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# Nutritional Value of some Edible Forest Fruits

Nawal A Abdel-Rahman, Innam I Awad and ELrakha B Babiker

Food Research Centre, P. O. Box 213, Khartoum North, Sudan

Corresponding Author: Nawal A Abdel-Rahman

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### ABSTRACT

Non-wood forest products (NWFPs) have received great attention during the last years since they have important usages throughout the world. Forest fruits are one of these NWFPs. Sudanese forest fruits are used traditionally as foods as well as medicines. Doum (*Hyphaene thebaica* L), kirkir (*Randia geipaeiflora*), karmadoda (*Nauclea latifolia*) and godeim (*Grewia tenax*) are some of the indigenous fruits of the Sudan. The minerals profile, essential and non-essential amino acids values of these fruits were studied. These forest fruits were found containing adequate amount of minerals. Doum and kirkir are rich in P and K, karmadoda is rich in P, K, Mg and Ca; while godeim is rich in Mg, K, Ca and Fe. Karmadoda was found rich in the essential amino acids, leucine (318.59 mg/100g), isoleucine (167.28 mg/100g) and valine (214.93 mg/100g), however, kirkir was found rich in arginine (543.71 mg/100g). karmadoda was also rich in the non-essential amino acids alanine, aspartic acid, glutamic acid, glycine, serine and proline of 237.46, 421.43, 782.76, 183.70, 156.23 and 165.98 mg/100g, respectively. Therefore, these fruits can be used in several foods as ingredients. Karmadoda can be used as a supplement for minerals and essential and non-essential amino acids.

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**Keywords:** amino acids; antioxidants; biofortification; livelihood; nutrients; poor countries; staple food.

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### INTRODUCTION

Non-wood forest products (NWFPs) can take a significant role in rural livelihood strategies and can contribute to sustained forested landscape in various tropical areas (Sunderland, 2011; Arnold, 2011; FAO, 2010; Ros-Tonen and Wiersum, 2005). Forest fruits are spread in the tropics region among many countries in the world. Frequent crop failure in arid and semi-arid zones often results in the poor nutrition of local people (Bird and Shepherd, 2003). For this reasons it is important to find other resources for getting enough food for the growing population (Johns and Sthapit, 2004; Jens, 2002; Leakey, 1999; Mayer, 1997). Forest fruits help in maintaining household nutrition throughout the off season of different agricultural products for the rural population (Faye, 2010). Fruits are not only a superior taste choice; they are an excellent source of very important substances such as amino acids to improve the health property (Divisi, 2006). Fruits are rich in thiamin, riboflavin and niacin (FAO, 2006). Some forest fruits are a rich source of sugars, protein and fats.

Most forest fruits under study are spread in the tropical regions in Western Sudan (Robinson, 2005); however godeim is grown in many regions throughout Sudan. It contains glucose, fructose, pectin substances, fibre and vitamin C (Abdel-Rahman, 2014), as well as calcium, magnesium, potassium, iron and zinc (Fasoyiro, 2005; El-Gazali, 1998). In addition, these fruits are affluent in carbohydrate, soluble sugars, fibre, protein and  $\beta$ -carotene (Abdel-Rahman, 2011). Beta-carotene and vitamin C are very powerful antioxidants that work in the body to eliminate free radicals (Abdel-Rahman, 2012; Lanchance, 2001; Rock, 2000). Both  $\beta$ -carotene (Druesne-Pecollo, 2010) and vitamin C have been shown to be helpful for preventing suitable conditions of various types of cancer (breast cancer) (Cho, 2003), as well as atherosclerosis, cardiovascular and diabetic heart disease (Arts and Hollman, 2005). Henriquez, (2010) recorded that meals high in antioxidants defend against cancer diseases. The biofortification of staple food crops is a new public health approach to control vitamin A, iron and zinc

deficiencies in poor countries (Bouis, 2011; Nestel, 2006). The objective of this study was to evaluate the nutritive value of edible parts of some Sudanese forest fruits namely doum, kirkir, karmadoda and godeim.

## MATERIALS AND METHODS

### *Preparation of Sample:*

The forest fruits were obtained from western Sudan (Southern Kordufan State). Doum and kirkir were peeled and crushed using mortar and pestle, while karmadoda was peeled and cut into small pieces using sharp clean stainless steel knives. However, of godeim were removed manually (Abdel-Rahman, 2014).

### *Minerals Determination:*

Determination of minerals profile was conducted according to the method described by Pearson (1982). The evaluated were calcium (Ca), magnesium (Mg), potassium (K), iron (Fe), sodium (Na), phosphorus (P) and manganese (Mn).

Each sample was burnt in a muffle furnace (model: Carbolite – Bamford S30 2 AU, Sheffield, England) at 550 °C and left until a white ash with a constant weight was obtained. The ash was washed for 10 minutes after addition of 5 ml of HCl (20 %). Then the solution was carefully filtered in a 50 ml volumetric flask, and then the volume of the solution was completed to the mark. Minerals were determined using an atomic absorption spectrophotometer (model: Instrument Shimadzu - AA - 6800). In the case of Potassium and Sodium a flame photometer (model: Even LTD, England) was used. All chemicals and reagents, used in this investigation, were of analytical grade.

### *Amino Acids Determination:*

The amino acids compositions of the samples under study were determined according to the Official Method of the AOAC (2000) by using performic acid oxidation-sodium metabisulfite method (994.12). Performic acid oxidation was performed prior to hydrolysis to oxidize cysteine and methionine to cysteins and methionins sulfone, respectively. Sodium metabisulfite was added to decompose per formic acid. Amino acids were liberated from protein by hydrolysis with 6.0 N HCl. Then, samples hydrolysates were diluted with sodium citrate buffer and the amino acids of each sample were determined by using HPLC system (model: Sykam. S 7130 Amino Acids. Reagent Organizer). Tryptophan is destroyed by hydrolysis, whereas tyrosine is destroyed by oxidation.

### *Chemical score:*

The chemical score of the samples was calculated according to the equation described by (Seligson and Mackey, 1984), by summing the total milligrams of amino acids per 100 grams protein.

### *Calculation of Energy Value:*

The caloric values of the different samples were calculated by summing the values obtained through multiplying the contents of fats, protein and carbohydrates by the coefficients recorded by IMNA (2002).

## RESULTS AND DISCUSSION

### *Mineral Contents*

Minerals are substances that are not produced by plants or animals, but originate from the soil by absorbance; however minerals from plants sources fluctuate from area to another. Minerals content of the forest fruits studied are presented in Table 1. The samples reported changeable levels of calcium ranged from 75 to 7310 mg/kg for kirkir and godeim, respectively. The minimum value was lower than 1900 mg/kg, while the maximum value was higher than 6100 mg/kg reported by Abdel Muti (2002) for kirkir and godeim, respectively. According to El-Nouri and El-Talbani (1981) Karmadoda and godeim fruits have calcium content more than one and half of hawthorn (*Crataegus azarolus*, 3539 mg/100kg), double that of strawberry (2900 mg/100kg), three times to that of figs (1860 mg/100 kg) and five times to that of guava (1140 mg/100 kg). Iron levels varied from 193 mg/kg (karmadoda) to 835 mg/kg (godeim). The maximum result is in accordance with 800 mg/kg recorded by Abdel Muti (1991) for the same forest fruit. However, the value of iron obtained for kirkir was close to that reported by Amata (2012). According to the FAO (2013) 40 – 100 grams of godeim could provide about 100% of iron daily requirement for children under 8 years old. Food fortification with iron is recommended when dietary iron is insufficient or the dietary iron is of poor bio-availability (WHO/ FAO, 1996). High variation was observed in results of phosphorus content; godeim recorded a negligible value of 1.4 mg/kg and doum showed the highest value of 24270 mg/kg. The level of P in doum fruit is higher than two cultivars of apples called golden apple and quince skin of 651 and 1269 mg/kg, respectively (Özcan, 2012). In this investigation, sodium content ranged from 210 to 4320 mg/kg. The richest forest fruit in sodium content is doum and the poorest fruit is godeim. Results concerning sodium content of karmadoda and godeim are in agreement with that reported by

Cunningham, (2001) who found that the sodium of 44 fruits and vegetables between ranged between 0 – 1100 mg/kg. While, doum and kirkir fruits have Na content more than the highest level mentioned above. From the findings presented in Table 1, karmadoda fruit demonstrated the highest Mg content (7193 mg/kg). Doum, kirkir and karmadoda fruits are rich in magnesium compared to strawberry which is known to contain 1000 mg/kg (Gil, 2006). The Mg content of doum obtained agreed with that reported by Okwu and Morah (2004) for *Dennettia tripetala* fruit. Manganese content ranged between 10 and 51 mg/kg. These values obtained are closed to 7 – 55 mg/kg reported by Ertürk, (2006) for some fruit of chestnut cultivars. Potassium content was found to be minimum in karmadoda of 7700 mg/kg and maximum in doum of 36734 mg/kg).

These results showed that doum and kirkir had K content higher than that of the richest fruits and vegetables of 4250 and 10800 mg/kg recorded by McCane, and Widdowson (1960) for rhubarb and parsley, respectively. On the other hand, karmadoda value of K was out of the range, and godeim value agrees to result mentioned by Abde-Rahman, (2011). According to the above mineral profile, those forest fruits are the best sources of minerals for human consumption and health. Segura, (2006) found that at the consumer level, a high intake of calcium, magnesium and potassium is associated with the protection against bone demineralization, arterial, hypertension, insulin resistance and overall cardiovascular risk.

### **Amino Acids**

The most common method for evaluation of protein quality is usually based primarily on its content of certain essential amino acids compared to its amount in a reference protein (Wolzak, 1981). Results of amino acids values are presented in Table 2.

The levels of amino acids in doum fruit were 88.66 % from total protein. However, the fruit was found containing limiting quantities of some essential amino acids; leucine, valine, phenylalanine, threonine and arginine. On the other hand, non-essential amino acids values obtained for this fruits were higher than those of essential amino acids. Limited values were recorded for the sulphur amino acids methionine and cystine. These results are in accordance with the data mentioned by Abdel Muti (2002) for doum fruit. Glutamic acid recorded the highest percentage from total amino acids. It is important in the metabolism of sugars and fats and also helps the transportation of potassium across the blood-brain barrier (Dutta, 2013).

The chemical score has been suggested to replace the protein efficiency ratio (PER) as the official method for measuring protein quality (Steinke, 1979). The chemical score of amino acids of kirkir was found to be 3534.856 (total milligrams of amino acids per 100 grams), which is equivalent to 89.99 % from total protein. The kirkir's protein contains acceptable quantities of nutritionally essential amino acids; except methionine. Arginine recorded the highest percentage among the amino acids of kirkir fruit. It is available in the body as a free amino acid and is a component of most proteins and a substrate for several non-proteins and nitrogen-containing compounds (Nieves and Langkam-Henken, 2002). Osiecki, (2004) reported that arginine is a very important amino acid for babies, because new born cannot make their own arginine for the first few months of their life. Niittynen, (1999) mentioned that arginine may protect against cardiovascular diseases and seem to lower blood pressure; it may also inhibit atherogenesis. Hurson, (1995) claimed that oral Arginine supplementation may be taken safely in elderly humans to decrease total serum cholesterol with a reduction in the low-density lipoprotein. Moreover, the highest level of nutritionally non-essential amino acid was recorded for glutamic acid followed by alanine then proline. In addition, alanine is quantitatively the primary amino acid released by muscles (Filig, 1973). Furthermore, it plays with glutamic acid a key role in maintaining glucose levels in the body by helping the body to convert glucose into energy (Layman, 2003).

The sulphur amino acids recorded the lowest values. Galili and Amir (2012) found that legumes and cereals contain adequate amount of sulphur amino acids, while fruits contain only 27 mg/g of total protein in the food source. These results are similar to those obtained for sulphur amino acids. Stampler and Brown (2009) claimed that the most important amino acids in vegetable protein is related to blood pressure. Diet high in vegetable protein and low in animal protein has favorable effect on blood pressure.

Reading of HPLC amino acid analyzer for karmadoda forest fruit are presented in Table 2. The protein of this fruit is rich in the essential amino acids arginine, leucine and valine. Followed by lysine, isoleucine, phenylalanine and threonine. Histidine and methionine scored the lowest values, while tryptophan was not detected. Valine is essential in the repair and growth of tissues and maintaining the nitrogen balance in the body and assists with leucine to regulate blood sugar and energy levels (Layman, 2003). Lysine is one of the important essential amino acids, it is required for growth and bone development in children and assists in calcium absorption and also in maintaining the correct nitrogen balance in the body (Tunsaringkarn, 2012).

Karmadoda fruit is also rich in nutritionally non-essential amino acids; glutamic acid, aspartic acid and alanine. Aspartic acid is made from glutamic acid, and the last one is significant in the metabolism of sugars and fats, as well as helps with the transportation of potassium across the blood-brain barrier (Osiecki, 2004). According to the above findings karmadoda fruits could be a supplement for essential and non-essential amino acids.

Godeim fruit is poor in amino acids compared to other forest fruits under study. It's the chemical score of amino acids constitute 96.96 % from total protein. This protein contains limiting amounts of some nutritionally essential amino acids, as valine, leucine and threonine.

Table 3 shows that doum, kirkir and karmadoda are containing adequate amounts of some essential amino acids, and 100 g of these forest fruits provide good percentages of daily requirements for adults (70 kg weight). These results make the forest fruits under study excellent sources for livestock feed supplementation.

### CONCLUSION

These forest fruits investigated are found rich in minerals and amino acids. Therefore, more attention should be given to these forest fruits and try to incorporate them in different food products as ingredients eg. nectars, beverages, jams formulation and school-age children foods

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