13^{bc}	7.35 ±0.17^{bA}	7.05 ±0.22^{bB}	6.80 ±0.21^{bB}	7.07 ±0.12^{b}
T5	7.40 ±0.16^{dA}	7.15 ±0.18^{dB}	6.95 ±0.22^{bB}	7.17 ±0.11^{c}	7.15 ±0.17^{bA}	6.35 ±0.20^{cB}	6.15 ±0.21^{cB}	6.55 ±0.13^{c}
	Taste				Appearance			
T1	6.10 ±0.19^{dA}	5.90 ±0.16^{cA}	4.75 ±0.19^{dB}	5.58 ±0.15^{d}	7.25 ±0.15^{cA}	7.01 ±0.19^{bB}	5.85 ±0.08^{cC}	6.70 ±0.14^{c}
T2	7.15 ±0.13^{bA}	7.05 ±0.16^{aA}	6.40 ±0.19^{bB}	6.87 ±0.11^{b}	7.45 ±0.19^{bcA}	7.25 ±0.21^{abA}	6.80 ±0.21^{bC}	7.17 ±0.13^{b}
T3	7.55 ±0.14^{aA}	7.25 ±0.15^{aB}	7.35 ±0.17^{aAB}	7.38 ±0.09^{a}	7.75 ±0.08^{aA}	7.45 ±0.14^{aB}	7.15 ±0.20^{aC}	7.45 ±0.09^{a}
T4	7.25 ±0.27^{bA}	7.15 ±0.15^{aA}	6.65 ±0.18^{bB}	7.02 ±0.13^{b}	7.65 ±0.13^{abA}	7.40 ±0.15^{aB}	7.10 ±0.19^{aC}	7.38 ±0.10^{ab}
T5	6.50 ±0.15^{cA}	6.25 ±0.13^{bB}	5.80 ±0.15^{cC}	6.18 ±0.10^{c}	7.45 ±0.16^{bcA}	7.10 ±0.22^{bB}	5.90 ±0.18^{cC}	6.82 ±0.00^{c}
	Overall acceptability							
T1	7.20 ±0.13^{cA}	6.90 ±0.10^{cB}	6.00 ±0.00^{cC}	6.70 ±0.11^{c}				
T2	7.50 ±0.17^{bA}	7.10 ±0.10^{bcB}	6.70 ±0.15^{bC}	7.10 ±0.10^{b}				
T3	8.00 ±0.15^{aA}	7.60 ±0.16^{aB}	7.30 ±0.15^{aC}	7.63 ±0.10^{a}				
T4	7.50 ±0.17^{bA}	7.20 ±0.13^{bB}	6.90 ±0.10^{bC}	7.20 ±0.09^{b}				
T5	7.00 ±0.00^{cA}	6.90 ±0.10^{cA}	6.10 ±0.10^{cB}	6.67 ±0.09^{c}				

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter for the same attribute.

A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter for the same attribute.

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T3: Extract + sucrolose (0.0246 g/100 ml).

T4: Extract + stevia (0.0596 g/100 ml).

T5: Extract from local syrup market.

The overall acceptability of roselle beverage ranged from 6.67 to 7.63, which was significantly higher in T3, while it was significantly lower in T5.

Statistical analysis did not appear any significant difference between T2 and T4, T1 and T5, which contained 7.10 and 7.20, 7.70 and 6.67, respectively. The overall acceptability of roselle beverage decreased significantly from 7.20, 7.50, 8.00, 7.50 and 7.00 at zero time of storage to 6.00, 6.70, 7.30, 6.90 and 6.10 at the end period of storage in T1, T2, T3, T4 and T5, receptively. Generally, T1 and T5 have bottomed comparing to other treatments conversely, the T3 have peaked for example, the T3 was the highest sensory characteristics, and it was followed by T4 and T2 to be 7.63, 7.20 and 7.10, respectively for instance. These results are in agreement with the obtained result by **Bolade *et al.* (2009) and Fasoyiro *et al*. (2005).**

Conclusion

The beverage industry is moving towards a healthier, more natural future as this is what consumers demand. This will require a lot more research on sweeteners and other additives. In the case of sweeteners, the beverage industry is yet to find sweeteners that offer good quality taste and also meet health demands.

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تقييم مشروب الكركديه منخفض السعرات الحرارية

رنا مجدى ابراهيم صيام * – أيمن سيد دياب – جلال عبدالفتاح ابراهيم غزال***

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*** قسم الصناعات الغذائية – كلية الزراعة – جامعة بنها – مصر**

**** معهد بحوث تكنولوجيا الأغذية – مركز البحوث الزراعية – الجيزة – مصر.**

تحتوى كوؤس الكركديه الجافة على 10.85 و 6.75 و 8.61 و 1.10 و 13.60 و 69.94٪ من الرطوبة، البروتين ،الرماد ، مستخلص الأثير، الألياف الخام والكربوهيدرات المتاحة على التوالي. وكان محتوى المعادن الرئيسية لكوؤس الكركديه الجافة من الكالسيوم، الماغنسيوم، الفوسفور، الحديد والبوتاسيوم 688.34، 234.68، 34.88، 33.42 و 20.56 مجم/ 100 جم على التوالى (على أساس الوزن الجاف). كما إحتوت كؤوس الكركديه المجففة على 113.60 و 46.50 و 28.68 و 76.26 و 8.32 مجم/100 جم من الأسكوربيك، البولي فينول الكلية والفلافونويدات، مضادات الأكسدة والأنثوسيانين، على التوالي (على أساس الوزن الجاف). وبتخزين مشروبات الكركديه لمدة 6 أشهر، وجد أن محتوى المواد الصلبة الذائبة، الرماد الكلي، السكريات الكلية، السكريات المختزلة، السكريات غير المختزلة والحموضة تتراوح من 3.19 إلى 15.63 ، 3.33 إلى 7.25 ، 30.31 إلى 81.45 ، 12.60 إلى 20.81 ، 9.03 إلى 65.41 ، 0.59 إلى 0.77٪ على التوالي.

لوحظ أيضا أن بزيادة فترة التخزين حتى 6 أشهر أدت إلى انخفاض معنوي في محتوى السكريات الكلية، والسكريات المختزلة والحموضة لمشروب الكركديه. تراوحت قيمة الرقم الهيدروجيني لمشروب الكركديه من 2.58 إلى 2.80. تراوحت المركبات الفينولية الكلية والفلافونويدات ومضادات الأكسدة من 0.90 إلى 1.24 و 0.34 إلى 0.83 مجم/جرام و 20.50 إلى 77.14 ميكرو مول / جرام على التوالي.

بينما أدت زيادة فترة التخزين لمدة 6 أشهر إلى انخفاض معنوي في المركبات الفينولية الكلية والفلافونويدات ونشاط مضادات الأكسدة. كما لوحظ انخفاضاً معنوياً للخصائص الحسية (اللون والرائحة والمذاق والمظهر والقبول العام) خلال فترة تخزين مشروب الكركدية.