

Full Length Research Paper

***Detarium microcarpum* Guill and Perr fruit proximate chemical analysis and sensory characteristics of concentrated juice and jam**

Abdalbasit Adam Mariod¹, Mohamed Elwathig S. Mirghani^{2*}, Ahmad Bustamam Abdul³ and Siddig Ibrahim Abdelwahab³

¹Food Science and Technology Department, College of Agricultural Studies, Sudan University of Science and Technology, P. O. Box 71 Khartoum North, Sudan.

²Department of Biotechnology Engineering, Kulliyyah, Faculty of Engineering, International Islamic University Malaysia. (IIUM), P. O. Box 10, Gombak, 50728 Kuala Lumpur, Malaysia.

³UPM-MAKNA Research Laboratory, Institute of Bioscience, Universiti Putra Malaysia, Serdang, 43400, Malaysia.

Accepted 27 April, 2009

This study was carried out to produce food products mainly concentrated juice and jam from the fruit pulp of *Detarium microcarpum* (DM), and compare them with a commercial sample as control. The proximate chemical analysis of the dried fruit pulp of DM showed high proportions of carbohydrate (40-42.0%) and protein (29.1-30.9%); samples from Abu Gibaiha (AB) are the highest in both protein and carbohydrates in comparison with other samples from Ghibaish (GH) and Omdurman (OM). ICP-MS was used to determine the minerals (on mg/100 g dry weight basis). Concentrations of major elements K, Na, Mg and Ca were found to be higher in AB followed by GH and OM, respectively, with low levels in minor elements. The sensory evaluation of the produced jam and concentrated juice from the fruit pulp of DM was significantly preferred ($P \leq 0.05$) by the panelists for their color, odor, taste, texture and overall acceptability to the control samples. The results of this study offer the conditions that may lead to a better processing of this fruit.

Key words: Concentrated juice, *Detarium microcarpum*, jam, minerals, proximate analysis.

INTRODUCTION

Detarium microcarpum Guill. and Perr. is an African tree belonging to the family, Caesalpiniaceae. The tree height reaches up to 15 m and it can reach 25 m in moist areas; the tree can be easily distinguished by its broken grey bark, with dark green 8-12 cm leaves (FAO, 1995). The tree is widely distributed in dry Savannah areas of Africa, and in Sudan it is found in Darfour, Blue Nile and Kordofan States, where it is locally known as Abu-laili in Sudan, 'dank' in Senegal and 'tamba dala' in Mali. The roots, stems, bark, leaves and fruits are all used to treat ailments e.g. tuberculosis, meningitis, and diarrhea. The fruit is edible and rich in vitamin C and the leaves and seeds are also used in cooking

(<http://en.sl.life.ku.dk/upload/122net.pdf>). The pulverized seeds cotyledons are used as a thickener and emulsifier in traditional food preparations in some African countries. A compositional studies of this legume revealed that it is a rich source of polysaccharide gum (Onweluzo et al., 1994). The dehulled seed flour contained 3.5% moisture, 3.5% ash, 2.9% crude fiber, 15% crude fat, 37.1% crude protein and 39% carbohydrate (Akpata and Miachi, 2001). The infusion of the bark is reported to possess diuretic, anti-inflammatory and anti-parasitic properties, whereas its fruits and leaves are used in the treatment of dysentery and syphilis (Ikhiri and Ilagouma, 1995). Abreu and Relva (2002) isolated benzoylated carbohydrate fractions from the bark extract of *D. microcarpum* and they analyzed its carbohydrate content by GLC-CIMS. The seed polysaccharide was evaluated as a stabilizer and gelling agent in some processed fruit products and

*Corresponding author. E-mail: elwathig@hotmail.com.

were highly acceptable and had good storage stability during two months at ambient storage (Onweluzo et al, 1999).

The fruit of *D. microcarpum* had the highest total phenolic, flavonoid and antioxidant values between fourteen wild edible fruits from Burkina Faso (Meda et al., 2008). Foods are concentrated because the concentrated forms have become desirable components of diet in their own right. Thus, fruit juices plus sugar with concentration become jelly (FAO, 1992). The most common concentrated fruit and vegetable products include items as fruit and vegetable concentrated juices and jams (FAO, 1997). Concentrated juice and jam provide an abundant source of sugars, vitamins, minerals, fiber and some phytochemicals. They are so important in the diet especially for Sudanese school children living in towns, where mothers used to provide their children with jam sandwich.

Knowledge of physico-chemical characteristics of the final products is essential for conception and equipment size and process. Sensory evaluation is also important for the selection of the most suitable fruit for making the most appreciated jam and juice by consumers.

This paper reports on value addition to *D. microcarpum* through characterization of the raw material. Then, the study of the sensory properties of jam and concentrated juice, prepared in our laboratories, was considered. This would be helpful to the industry to design new food products, machinery and quality control. Sensory properties of the prepared concentrated juice and jam were evaluated and compared with those of Rozana juice and Saeed jam (the most consumed in Sudan), in order to test the consumer reaction to this new products.

MATERIALS AND METHODS

Samples, solvents and reagents

All solvents used were of analytical grade. n-hexane, methanol, chloroform, petroleum-ether, high quality pectin and citric acid were obtained from Prime for scientific services, Khartoum, Sudan. HCl, NaOH, HNO₃, H₂O₂ Suprapur grade (Merck, Darmstadt, Germany), commercial Rozana concentrated juice and Saeed jam were purchased from local supermarket in Khartoum north, Sudan

Three homogeneous *D. microcarpum* samples were obtained from three different localities- Ghibaish (GH), Abu Gibaiha (AB) and Omdurman (OM), respectively

Moisture content

A clean crucible was dried to a constant weight in air-circulated oven at 105°C. A known weight of the seed sample was placed in the crucible and dried in the oven at 105°C to constant weight for 2 h. The crucible and its content were cooled in a desiccator and weighed. The moisture content was calculated and expressed in percentage following the standard methods of the Association of Official Analytical Chemists (1990).

Fat content

Crude fat in the seed sample was determined by extraction with anhydrous diethyl ether in a Soxhelt apparatus following the stan-

dard methods of the Association of Official Analytical Chemists (1990).

Ash and organic matter content

A crucible was pre-heated in a muffle furnace at 500°C, cooled in desiccator and weighed. 2 g of the sample was transferred into the crucible and weighed. The crucible and its content were kept in the muffle furnace at 525°C until white ash was obtained after twelve hours. The organic matter content was calculated by subtracting the percent ash content from 100 following the standard methods of the Association of Official Analytical Chemists (1990).

Protein content

2 g ground sample was weighed into a 300 cm³ Kjeldahl digestion flask and few antidumping granules (1.0g of K₂SO₄ and anhydrous CuSO₄) were added to the flask. 25 cm³ of concentrated sulphuric acid (98% w/w) was added. The flask was fixed on the Kjeldahl digestion jack and heated slowly at first until frothing subsides and then vigorously with occasional rotation, conical flask was titrated with 0.1 mol hydrochloric acid, and an estimate of the crude protein content was calculated by multiplication of the organic nitrogen content by a factor of 6.25. The percentage protein was calculated following the standard methods of the Association of Official Analytical Chemists (1990).

The three different samples (AB, GH and OM) were analyzed in triplicate. Total carbohydrate content was calculated from the difference.

Mineral analysis

Two replicate aliquots (500 mg) from each of the dried, powdered fruit pulp of *D. microcarpum* were weighed, then wet-ashed by refluxing overnight with 15 ml of concentrated HNO₃ and 2.0 ml of 70% HClO₄ at 150°C. The samples were dried at 120°C and the residues were dissolved in 10 ml of 4.0 N HNO₃-1% HClO₄ solution. The mineral content of each sample solution was determined following the standard methods of the Association of Official Analytical Chemists (1990) by an Agilent Technologies 7500c inductively coupled plasma mass spectrometry (ICP-MS) system (Agilent Technologies, Wilmington). Wavelengths used for the tested minerals were: aluminum (Al), 396.152; calcium (Ca), 393.366; cadmium (Cd), 226.502; chromium (Cr), 206.149; cobalt (Co), 238.892; copper (Cu), 224.700; iron (Fe), 239.562; lead (Pb), 220.353; magnesium (Mg), 279.553; manganese (Mn), 257.610; nickel (Ni), 221.647; potassium (K), 766.490; zinc (Zn), 213.856. The mineral contents of the samples were quantified against standard solutions of known concentrations which were analyzed concurrently.

Extraction of cellular juice from fruit

The dried mature fruits of *D. microcarpum* were thoroughly washed under running tap water, dried in oven at 40°C for 4 h, corticated manually to get rid of the inside hard seeds. The obtained dried pulp was ground to pass through 0.5 mm sieve by a grinding mill (Petra electric, Burgau, Germany) and then extracted by water at room temperature, filtered using normal filter.

Juice concentration

The concentrated juice was obtained by putting the extract in an open kettle which was heated by electric heater. Enough amounts

Table 1. Proximate chemical analysis of *Detarium microcarpum* fruit pulp (%).

Parameter	Ghibaish	Abu-Gibaiha	Omdurman
Protein	29.4±0.4 ^b	30.0±0.4 ^a	29.6±0.5 ^b
Moisture	5.74 ±0.12 ^a	5.54 ±0.15 ^a	5.55±0.42 ^a
Fat	1.59±0.21 ^b	1.41±0.25 ^c	1.71±0.23 ^a
Fiber	19.05±0.28 ^b	18.15±0.26 ^c	20.39±0.06 ^a
CHO*	41.62±0.31 ^b	42.21±0.42 ^a	40.15±0.35 ^c
Ash	2.60±0.12 ^a	2.49±0.13 ^b	2.69±0.14 ^a

All values given are means of three determinations, values followed by different superscript letters are significantly different ($P < 0.05$).

*Total carbohydrates were calculated by difference.

of refined white sugar and 0.3-0.5% citric acid were added to the open kettle; mixing and heating was started gradually up to 80°C. The concentration was stopped when the mixture reached 56% of total soluble solids measured by refractometer (Bellinghan and Stanley Ltd., Tunbridge Wells, UK) (FAO, 1995). High temperatures and long concentration times were avoided in order to reduce or eliminate damage. Thickening and burn-on of product to the kettle wall was also avoided as these gradually lower the efficiency of heat transfer and slow the concentration process. The procedure and formula used are similar to that used in commercial product. The obtained concentrated juice was kept in dry clean plastic jars and stored at -3°C.

Jam processing

After sorting, the dried fruits were corticated manually to get rid of the inside hard seeds, the obtained dried pulp (flesh) was washed and air dried over four hours before grinding. The obtained dried grinded flesh was boiled in water (1:1; w/w) for 15 min. About 540 g of sucrose and 50 g of pectin (as stabilizer) were added to 1 kg of dried flesh. Samples were cooked to about 65 Brix in an open kettle, with manual stirring. Soluble solids content (Brix) was determined using an Abbe refractometer (Bellinghan and Stanley Ltd., Tunbridge Wells, United Kingdom) at 25°C (AOAC, 1990). The pH was adjusted at the end of cooking to 4.0 ± 0.1 with a citric acid solution (10%; w/v). Then, the jam (after reaching 65 Brix) was poured into glass jars (250 g) with screw caps and sterilized using steam at 90°C for 15 min. The procedure and formula used are similar to that used in commercial product. Samples were immediately cooled to room temperature and stored at 4°C prior to physico-chemical and sensory analysis and at ambient temperature for color stability.

Sensory evaluation

The samples (concentrated juice and jams) were presented in a perfectly homogeneous way, i.e. identical conditions of conservation, preparation and presentation. The samples were presented in an anonymous way with a simple coding of three numbers. Juices and jams were evaluated for texture, color, taste and odour. The mean value of these sensory properties was evaluated as overall acceptability. The samples were evaluated based on a five point hedonic scale, where one represented "disliked extremely" and five represented "liked extremely" (Larmond, 1982). Hedonic evaluation was done by an untrained panel consisting of 24 subjects (14 males and 10 females) from the students and the staff members of the Food Science and Technology Department, Sudan University of Science and

Technology (Khartoum North, Sudan). *D. microcarpum* dried fruit concentrated juice and jams were compared with the most consumed concentrated juice (Rozana from Saeed food factory) and jam (Saeed jam) in Sudan, in order to predict the acceptance of the *D. microcarpum* juices and jams by consumers.

Statistical analysis

Analytical values were determined, using three independent determinations. Values of different parameters were expressed as the mean \pm standard deviation (\pm SD). Student's t-test, at the level of $P < 0.05$, was applied to data to establish significance of difference between the samples. Statistical analyses were performed using the statistical program Statgrafics® (Statistical Graphics System version 4.0, 1989).

RESULTS AND DISCUSSION

Proximate chemical analysis

The results of the proximate analyses presented in Table 1 show that *D. microcarpum* (DM) fruit pulp has high proportions of carbohydrate (40-42.0%) and protein (29.1-30.9%); samples from Abu Gibaiha (AB) are the highest in both protein and carbohydrates in comparison with other samples from Ghibaish and Omdurman. Environmental factors, such as climate, soil may affect as Abu Ghibaiha is rich savannah with heavy clay soil while Ghibaish is poor savannah with sandy soil and Omdurman is desert with sandy soil. The carbohydrates content will be useful because it will enrich any diet where high carbohydrates content is of paramount importance. Consistent tendencies toward lower crude protein, and lower carbohydrate contents were observed in OM sample compared to other samples. With the finding that the carbohydrates content is high, it encourage using fruit of DM in concentrated juice and jam processing.

Mineral analysis

Minerals analyses are essential to guarantee the quality

Table 2. Minerals compositions of *Detarium microcarpum* fruit pulp (mg/100 g dry weight).

Parameter	Ghibaish	Abu-Gibaiha	Omdurman
K	1463.25 ±0.52	1475.75±0.67	1453.75±0.62
Na	420.50±0.40	424.50±0.36	412.50±0.42
Mg	12.20±0.12	15.26±0.21	10.16±0.11
Ca	136.12±0.22	141.11±0.45	130.26±0.21
P	1.05±0.10	1.17±0.11	1.09±0.11
Fe	2.73±0.11	3.22±0.13	2.10±0.12
Zn	0.41±0.10	0.44±0.12	0.45±0.11
Cu	0.35±0.12	0.43±0.12	0.32±0.11
Mn	2.65±0.41	2.75±0.32	2.45±0.22
Co	2.71±0.21	3.25±0.41	2.65±0.41
Al	1.12±0.12	1.00±0.11	0.86±0.11
Cd	0.002±0.12	0.001±0.11	0.003±0.13
Ni	0.001±0.11	0.00±0.00	0.00±0.00

All determinations were carried out in triplicate and mean value ± standard deviation (SD) reported.

Table 3. Sensory properties of *Detarium microcarpum* juice compared to commercial rozana juice.

Product	Texture	Color	Taste	Odor	Overall acceptability
Ghibaish	4.00±0.15 ^a	3.90±0.15 ^a	3.53±0.41 ^b	4.10±0.41 ^a	3.65±0.43 ^a
Abu-Gibaiha	4.26±0.02 ^a	4.23±0.22 ^a	3.92±0.41 ^a	4.45±0.42 ^a	3.85±0.32 ^a
Omdurman	3.13±0.08 ^b	3.30±0.41 ^b	3.11±0.25 ^b	3.43±0.35 ^b	3.12±0.12 ^b
ROZ	3.63±0.05 ^b	3.70±0.51 ^b	3.72±0.34 ^a	3.37±0.45 ^b	3.40±0.4 ^b

ROZ = Rozana reference concentrated juice.

All values given are means of three determinations. Values in the same column with different superscript letters are significantly different ($P < 0.05$).

of any food product; ICP-MS allowed us to determine the content of 13 minerals, many of which are required in human diet. Table 2 summarizes the results of minerals analyses in DM three samples (AB, GH, and OM) with macro elements (K, Na, Mg and Ca) being the predominant elements. The three samples were significantly different ($P < 0.05$) in their macro element content. Concentrations of major elements K, Na, Mg and Ca were found to be higher in AB (1475.75, 424.5, 15.26 and 141.1 mg/100 g, respectively), followed by GH (1463.3, 420.5, 12.2, and 136.1, respectively) and OM (1453.7, 412.5, 10.1 and 130.3, respectively). The difference in soils may affect as Abu Ghibaiha is heavy clay soil which is rich in many elements while Ghibaish and Omdurman are sandy soil and poor in elements. This result was found to be less in amount than that reported by Umar et al. (2007) who found 1593.7, 438.5, 20.5, and 160.0 mg/100 g of samples in the pulp of Nigerian DM. Potassium was the most abundant element in the three samples of DM analyzed, which is a mineral essential to bone structure and function. The concentration of the minor elements Al, Pb Ni, Mn, Cd, Cu, Cr, Co and Fe levels were found at low levels, in the studied samples.

Sensory evaluation

Concentrated juice

The dried fruit of DM was used to prepare a concentrated juice. Table 3 shows the sensory properties of DM concentrated juice compared to commercial Rozana juice. From this table it was clear that the juice made from AB sample received the highest score ($P < 0.05$) in texture, colour, taste, odour and over all panelist acceptability of 4.26, 4.23, 3.92, 4.45 and 3.85 (on a 5-point hedonic scale) respectively in comparison with Rozana juice and juice made of other samples. The juice made of GH came in the second rank followed by the juice made of OM. This suggests that the DM pulp could be suitable for concentrated juice processing, because texture, colour, taste, odour are the sensory parameters which are used by a consumer to evaluate concentrated juice.

Jam processed using DM pulp

Sensory properties of DM jam compared to commercial

Table 4. Sensory properties of *Detarium microcarpum* jam compared to commercial ones.

Product	Texture	Color	Taste	Odor	Overall acceptability
Ghibaish	4.10±0.11 ^b	3.75±0.32 ^a	4.13±0.12 ^a	3.60±0.11 ^a	3.47±0.12 ^b
Abu-Gibaiha	4.47±0.21 ^a	3.83±0.41 ^a	4.20±0.13 ^a	3.63±0.12 ^a	3.91±0.11 ^a
Omdurman	3.43±0.15 ^d	3.37±0.42 ^b	3.37±0.11 ^c	3.13±0.13 ^c	3.10±0.13 ^c
Saeed reference jam	3.93±0.10 ^c	3.63±0.35 ^b	3.65±0.15 ^b	3.37±0.11 ^b	3.45±0.15 ^b

All values given are means of three determinations. Values in the same column with different superscript letters are significantly different ($P < 0.05$).

one is shown in Table 4. Results from this table show that there are not any significant differences ($P > 0.05$) relative to the appreciation of the colour, the odour and overall acceptability between Saeed jam (reference product) and AB, GH, and OM jams. AB, and GH jams were more appreciated by consumers than reference Saeed jam ($P < 0.05$). Concerning the texture and the taste attributes it was clear that consumers preferred AB, and GH jams to OM and SA.

Conclusion

From the results of this study it can be concluded that the MD fruit pulp has high proportions of carbohydrate (40-42.0%) and protein (29.1-30.9%), which are considered dietary essential. DM samples have high amount of K, Na, Mg and Ca and being the predominant elements. The three samples were significantly different ($P < 0.05$) in their macro element content. The results of this study suggested that DM pulp could be suitable for concentrated juice and jam processing.

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