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A Comparative Study on Red and White Karkade (*Hibiscus sabdariffa* L.) Calyces, Extracts and Their Products

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Abstract: This study dealt with red and white karkade calyces (*Hibiscus sabdariffa* L.) which are found in different parts of the world especially, the tropical and subtropical areas. In Sudan karkade is grown in western parts of the country (Kordofan and Darfur). In this study the chemical composition of dry red and white Roselle calyces was studied. It was found that, the red and white karkade calyces were contained 11 and 9.3% moisture respectively. Also the following was found respectively, 0.16 and 0.12% (fat), 13.2 and 12% (fiber), 7.88 and 7.35% (protein), 10.6 and 9.5% (ash) and 57.16 and 61.55% (carbohydrates). The red and white karkade calyces were also contained 11 and 15.5 mg/100 g of vitamin C, 60 and 50 mg/100 g of calcium, 25 and 20 mg/100 g of iron and 9 and 11 mg/100 g titrable acidity, respectively. Extraction of karkade calyces was carried out using different soaking ratios ranging from 1:6 to 1:12 and different soaking periods ranging from 1-4 h. For cold extraction the best soaking ratios and soaking period for red karkade were 1:10 for 2 h and ratio of 1:12 for 3 h for white karkade. Cold and hot drinks as well as jams and marmalades were made from both types of Roselle extracts. All these products were subjected to sensory analysis and tested for preference by sensory panels using hedonic scale. The sensory evaluation of cold and hot drinks made from both kinds of red and white karkade revealed that there was no significant difference as regard to the overall preference. The sensory evaluation of jams showed that there were no difference according to it is appearance, color, flavor and overall acceptability. However, there were differences in consistency.

Key words: Red and white karkade calyces, cold and hot drinks, jams production

INTRODUCTION

True Roselle is *Hibiscus sabdariffa* L. family "Malvaceae", tribe "Hibiceae" and there are two main types. From economical point of view the most important is *Hibiscus sabdariffa var. altissima* Wester, an erect, sparsely-branched annual to 16 ft (4.8 m) high, which is cultivated for its jute - like fiber in India, the East Indies, Nigeria and to some extent in tropical America. The stems of this variety are green or red and the leaves are green, sometimes spiny and not used for food. This type at times has been confused with kenaf, *Hibicus cannabinus* L., a somewhat similar but more widely exploited fiber source. The other type of Roselle, *Hibiscus sabdariffa var. sabdariffa*, embraces shorter, fleshy which has green, red - streaked, inedible calyces, (Morton, 1987). The last one is commonly known as hibiscus or Roselle grows in many tropical and subtropical countries and is one of highest volume especially botanical products in international commerce. Roselle is fiber, but the swollen calyces are the plant part of commercial interest. As flowers fall off, the bright red calyces swell. These are harvested by hand, dried and sold whole in to the herbal tea and beverage industry. The flavor is a combination of sweet and tart, similar to cranberry. In addition to international markets, there are extensive local and regional markets as well where it is processed into hot and cold herbal beverages, jellies, confectionaries and other products, (FAO, 1988). In the Sudan the plant is called karkade. It is used in urban areas; it is the calyces of the flower that is the article of trade and the most important part of the plant. There are two types of karkade calyces according to the commercial terminology used in Sudan namely Al Rahad and Al Fashir types. In international trade Al Rahad quality is preferred because is has a deep red color and special flavor. However, it has been found that there are at least four types within Al Rahad quality differing in size and shape of calyx, content of the important constituents and time of ripening. Some of the vernacular names used to differentiate between Al Rahad varieties are: Um Sharaya, Um Shibak, Um Bugia etc. (Percy, 1969).

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The objectives of this study were as follows:

- To determine the chemical composition of red and white karkade calyces.
- To compare the cold and steams extraction methods with regard to the quality.
- To determine the best methods of extraction in term of ratio of calyces/water and time of extraction.
- To carry out organoleptic evaluation for cold and hot drinks and jams made from both red and white karkade extracts.

MATERIALS AND METHODS

Materials and sample preparation: The white karkade was purchased from the local market of Wad-Madani, Sudan, while the red karkade was obtained from Elgazira Scheme, Elhoush City about 30 km south west of wad-Madani. The dry calyces were crushed to fine powder, bottled and kept at 5°C for all further studies.

Proximate analysis: The prepared dry calyces were analyzed for moisture, ash and crude fiber according to the AOAC (1984). Crude fat was determined according to the AOCS (1981). Crude protein was determined according to the AACC (1983). The total carbohydrate content was calculated by subtracting the previous components from 100.

Determination of pH, total soluble solids and titrable acidity: Extracted karkade was prepared from 20 g of dried karkade calyces soaking in 200 ml distilled water. The pH was measured by using Philips 9418 pH meter. The total soluble solids was determined by using hand refractometer at room temperature and corrected to 20°C from table of temperature correction of reading of refractometer Meloan and Pomeranz (1987). Total titrable acidity was determined by titration against 0.1 N KOH according to the Ranganna (1979).

Determination of ascorbic acid, calcium and iron: The ascorbic acid was determined according to Ruck (1963). The calcium (Ca^{++}) content was determined as described by AOAC (1970) method in which flame-photometer (coring 400) was used for analysis. The iron content was determined according to the Chapman (1978) method, with some modifications.

Karkade calyces extraction: The extraction was carried out by using soaking ratios of 1:6, 1:8, 1:10 and 1:12 (karkade calyces: tap water) at room temperature with different soaking times of 1, 2, 3 and 4 h, respectively.

Steam extraction: Fifty grams of dried karkade calyces (red and white) were soaked in tap water and then extracted with steam distillation using 800 ml of water for a period of 15, 30, 45 and 60 min.

Preparation of cold and hot drinks: The cold and hot drinks were prepared from cleaned dried karkade calyces, soaked in ratio of 1:10 (red karkade calyces: water) for tow hours and ratio of 1:12 (white karkade calyces: water) for three hours at room temperature, then the solution was diluted to 1:3 and 1:2 for red and white karkade respectively.

Processing of jam by using karkade extracts: The prepared extracted Karkade and half of sugar was placed in a cooker and mixed well. The mixture was boiled under continuous stirring for 12-15 min during which remaining sugar was added. The total soluble solid was reached to 64°C brix. Then the pectin (20 gm for each kg extract) was added. The gelatin mixture was boiled until the total soluble solids reached 68°C brix. Then heating was turned off and the jam was cooled to 87°C and sterilized, packaged in dry jars and stored at room temperature.

Sensory analysis: The cold and hot drinks and jam manufactured from extracted karkade were evaluated through sensory analysis for appearance, color, flavor, consistency and overall acceptability by ten judges from the Food Research Centre, Shambat on a hedonic scale of 9 to 1 points who rated the samples according to the following scale: 9 = excellent; 8 = very good; 7 = good; 6 = fairly good; 5 = satisfactory; 4 = fairly bad; 3 = bad; 2 = very bad; 1 = extremely bad. Analysis of variance was carried out for each parameter.

RESULTS AND DISCUSSION

The proximate analysis of karkade calyces (red and white) are presented in Table 1. The moisture contents were found to be 11% and 9.3%, respectively. These results were close to that obtained by Ibrahim *et al.* (1971) who reported a range of 9.2-14.9% for the Sudanese karkade calyces and lower than that reported by Ismail (1980) which was 12.60%. The crude protein contents were found to be 7.88% and 7.53%, respectively. These results were within the ranges of (7.05-9.4%) and (7.9-9.3) which were reported by Ibrahim *et al.* (1971) and Busson *et al.* (1957), respectively and lower than 9.44% which was reported by Ismail (1980). The crude fiber contents were 13.2% and 12%, respectively. These results were lower than 14% which was found by Ibrahim *et al.* (1971). The crude fat contents in this study were found to be 0.16% and 0.12%, respectively. The ash contents were 10.6% and 9.5%, respectively. These values were higher than 9% which was reported by Mclean (1973) and within the range of 8-11.6% which was reported by Ibrahim *et al.* (1971). The total carbohydrate contents in this study were found to be 57.16% and 61.55%, respectively.

The ascorbic acid content of dry calyces (red and white) were (11 and 15.5) mg/100 g, respectively. These results were lower than the range of 40-50 mg/100 g and 7.12 mg/100 g which were found by Reaubourg and Monceaux (1940) and Ibrahim *et al.* (1971), respectively. The total soluble solids of dry calyces (red and white) in

Table 1: Chemical analysis of dry karkade calyces (red and white)

Component	Red karkade (%)	White karkade (%)
Moisture	11.00	9.30
Crude protein	7.88	7.53
Crude fiber	13.20	12.00
Crude fat	0.16	0.12
Ash	10.60	9.50
Total carbohydrates	57.16	61.55
Ascorbic acid (mg/100 gm)	11.00	15.50
Titrable acidity (mg/100 gm)	9.00	11.00
Total soluble solids (%)	5.00	5.50
Calcium (mg/100 gm)	60.00	50.00
Iron (mg/100 gm)	25.00	20.00

this study were 5% and 5.5%, respectively. This makes white karkade calyces at an advantage with regard to addition of sugar in jam manufacture. The calcium contents of dry calyces (red and white) were (60 and 50) mg/100 g, respectively and the iron contents were (25 and 20) mg/100 g, respectively. Generally, the results indicated that, the red and white karkade contribute to nutrition as they contain reasonable amounts of iron, ascorbic acid and calcium.

The various soaking ratios for the red and white karkade cold extraction were presented in Table 2. The pH values of red and white karkade extract were ranged from (2.43 to 2.58) and (2.32 to 2.42), respectively. These results were agreement with the range of 2.57-2.80 which was reported by Ibrahim *et al*. (1971). Ismail (1980) reported a low pH value of 2.70 from extract ratio of 1:9, the total soluble solids were reduced from (6.0 to 3.5) and (7.0 to 5.0) ml, respectively, the volumes were increased with increasing ratios and the color was changed from (extremely red to light red) and extremely yellowish to light yellowish. Generally, the soaking ratio of 1:10 gave the best extract with regard to volume of extract, total soluble solids and color.

The various soaking period for red and white karkade cold extraction were presented in Table 3. The pH values of red and white karkade extract were varied from (1.93 to 2.02) and (1.90 to 1.99), respectively, the volumes of extract were decreased with the increasing of soaking time, the total soluble solids were slightly increased with increasing of soaking time and the color was also changed from (light red to extremely red) and (light yellowish to extremely yellowish). The solution was diluted (1:10) for red karkade and it was the best ratio for soaking and 2 h was an optimum period for soaking because volume was high, total soluble solids was very good and the color was acceptable. The solution was diluted (1:12) for white karkade and it was the best ratio for soaking and 3 h was an optimum period for soaking. Generally, there were differences in pH and total soluble solids between red and white karkade. The low pH for white karkade extract indicated that the percentage of organic acids was high. The total soluble solids of white karkade were also higher than that of the red one.

The various steam extraction of red and white karkade was presented in Table 4. The pH values ranged from (2.37 to 2.91) and (2.34 to 2.73), respectively, the volumes were increased with the increasing time of distillation, the total soluble solids were decreased and the color was changed from (light red to extremely red) and (light yellowish to extremely yellowish), therefore the thirty minutes extraction period gives highest total soluble solids and acceptable color.

The sensory evaluation of cold and hot drinks of red and white karkade calyces showed that there is no significant difference as regarded to the overall preference. Nevertheless the panelist accepted the red karkade extract very much than the white karkade extract, this probably due to the red color being more attractive than white color.

As shown in Table 5, the analysis of variance of appearance, color, flavor and overall acceptability showed no significantly difference in preference of above attributes of jam prepared from red karkade extract, jam from white karkade extracted and jam from white karkade extract with slices of orange (Marmalade). The results showed that there was significant difference ($p = 0.05$) in consistency of jam products.

Table 2: Effect of soaking ratio on various quality parameter of red and white karkade

	pH		T.S.S (%)		Volume (ml)		Color	
Ratio	Red	White	Red	White	Red	White	Red	White
1:6	2.43	2.32	6.0	7.0	215	210	E. red	E. yellowish
1:8	2.49	2.36	5.0	6.0	310	306	V. red	V. yellowish
1:10	2.55	2.37	4.5	5.5	402	405	A. red	A. yellowish
1:12	2.58	2.42	3.5	5.0	489	491	L. red	L. yellowish

E.V.A.L: Means extremely, very deep, acceptable and light

Table 3: Effect of soaking periods on various quality parameter of red and white karkade

	pH		T.S.S (%)		Volume (ml)		Color	
Soaking periods	Red	White	Red	White	Red	White	Red	White
1 h	2.02	1.99	4.5	5.0	409	490	L. red	L. yellowish
2 h	1.96	1.95	5.0	5.3	401	479	A. red	A. yellowish
3 h	1.94	1.91	5.0	5.5	394	471	V. red	V. yellowish
4 h	1.93	1.90	5.2	5.5	390	468	E. red	E. yellowish

E.V.A.L: Means extremely, very deep, acceptable and light

Table 4: The effect of steam extraction periods on various quality parameters of red and white karkade

Extraction periods	pH		T.S.S (%)		Volume (ml)		Color	
	Red	White	Red	White	Red	White	Red	White
15 min	2.91	2.73	4.5	5.0	41	44	L. red	L. yellowish
30 min	2.63	2.52	5.0	6.0	54	45	A. red	A. yellowish
45 min	2.41	2.41	5.0	6.5	50	51	V. red	V. yellowish
60 min	2.37	2.34	5.2	6.5	55	52	E. red	E. yellowish

E.V.A.L: Means extremely, very deep, acceptable and light

Table 5: Organoleptic quality assessment of various kinds of karkade jams

Parameters	Appearance	Cons.	Color	Flavor	OA
A	7.1[a]	6.7[b]	7.2[a]	7.1[a]	7.1[a]
B	7.4[a]	6.6[b]	7.5[a]	7.8[a]	7.6[a]
C	7.9[a]	8.0[a]	7.8[a]	6.7[a]	7.3[a]

[ab]Means within the same column having the same letters are not significantly different according to Duncan's multiple range tests. A: Jam of white karkade extract. B: Jam of white karkade with slices of orange (Marmalade). C: Jam of red karkade extract. OA = Overall Acceptability, Cons. = Consistency

Conclusion and recommendations: The optimum soaking ratio and period for red and white karkade calyces extraction are 1:10 for two hours and 1:12 for three hours respectively. Cold extraction gives better extract quality than steam extraction. 30 min is the best period for steam distillation. The ascorbic acid content in white karkade was higher than that of red karkade. Sensory evaluation for cold and hot drinks of red kakade revealed that it was more acceptable than white karkade cold and white drinks. However, the difference was significant. Jams made from both types of Roselle extracts were highly valued by the panelists.

This study recommended that, the extracted karkade which is used for a delicious traditional drink which can be developed into a beverage. Karkade calyces have a good esthetic value, so further studies regarding the white karkade calyces and seeds as well as needed (identification of the types of sugar present in the karkade extract is to be carried out and minerals, analysis should be done to know more minerals other than those given in this study). Market research regarding manufacturing carbonated beverage from karkade calyces should be carried out. Currently the karkade in Kordofan and Darfur areas has a limited traditional uses especially the leaves of white karkade which are used for sauce (Mulah) preparation called Karaso. While the seeds are fermented to produce a meat substitute called Frundu. Analysis regarding the chemical composition of Frundu and Karaso should be carried out.

REFERENCES

AACC, 1983. Approved methods of analysis. American association of Cereal Chemists, St. Paul MIN, USA.

AOAC, 1970. Official methods of analysis. 14th Edn., Association of Official Analysis Chemists, Washington, DC.

AOAC, 1984. Official methods of analysis. 14th Edn., Association of Official Analysis Chemists, Washington, DC.

AOCS, 1981. Official Tentative Methods of Analysis. 13th Edn., American Oil Chemists Society, Champaign, Lesion 61920, USA.

Busson, F., P. Garwier and P. Deniel, 1957. Amino acids content of the calices of (*Hibiscus sabdariffa*). JAPP Trop et APP, 4: 265-266.

Chapman, H.D., 1978. Method of analysis for soils, plant and water. University of California Citrus Experiment Station August Reprinted September 1978.

FAO, 1988. *Hibiscus sabdariffa*. In Traditional Food Plant. FAO food and nutrition paper No. 42. pp: 328-332. Food and Agriculture Organization Rome, Italy.

Ibrahim, M.E.H., K.A. Karamilla and A.G.H. Khattab, 1971. Biochemical studies on karkade (Roselle) (*Hibiscus sabdariffa*). Sud. J. Food Sci. Technol., 3: 37-39.

Ismail, I.A., 1980. Effect of some additives and processes of the quality of the spray dry karkade. University of Khartoum, Sudan.

Mclean, K., 1973. Roselle (*Hibiscus sabdariffa* L.) as cultivated edible plant UNDP/FAO project SUD/70/543, Sudan Research Centre Khartoum North.

Meloan, C.E. and Y. Pomeranz, 1987. Food Analysis Theory and Practice. 3rd Edn., Van Nastrand Rein folds Comp. New York.

Morton Juluia, F., 1987. Roselle P. (281-286) in fruits of warm climates, Miami FL.

Percy, F.P., 1969. Karkade investigation, progress reports UNDP FAO Project Sudan. 70/543, Khartoum.

Reaubourg, G. and R.H. Monceaux, 1940. Le karkade (*Hibiscus sabdariffa* L.) etude de carcteres chimiques, botanqueset pharmacalogiques. J. Pharm et chim, 132: 292-305. Cited by Mclean (1973).

Ranganna, S., 1979. Manual of Analysis of Food. 7th, Churchille living stone.

Ruck, J.A., 1963. Chemical methods for analysis of fruit and vegetables products. 1154 department of agriculture, Canada.