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The Nutritive Value of Jakjak (*Azanza garckeana* L.) Fruit and its Utilization in Juice Production

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ABSTRACT

The objective of the present study was to investigate the nutritive value of jakjak fruit. Jakjak fruit was chemically analyzed and processed into juice which was then evaluated to determine the physicochemical, microbiological and sensory characteristics. The contents of moisture, crude protein, fat, crude fiber, ash, carbohydrate and energy value were 13.542±2.5, 10.05±1.8, 1.04±0.01, 45.524±1.4, 7.3±0.5, 22.444±3.7% and 46.182 kJ/100 g, respectively. Jakjak fruit also contained the minerals (mg g^{-1}); iron (0.06), sodium (0.6), potassium (13.6) and calcium (0.56). The analyses of Jakjak juice showed that its pH value, Total Soluble Solid (TSS) and ascorbic acid contents were 5.48±0.01, 4.5±0.5% and 21.1344 mg/100 g, respectively. The microbiological analyses indicated that all jakjak juice samples were free from mould and yeast while they contained a range 1.20×10^{7} to 1.72×10^{65} CFU mL^{-1} total bacterial count. The sensory evaluation showed significant differences in colour and appearance and texture while insignificant difference were found in flavor and over all acceptance level. Jakjak fruit juice contained appreciable amounts of various minerals and ascorbic acid. The microbial analysis indicated that jakjak fruits juice was free for mould and yeast but high number of total bacteria count was found. The sensory evaluation revealed that the overall acceptance was notable for jakjak fruits juice.

Key words: Chemical composition, microbiological analyses, iron, calcium, sensory characteristics.

INTRODUCTION

Jakjak is one of the valuable plant species that grows naturally in Sudan, its scientific name is *Azanza garckeana*. It is largely spread in arid area such as sand and near mountain, specially in Savanna plantation area at the Southern Darfur and Jabl Mara mountain area. It is the indigenous fruit trees although undomesticated play many important roles in people living in rural areas of Darfur states (Sudan). Indigenous fruit trees are important traditional sources of nuts, fruits, spices, leafy vegetables, edible oil and beverages (Taylor and Kwerepe, 1995). Like vegetables, indigenous fruit trees provide vitamins and minerals essential for the proper maintenance of human health (Saka and Msonthi, 1994).

The indigenous food and medicinal plants play an important role for many African people. These products constitute alternative source of nutrition and the rural people communities in many African countries use some of them in medical treatment (Arnold and Perez, 2001; Ladio and Lozada, 2004; Scherrer *et al*., 2005).

The fruits of *Azanza garckeana* are eaten in many African countries before ripe while slightly green or when ripe, however, sometimes they are being dried to be utilized after reconstitution (Mojeremane and Tshwenyane, 2004).

The indigenous fruit bearing tree species have many benefits and uses (FAO, 1982; Maghembe *et al*., 1994), they tree are rich in many macronutrients such as sugars, vegetable oil and proteins and/or micronutrients such as vitamins and minerals, beside providing shade and medicine to rural communities as well as production of fruits and fodders.

In Darfur States (Sudan), the jakjak fruit trees yield a crop in poor rainfall years, especially during droughts. The fruits of jakjak fruit have been reported in many in number of African markets (Kwesiga and Muanza, 1995; Taylor and Kwerepe, 1995). This is indication that the species is not a simple and occasionally exploited tree of the wild vegetation but has a role in economic systems of farmers. It is increasingly becoming popular as an alternative source of food and nutritional security. The jakjak plant is used in traditional medication, treatment and food in Darfur States (Sudan). Jakjak fruit may be eaten ripe (chewing), fresh or is kept for later usage, because it consists of great proportion of sugars, vitamins and minerals. Also it is used as a sauce before ripe, porridge (madeda), juice preparation and for school boys chewing. All these benefits and traditional uses of jakjak guided to investigate this beneficial plant fruit as attempt to promote the food security and poverty alleviation in rural communities and to encourage its utilization of basis of scientific findings. Therefore, the objectives of this work were to determine the chemical composition and microbiological characteristics of jakjak fruits, utilize jakjak in juice production and assessment of its quality.

MATERIALS AND METHODS

Materials: Jakjak fruits were collected from local market (Nayala) Southern Darfur State, (Sudan) during the harvesting period October (2010). The fruits were transported to the laboratory in jar at room temperature in order to carry out pending the different analyses and preparation of jakjak juice.

Physical analysis: Physical analysis was carried out in triplicate for jakjak fruits samples before juice extraction. The analyses included: measurement of fruit length, fruit width, fruit weight, fruit color and fruit volume, using a vernier caliper, digital balance, visually, volumeter, respectively.

Chemical analysis of jakjak fruit: Proximate analysis was carried out for samples of jakjak fruits to determine moisture, protein, fiber, fat and ash content according to AOAC (2000) method while the carbohydrate content was determined by difference.

Minerals determination: The contents of sodium, potassium and calcium were determined in jakjak fruit samples according to AOAC (1970) method using flame photometer (coring 400).

Production of jakjak fruits juice: Three types of jakjak fruit juice were prepared including; Soaked Jakjak Juice (SJJ), Mixed Jakjak Juice (MJJ) and Boiled Jakjak Juice (BJJ).

For preparation of soaked jakjak fruit juice, 25 g of jakjak fruits were soaked in 200 mL distilled water in water bath for four hours, then the juice was extracted, concentrated for about 30 min.

For preparation of mixed juice, 100 g of clean jakjak fruits were pulped in 900 mL distilled water, blended, filtered then a clear juice was obtained which was then concentrated for about 30 min.

For preparation of boiled juice, 100 g of clean jakjak fruits were boiled in 900 mL distilled water at about 80°C for one hour, the contents were filtered and concentrated for about 30 min.

Evaluation of juice quality: The quality of jakjak fruits juice samples were determined using physicochemical, microbiological analyses as well as sensory evaluation.

Determination of total soluble solids and pH: The total soluble solids content of jakjak fruit juice was measured using hand refractometer at room temperature. The pH value was measured by using a digital pH meter, according to AOAC (1990).

Determination of ascorbic acid: Thirteen gram of sample were blended with reasonable amount of 0.4% oxalic acid for one minute, aliquot was transferred to 500 mL volumetric flask, made up to volume with 0.4 oxalic acid and was filtered through No. 4 Whatman filter paper 20 aliquot were pipetted and titrated against the dye solution to faint pink end point:

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titration} \times \text{dye strength} \times \text{dilution}}{\text{Weight of sample}}$$

Jakjak fruits juices sugar determination: The sugar profile of jakjak fruit was determined by Thin Layer Chromatography (TLC). Standard sugars (mannose, fructose, glucose and ribose) were spotted on silica dry plate.

Total viable count bacteria count: The total viable count per mL of Jakjak juice was determined following the method of APHA (1967). Incubation was accomplished at 30°C for 48 h. Plates containing between 30-300 colonies (CFU mL^{-1}) per mL of sample were used for calculation.

Yeast and mould count of jakjak juices: The yeast and mould strains were enumerated by culturing them on Potato Dextrose Agar (PDA) medium and incubating for 48 h at 25°C (APHA, 1967).

Sensory evaluation: Sensory evaluation was carried out to judge the quality of jakjak juice using 15 panelists according to Larmond (1967). The panelists were asked to express their degree of liking or disliking.

RESULTS AND DISCUSSION

Physical characteristics of jakjak fruits: The physical characteristics of jakjak fruits are presented in Table 1. The weight, length, width and volume values were 15.6±1.5 g, 2.7±0.5, 2.5±0.09 cm and 10.6±1.5 cm^3, respectively. The visual color of jakjak fruits, however, was brown. The weight of jakjak fruits seeds and pulp were 4.27±0.6 and 11.33±1.7 g, respectively. The seeds weight represented were 27.35±1.9% while the pulp weight represented about 72.65±2.1% of the total fruit weight.

Chemical composition of jakjak fruits: The chemical composition of jakjak fruits are indicated in Table 2. The moisture, ash and protein contents were 13.542±2.5, 7.3±0.5 and 10.05±1.8%, respectively. The protein content determined in the present study was lower than that reported by

Table 1: Physical characteristics of jakjak fruits

Parameter	Value
Weight (g)	15.6±1.5
Length (g)	2.7±0.5
Width (cm)	2.5±0.09
Visual color	Brown
Volume (cm^3)	10.6±1.5
Weight of seeds (g)	4.27±0.6
Weight of pulp	11.33±1.7
Seeds (%)	27.35±1.9
Pulp (%)	72.65±2.1

Values are Mean±SD, n = 3

Table 2: The chemical composition of jakjak fruits

Parameter	Value
Moisture (%)	13.540±2.5
Ash (%)	7.300±0.5
Fat (%)	1.040±0.01
Fiber (%)	45.524±1.4
Protein (%)	10.050±1.8
Carbohydrates (%)	22.440±3.7
Iron (mg/100 g)	6.000±0.1
Calcium (mg/100 g)	56.000±0.3
Sodium (mg/100 g)	60.000±0.5
Potassium (mg/100 g)	1360.000±1.3
Energy value (kcal/100 g)	2313.081±0.0

Saka and Msonthi (1994) who reported a value of 12% and within the range of legumes protein content (15-25%). The fat content of jakjak fruits was 1.04±0.01%, this value was lower than that of (Saka and Msonthi, 1994) which was 1.1%. The crude fiber content of jakjak fruit was 45.52±1.4, this result was higher than 45.3% which was found by Saka and Msonthi (1994). The total carbohydrate content was 22.444±3.7% which was lower than that reported by Saka and Msonthi (1994) who reported a value of 35.2% in jakjak fruit.

The minerals content of jakjak fruits is also presented in Table 2. The iron and potassium contents were 6.0 and 1360 mg/100 g, respectively. However, the calcium and sodium contents were 56 and 60 mg/100 g, respectively. These values were higher than those reported by Saka and Msonthi (1994), which were 9.5 and 20.2 mg/100 g, respectively. Presence of minerals in jakjak fruit was in agreement with (Mojeremane and Tshwenyane, 2004) who reported that the species is an important source of essential minerals particularly P, Ca, Mg and Na. Presence of these minerals in jakjak fruits indicates that it is a good supplement for the consumers of these fruits. Iron is essential in small amounts for both plant and animal life. Biologically iron is the most important transitional element. The human body contains about 4 g of iron. About 70% of this is foundation as hemoglobin. The function of hemoglobin is to pick up dioxygen at the lungs. Hemoglobin is also important biologically in myoglobin which is used to store oxygen in muscles (Lee, 1996). Calcium is important in bones and teeth as appetite $Ca_3(PO_4)_2$ and the enamel on teeth. Ca^{2+} ions are important in blood to maintain the regular beating of the heart and daily intake 1000-1200 mg are recommended (Lee, 1996).

Sodium ions are more actively expelled from cell, than potassium ions. These ions transport is sometimes called a sodium pump and it involves both the active expulsion of sodium and the active take-up of potassium ions. In animal cells the concentration of potassium is about 0.15 M the concentration of sodium is about 0.01 M. In body fluid (lymph and blood) the concentration of potassium and sodium are about 0.003 and 0.15 M, respectively (Lee, 1996). The different ratios of sodium to potassium inside and outside the cells produces an electrical potential across the cell membrane which is essential for the functioning of nerve and muscle cells and daily intake of sodium and potassium were 2400,3500 mg, respectively (Lee, 1996).

The energy value of jakjak fruits was 2313.081 kcal/100 g. The high energy value of jakjak fruit could be attributed to its high content of carbohydrates.

Characteristics of jakjak fruits juice: As presented in Table 3, the pH values of soaked juice, boiled juice and mixed juice, were 5.47±0.01, 5.47±0.01 and 5.48±0.01, respectively. These values were closely related to pH values of guava nectar, mango nectar and orange nectar which were 4.6±0.41, 4.4±0.1 and 4.1±0.1, respectively as reported by Kakum (2009) the lower pH value determined in this study was within pH of most fruit juices.

The Total Soluble Solids (TSS) of jakjak fruits juices (soaked juice, boiled juice and mixed juice were 4.0±0.5, 4.5±0.5 and 4.5±0.5%, respectively. These results were lower than those of guava nectar, mango nectar and orange nectar which were 17, 28.2 and 20.9, respectively, as reported by Kakum (2009).

The ascorbic acid content of mixed, boiled and soaked juices which were 21.1344 mg/100 g, 21.1144 mg/100 g, 21.1344 mg/100 g, respectively. These results were slightly lower than 21.5 mg/100 g as reported by Saka and Msonthi (1994) and lower than those of guava nectar, orange nectar and mango nectar were 199±0.22, 44.1±0.2 and 28.9±0.06 mg/100 g, respectively, as reported by Kakum (2009).

Ascorbic acid (vitamin C) contributes to the nutritional value of fruits juices and it is an essential water soluble vitamin. It also aids in the formation of liver bile which helps to detoxify alcohol and other substances. It had been reported that ascorbic acid reduces the activity of the enzyme, aldose reductase which helps to protect people from diabetes. It may also protect the body against accumulation or retention of the toxic mineral lead (Raff *et al*., 2004).

Microbiological analysis: Table 4 showed the microbiological characteristics of jakjak fruits juice samples. All samples were found to be free from moulds and yeast. These values were in

Table 3: pH, total soluble solid and vitamin C values of jakjak juice

Parameter	pH	TSS (Brix^0)	Vitamin C (mg/100 g)
Soaking juice	5.47±0.01	4.0±0.5	21.1344
Boiling juice	5.47±0.01	4.5±0.5	21.1144
Mixing juice	5.48±0.01	4.5±0.5	21.1344

Values are Mean±SD, n = 3, Brix^0: % measurement of TSS

Table 4: Total viable count of yeast, mould and total bacteria in jakjak juice

Jakjak fruits juices	Total yeast and mould (CFU mL^{-1})	Total bacteria (CFU mL^{-1})
Mixed juice	nd	120×10^5
Boiled juice	nd	172×10^4
Soaked juice	nd	108×10^5

nd: Not detected

Table 5: Sensory evaluation of jakjak fruit

Fruits juices	Appearance	Texture	Color	Flavor	Overall acceptability
Mixed	7.75[a]	7.91[a]	8.08[a]	7.30[a]	7.91[a]
Boiled	7.00[ab]	7.41[ab]	7.66[ab]	7.66[a]	7.33[a]
Soaked	6.16[b]	6.66[b]	6.83[b]	7.00[a]	7.00[a]

The similarity of letters within column means there is no significant difference between the samples or brands

agreement to those of Kakum (2009) who found that: the orange, guava and mango nectars were free from yeast and moulds. Absence of yeast and moulds indicates that the juice samples were produced under hygienic conditions. In contrast, all juice samples contained appreciable numbers of total bacterial counts, however, the mixed, boiled and soaked juices contained 1.20×10^7, 1.72×10^6 and 1.08×10^7 CFU mL^{-1}, respectively. These high counts of bacteria might reached the juice samples after production due to improper handling.

Sensory evaluation: The sensory evaluation of jakjak fruits juice sample was presented in Table 5. Notable differences were found in most of the sensory characteristics of the three juice types. There was significant difference in appearance, textures and color between the mixed and soaked juices while there was no significant difference in flavor and overall acceptance. The panelists gave highest scores for overall acceptance to the mixed juice (7.91), followed by the boiled juice (7.33) and finally the soaked juice (7.00). Generally, the panelists accepted jakjak fruit juice, this is an indication for potentiality of utilizing jakjak fruit in production of juice.

CONCLUSION

The outcome of this study is considered very important from nutritional point of view. The nutritional value of jakjak fruits was accomplished through determination of chemical, physical, physicochemical, microbial and sensory evaluation. Jakjak fruit contained appreciable amounts of various minerals, calcium, sodium, potassium and iron. In addition, the content of ascorbic acid was relatively high. The most profile sugar identified was fructose. In addition, the other components were found to be as follow, total carbohydrates 22.444±3.7%, fat 1.04±0.01%, protein 10.05±1.8%, crude fiber 45.624±1.4%, moisture 13.542±2.5%, ash 7.3±0.5% and the energy value 2313.081 kcal/100 g. As for microbial analysis, jakjak fruits juice was free for mould and yeast but high number of total bacteria count was found. The sensory evaluation revealed that the overall acceptance was notable for Jakjak fruits juice. People in Darfur also use jakjak fruits especially schoolboys whose chew it, porridges (madeda) preparation and use to sauce preparation before ripe.

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