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The Potential of *Hyphaene thebaica* (Doum palm) Fruits Extract as a Substitute for ORS in the Management of Diarrhea in Children under Five in Sinnar State, Sudan

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Abstract: ***The study was conducted to evaluate the Nutritional Efficacy of Doum (Hyphaene thebaica) Extract in the Management of Diarrhea in Children under Five in Sinnar State, Sudan. The study sample included 120 children suffering from diarrhea in Singa Teaching Hospital in the period from April 2018 to April 2019. The demographic data was collected by interviewing (Questionnaire) children mothers. The data was analyzed by Statistical Package for Social Sciences (SPSS). 120 children with moderate diarrhea were divided into two groups. Group 1 was given ORS as a control and Group 2 was given Doum (Hyphaene thebaica) solution in the Child Emergency Department (CED) over a period of 2–6 h, under supervision of a trained team to restore weight lost and balance Na^+, K^+ levels and thus remove and reduce signs of dehydration. The result showed that the majority of the patients were of the ages 11 - 20 months including (60%) males and (40%) females. Most of the patients (70%) had sunken eyes, (65%) were unable of drinking and (66.6%) were sufferings from skin pinch goo's back. The mean values of moisture, ash, protein, fat and fiber contents in Doum powder were (5.44%), (3.28%), (6.81%), (0.37%) and (3.50%) respectively. The mean values of tannins contents were (22.60mg/100g), phenols (26.76 mg/100g) and phytic (9.07mg/100g). The concentrations of Fe, Cu, Pb and Co content in Doum powder were (311.95mg/100g), (0.060mg/100g), (Nil) and (Nil) respectively. The composition of the prepared Doum extract solution was as follows; 23 g Doum (Hyphaene thebaica) + 10g sugar + 1.68g NaCl completed to 1-liter water. Each child was given 75 ml/ 1kg wt. The results showed that children with moderate diarrhea who were given a solution of Doum had improved by (100%) and were better than those given (ORS). Their weights and (Na^+) and (K^+) levels were restored. The taste of Doum extract solution was accepted by the children more than ORS solution. The study concluded that Doum solution had proved successful for the children with moderate diarrhea in restoring their weight loss due to diarrhea, addressing the defects in the electrolytes and thus removing and reducing the signs of dehydration. Besides it is a local natural product, cheap and acceptable by the children.***

Keywords: Doum (***Hyphaene thebaica*)** Solution, Diarrhea in Children under Five

1. Introduction

Dehydration resulting from acute diarrheal illness is one of the most significant causes of morbidity and mortality in populations displaced by disaster. In some cases, it accounts for more than 50% of the deaths during the initial stages of a humanitarian emergency. The use of Oral Rehydration Therapy (ORT) has markedly reduced the morbidity and mortality associated with dehydration caused by diarrheal illness regardless of the etiology. In view of this problem, the World Health Organization has encouraged studies for treatment and prevention of diarrheal diseases (Agbon *et. al*., 2013).

Early diagnosis and treatment are thus essential to reduce the impact of diarrheal diseases on people affected by disasters. Early identification of cases allows the implementation of measures needed to prevent or lessen outbreaks that can occur in displaced populations in this context. The use of primary care management tools, such as the Integrated Management of Childhood Illness (IMCI) strategy is highly important. (WHO, 1988).

In some communities, the reliance on indigenous medicinal plants often can be attributed to a lack of medical doctors and unaffordable prices of pharmaceutical products, as well as people's faith in the benefits of traditional medicine (Issa *et al.,* 2018; Khider, 2018).

In Sudan, the medicinal and Aromatic Plants Research Institute (MAPRI) of the National Centre for Research (NCR) is exerting efforts for collecting, conserving, studying and documenting indigenous medicinal and aromatic plants in Sudan. Traditional medicine together with use of medicinal plants become an important part of the cultural heritage of Sudan (Watt & Breyer-Brandwijk, 1962; Elkhalifa, 2004; El badwi et. al., 2014; Skerman, 1965; Abu elgasim et al., 2016; Issa et al., 2018; Khider and Hubbe, 2018).

An investigation of anti plasmodial activity of selected Sudanese plants revealed that most plants from the family *Meliaceae* showed highly potent anti plasmodial activity (Ahmed *et al.*, 2010). The roots of *Balanites aegyptiaca* contain steroidal sapogenins which have strong detergent properties that form very stable foam in water solutions. Whereas, the bulb contains sugars and saponins exhibiting anti-inflammatory and immune-boosting properties as well as antibacterial effects. (Eltohami,1997).

Justification:

Malnourished children are increasing in number in Sinnar State, Sudan due to poverty in addition to the high illiteracy. Oral Rehydration Solution (ORS) taste is not acceptable or palatable to children and their mothers are reluctant to give ORS at home, since it usually needs Nasogastric tube to administer. Doum (*Hyphaene thebaica*) fruits are traditionally consumed and readily accepted by the Sudanese.

Objective:

The main objective of this study was investigating the potential of Doum extract as a substitute for ORS. The was focused on determining the suitability of the extraction method to formulate an effective rehydration solution. Furthermore, to test and compare the prepared Doum extract solution with the standard ORS regarding the acceptability and recovery patterns of the dehydrated children.

2. Materials and Method

Materials: ORS, Doum (*Hyphaene thebaica*), Sugar, NaCl and Water.

Subject: Hospitalized Children under five who were suffering from moderate Dehydration problem.

Subjects and study Location: Hospitalized Children under five suffering from moderate Dehydration problem were selected randomly from Singa Teaching Hospital, Temporary Residence and Abu Ella centers, Singa, Sudan.

Methodology

Design: Patients were divided into two groups (60 each) subject to treatment by using the Oral Rehydration Salt (ORS) as the control group and using Doum solution as group two.

Flow Up: 36 males and 24 females in each group were under the care of a nurse and the researcher for the collection of blood samples before and after treatment to test Na^+ and K^+ levels, observing, resolving and decreasing dehydration.

Preparation of (*Hyphaene **thebaica)* Powder Extract:** The powder Doum (***Hyphaene thebaica***) was collected from the city of Singa and was prepared by separating the seed from the powder by breaking it in a wooden (Houn) then kept in a dry place at room temperature.

Preparation of Doum Solution: Aseptically the specific amount of Doum (*Hyphaene thebaica***)** powder was measured according to the concentration of sodium and potassium required. The quantity was soaked in a liter of sterile water for 10 minutes, blended for 30 seconds and filtered. Extraction and solutions were made as shown in Figure (1).

Doum (*Hyphaene thebaica*) Solution Content:

23 g of Doum (*Hyphaene thebaica)* +10g sugar +1.5g NaCl completed to 1-liter water (Tables 2a and b).

Analysis Fruit Extract

The Moisture, Ash, Protein content and Crude fibre of (Doum) samples were determined according to the modified method of AOAC (2000). The determination of heavy minerals from ash was done by using atomic absorption spectrophotometry. Determinations of sodium and potassium were done by flame photometer and the determinations of sugar were done by High Performance Liquid Chromatography (HPLC) (Ultimate 3000).

Exposure Time: 6 hours' Specific dosage was applied. Avery vigilant and adequate control was implemented and the response was closely watched. The disappearance of rehydration symptoms (Lethargic, restless, Absence of tears, Sunken eyes, Dry mouth and tongue, thirsty, skin pinch goes back) were recorded (Table 1). Blood samples were taken and the electrolytes were examined after taking full dose of the specific solution using Electrolyte Equipment (Roche1980 Electrolytes Analyzer). Weight was monitored in 0 time, 2 hours and after 6 hours of admission.

Figure 1: Preparation of Doum (*Hyphaene thebaica*) solution

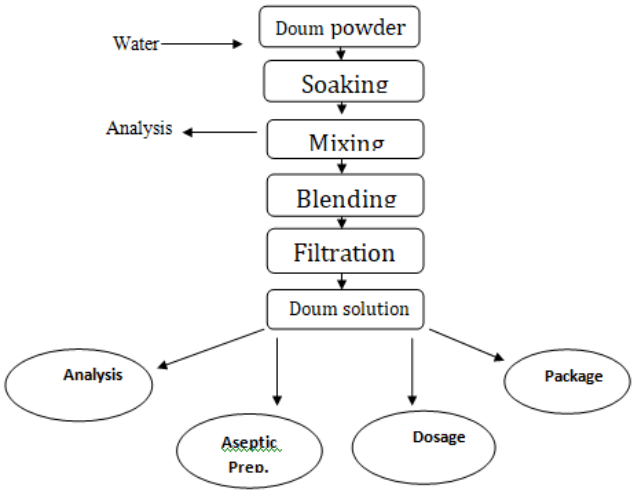

Table 1: Degree of Dehydration

Classification	General	Eye	Drinking	Skin
Sever of dehydration	Lethargic	Sunken	Unable to drink	V. Slow
Moderate dehydration	Irritable	Sunken	Eager	Slow
No dehydration	Alert	Normal	Normal	Normal

Table 2a: The Concentrations of Sodium, Potassium and Glucose in 20g/l Solutions

Solutions	K^+ mg/l	Na^+ mg/l	Glucose gm/l
ORS	162.350	171.429	13.5
Doum	138.748	11.429	3.685

Table 2b: The Concentrations of Sodium and Glucose in the administered Doum Solution

Solutions	Weight (g/l)	Na^+ g/l	Glucose g/l
Doum (Hyphaene thebaica)	23	1.5	10

3. Results and Discussion

Table (3) shows that the majority of the patients (48% males and 52% females) were of the ages 11-20 months (58.3%). All the patients were suffering from diarrhoea and showing dehydration symptoms.

Symptoms of the disease

Table (4) shows the symptoms recorded at admission. (100%) were irritable, most of the patients (70%) had sunken eyes, (65%) were unable of drinking water, and (66.6%) of the patients were sufferings from skin pinch goo's back.

Table (5) shows that the mean value of moisture content of Doum powder was (5.44%), ash (3.28%), protein (2.33%) fat (6.81%) and the mean value of fiber content was (3.50%).

Nutritionally, Doum fruit is an excellent source of carbohydrate and fiber. Additionally, micronutrients such as vitamins (especially B vitamins) and minerals including K, Na, Ca, Mg, and P also help to regulate the biological process in body and impart health benefits (Aboshora et al., 2014; Admassu et al. 2013). Various studies have revealed the fact that Doum fruit extracts contain high levels of phenols and flavonoids, which possess significant antioxidant and antibacterial activities (Aboshora et al., 2015; Hsu et al. 2006). On the other hand, Doum fruit has a high-quality protein varied between 2.86 and 5.01%, high proportion of lysine and cysteine varied between 4.09–4.16% and 0.2–1.62%, respectively. The limiting amino acid was threonine. The crude fat varied between 1.2 and 8.4%, crude fiber varied between 52.26% and 66.5%. The most important carbohydrates component was mannose which varied between 13% and 75.9%. (Auwal et al., 2013).

The chemical composition of the fruit pulp was reported by Cook et al. (2000), showing that the fruits were relatively rich in proteins, essential fatty acids (linoleic acid) and in selected trace elements. Other research on the Doum fruit pulp had shown that it contained 4.91% proteins, 5.26% fat, 4.5% ash and 85.33% total carbohydrate fatty acids, in particular the nutritionally essential linoleic acid (Issa et al., 2008).

Furthermore, Doum fruit is a good source of calcium, magnesium, potassium, iron sodium and negligible amount of nickel, cobalt and molybdenum. Phytochemical compounds of Doum fruit such as tannins, saponins, steroids, glycosides, flavonoid, terpenes and terpinoids were found at low and moderate concentrations (Auwal et al., 2013).

Table 3: Age and Sex Distribution

		Frequency	Percent%
Age	Less than 10 month	8	13.3
	11 to 20 month	35	58.3
	21 to 30 month	10	16.7
	Above than 30 month	7	11.7
	Total	60	100
Sex		Frequency	Percent%
	Male	29	48.3
	Female	31	51.7
	Total	60	100

Table 4: Symptoms at Hospital Admission

		Frequency	Percent
General	Diarrhea	60	100
	Total	60	100
G/C Lethargic		Frequency	Percent
	Irritable	60	100
	Total	60	100
Sunken eyes		Frequency	Percent
	Yes	45	75
	No	15	25
	Total	60	100
Drinking water		Frequency	Percent

	Unable	42	70
	Eager	18	30
	Total	60	100
Skin pinch goo's back		**Frequency**	**Percent**
	Very Slow	40	66.6
	Slow	20	33.4
	Total	60	100

Analysis of Doum Powder:

Minerals and vitamin C in Doum:

The results in (Table 5) show that the mean value of Vitamin C in Doum powder was (131.96mg/100g). The electrolyte and inorganic content of Doum showed it to be a rich source of K (671.45mg/100g), Ca (214.5m*g*/100g), Fe (311.95mg/100g), p (313.27mg/100g), Na (36.47mg/100g), Mg (99.44mg/100g) respectively.

The prepared Doum solution contained (30.35mg/ liter) Vitamin C, (49.34 mg/ liter) Ca,(223.43mg/ liter) K, (0.72 mg/ liter) P,(71.75mg/ liter) Fe,(8.39 mg/ liter) Na and (22.87mg/ liter) Mg respectively.

Table 5: Chemicals Composition of Doum

Doum powder (%)						
Doum	Moisture	Ash	Protein	Fat	Fiber	
Powder mg/100g	5.44±0.17	3.28±0.09	6.98±0.04	0.37±0.01	3.50±0.20	
Minerals and vitamin Content of Doum Powder and 20 g/l Solution						
Doum	Vitamin C	Ca	K	P	Fe	Na	Mg
Powder mg/100g	131.96±1.11	214.5±0.06	671.45±1.8	3.15±5.10	311.95±0.6	36.47±0.17	99.44±0.5
Solution mg/liter	30.35	49.34	223.43	0.72	71.75	8.39	22.87
Anti-nutritional of Doum Powder and Solution						
Doum	Tannins	Phenols	Phytate			
Powder mg/100g	22.26±0.94	25.43±0.23	7.97±0.09			
23 gm/l solution	5.12 mg/liter	5.48 mg/liter	1.83 mg/liter			

Anti-nutritional content of Doum Powder: Tannins, phenols and phytic content of Doum powder:

The mean value of tannins, phenols and phytic content of Doum powder were (22.26mg/100g), (25.43 mg/100g) and (9.07 mg/100g) respectively (Table 5).

The prepared Doum solution contained 5.12 mg/ liter Tannin, 5.48 mg/ liter Phenol, 1.83mg/ liter Phytic respectively. Different total soluble phenols values in Doum were published in different studies. (Mohamed et al., 2010; Aboshora et al., 2014). The highest four concentrations of phenolic compounds in Doum fruit aqueous extracts were found to be 3-OH tyrosol, E-vanillic acid, catechin and chlorogenic acid, while the lowest were of alpha-coumaric acid, cinnamic acid, p-coumaric acid and coumarins (Hetta and Yassin, 2006). It is well known that the bioactive potential of fruits and vegetables is attributed to their high content of polyphenols (Asami et al., 2003; Agostini-Costa, 2018).

Heavy Metals in Doum Powder:

The data in Table (6) revealed that mean value of Fe, Cu, Pb and Co content Doum powder were showed (311.95 mg/100g), (0.060mg/100g), (Nil) and (0.004mg/100g) respectively. The prepared Doum solution contained 71.75mg/ liter Fe, 0.013 mg/ liter Cu, Nil Co and Nil Pb respectively.

Table 6: Heavy metals in Doum

Heavy metals in Doum				
Doum	Fe	Cu	Pb	Co
Powder mg/100g	311.95 ±0.124	0.060 ±0.020	Nil	Nil
23 gm/l Solution	71.7 mg/liter	0.013 mg/liter	Nil	Nil

Effects on (Na^+) and (K^+) levels and weight of the children before and after Treatment

The data in Table (7) show that the mean values of concentration of (Na^+) before and after taking Doum solution were (132.19 ± 3.81 mmol/dl) and (134.97 ± 3.33 mmol/dl) respectively, while the concentration of (K^+) obtained before and after taking Doum solution were (3.23 ± 0.95 mmol/dl) and (3.73 ± 0.75 mmol/dl)

respectively. All these results were significant at (P ≤0.05).

The weights of children significantly increased (P≤ 0.05) after taking Doum solution from (7.133 ±2.02 kg) to (7.44 ±2.09 kg).

In general, Doum fruits showed antimicrobial and antihypertensive activities. These activities were attributed to the presence of flavonoids (El-egami et al., 2001).

Doum fruit was active against five pathogenic bacteria (Dosumu et al., 2006; Hossam et al., 2018). All Doum extracts showed strong antibacterial activity against *Staphylococcus aureus* and Salmonella typhi. These types of pathogens could contribute to diarrhea (Aboshora et al., 2014).

Table 7: Effects on (Na^+), (K^+) levels and Weights of the Children before and after Treatment with Doum Solution

Item	Treatment	Mean ± SD	Std. Error Mean	P. value	Correlation
Na^+ (mmol/dl)	Before	132.19± 3.81	0.60901	p ≤0.05	0.866
	After	134.97± 3.33	0.69901		
K^+ (mmol/dl)	Before	7.133±2.02	0.37016	p ≤0.05	0.650
	After	7. 44± 2.09	0.38254		
Weight Kg	Before	7.133± 2.02	0.37916	p ≤0.05	0.866
	After	7.44 ± 2.09	0.38254		

Table 8: The effect on (Na^+), (K^+) levels and weights of the children before and after using ORS

Item	Treatment	Mean ± SD	Std. Error Mean	P. value	Correlation
Na^+ mmol/dl	After	131.21± 4.14	0.75722	≤ 0.05	0.874
	Before	133.02± 4.13	0.75326		
K^+ mmol/dl	After	3.12± 0.374	0.06833	≤ 0.05	0.924
	Before	3.46± 0.405	0.07407		
Weight Kg	After	6.78± 1.452	0.26521	≤ 0.05	0.997
	Before	7.01± 1.449	0.26465		

The data in Table (8) show that mean values of concentrations of (Na^+) before and after taking ORS solution were (131.21 ±4.14 mmol/dl) and (133.02 ±4.13 mmol/dl), while the concentrations of (K^+) obtained were (3.12 ± 0.374 mmol/dl) and (3.46 ± 0.405 mmol/dl) respectively. The results indicated that the weights of children significantly increased from (6.78 ±1.452 kg) to (7.01 ±0.26465 kg). These results were significant (p ≤ 0.05) for the (Na^+), (K^+) levels and weights.

Although, the World Health Organization (WHO, 1988) has recommended the use of a high-osmolarity (90 mEq/L Na^+) mixture of glucose and 3 salts (20 g glucose, 3.5 g sodium chloride (NaCl), 2.5 g sodium bicarbonate [$NaHCO_3$], and 1.5 g potassium chloride (KCl), in 1 litre of water, our study demonstrated that, in this part of western Africa, a lower Na^+ content can be used effectively because the *V. cholera* infection is uncommon which results in a low loss of Na^+ in the stool. We developed a rehydration strategy that provided a higher osmolarity solution at the beginning of rehydration, followed by a lower osmolarity solution as suggested by (Pignatelli and Musumeci, 2003).

Comparison between Using Doum solution and ORS:

As in Tables (7 and 8), the Doum solution was better than ORS in restoring (Na^+) and (K^+) levels and weight of children. This is clearly indicated in Table (9). The changes in follow up time of (Na^+) and (K^+) levels and weight of children were (2.783; 1.807 mmol/dl) for Na^+, (0.499; 0.346 mmol/dl) for K^+ and (0.310; 0.220 kg) for weight gain when using Doum and ORS respectively. Numerous studies have validated the traditional use of anti-diarrheal medicinal plants by investigating the biological activity of extracts of such plants, which have antispasmodic effects, delay intestinal transit, suppress gut motility, stimulate water adsorption or reduce electrolyte secretion. Of the numerous phytochemicals (such as alkaloids, tannins, flavonoids and terpenes) present in active extracts, tannins and flavonoids are thought to be responsible for antidiarrheal activity by increasing colonic water and electrolyte reabsorption (Palombo, 2006).

Table 9: Comparison between using Doum solution and ORS solution at day 7

Item	Doum	ORS
Δ Na^+ mmol/dl	2.783	1.807
Δ K^+ mmol/dl	0.499	0.346
Weight gain kg	0.310	0.220

4. Conclusion

The study concluded that Doum rehydration solution is safe compared to WHO/ORS in the case of erroneous preparation. Doum is acceptable as diarrhea management solution for both children and their mothers compared to ORS. Doum helped efficiently in removing the symptoms of dehydration. It is a nutritious cheap local product that could be used at home lessening hospital stays.

References

[1] Aboshora, W.; Lianfu, Z.; Dahir, M.; Gasmalla, M. A.; Musa A, Omer E. and Thapa, M. (2014). Physicochemical, nutritional and functional properties of the epicarp, flesh and pitted sample of Doum fruit (Hyphaene Thebaica). *J. Food Nutr Res*.; 2(4):180–186. doi: 10.12691/jfnr-2-4-8.

[2] Aboshora, W.; Lianfu, Z.; Dahir, M.; Qingran, M.; Qingrui, S. and Jing, L.; Ammar, A. (2015). Effect of extraction method and solvent power on polyphenol and flavonoid levels in *Hyphaene Thebaica* L Mart (*Arecaceae*) (Doum) fruit, and its antioxidant and antibacterial activities. *Trop J Pharm Res*.; 13(12):2057–2063.

[3] Aboshora, W.; Lianfu, Z.; Dahir, M.; Qingran, M.; Musa, A.; Mohammed, A.; Gasmalla, A. and Omar, K. (2016). Influence of Doum (*Hyphaene thebaica* L.) flour addition on dough mixing properties, bread quality and antioxidant potential. J Food Sci Technol. 53(1): 591–600.

[4] Abu elgasim, A. K; Abdelkreim, M.; Mohammed, A. A. andMugadam, E. (2016). Study on common plants at savannah rangeland in Elsuki area, Sinnar State, Sudan. *IJISET – Intern. J. Innovative Sci. Eng. Technol*., *3* (13), 217-225.

[5] Admassu, M.;Bekele, A. and Kim, J.C. (2013). Nutritional composition of balanitesaegyptiaca (desert date) and hyphaenethebaica (Doum palm) fruits consumed by Hamadryas Baboons (Papiohamadryashamadryas) in Awash National Park, *Ethiopia. J NutrEcol Food* Res;1(3):198–206.

[6] Agbon,A.N.; Kwaneshie, H.K and Hamman,W.O.(2013). Antidiarrheal Activity of Aqueous Fruit Extract of *Phoenixdactylifera* (DATE PALM) in Wistar Rats.*British Journal of Pharmacology and Toxicology* 4(3): 121-127, 2013

[7] Agostini-Costa, T.S. (2018). Bioactive compounds and health benefits of some palm species traditionally used in Africa and the Americas – A review

[8] Ahmed, M.S.; Hussein, S.; Zeinab, A.; Salah, M.A.; Nefisa, A. and Hegazy, M. (2010). Physicochemical, Sensory and Function Properties of Wheat –Doum Fruit Flour Composite Cakes. Polish journal of food and nutrition sciences – Pol.*J. Food Nutr. Sci*. Vol .60, No.3, pp .237-242.

[9] AOAC. (2000). Official Methods of Analysis. 17th ed. AOAC Int., Gaithersburg, MD.

[10] Asami, D. K.; Hong, Y. J.;Barret, D. M.; Mitchell, A. E. (2003). Comparison of the total phenolic andascorbic acid content of freeze-dried and air-dried Marion berry, strawberry, and corngrown using conventional, organic, and sustainable agricultural practices. *Journal ofAgricultural and Food Chemistry*.;51:1237-1241

[11] Auwal, M.S.; Sanda, K.A.; Mairiga, I.A.; Lawan, F.A.; Mutah, A.A. and Tijjani, A.N. (2013). The phytochemical, elemental and hematologic evaluation of crude mesoc arp extract of albino rats. *Asian Journal of Biochemistry*.;8:14-23

[12] Cook, J.A.; VanderJagt, D.J.; Dasgupta, A.; Mounkaila, G.; Glew, R.S. and Glew, R.H. (1998). The use of the TROLOX assay to estimate the antioxidant content of 17 edible wild plants of Niger. Life Sci.; 63, 105–110.

[13] Dosumu, O.O.; Nwosu, F.O. and Nwogu, C.D. (2006). Phytochemical screening and anti-microbial studies of extracts of Hyphaene thebaica Linn (Mart) *Palmae. Int. J. Trop. Med*., 1, 186–189

[14] Issa, H.A.; Ramadan, M.T.; Ali, H.S. (2008). Effect of natural extracts from the fruits of Doum palm, carob and licorice on the quality and safety of apple slices. *J. Agric. Sci. Mansoura Univ*., 33, 6609–6623.

[15] El badwi, S. M.; Hassan, S. M. and Gameel, A. (2014). Medicinal plants in Sudan: role in animal and human health, productivity and poverty Alleviation.

[16] El-egami, A. A.; Almagboul, A. Z.; Omar, M.E.A. and El-Tohami, M.S. (2001). Sudanese plants used in folkloric medicine, screening for antibacterial activity. PartX.Fitoterapia.;**72**:810-817

[17] Elkhalifa, M.Y. (2003). Women and income generating activities and conservation of natural resources: Medicinal, culinary and aromatic plants in the Sudan. A document of the FAO Regional Office for the Near East. FAO.

[18] Elnasri, N.A.; Elsheik, M.A. and Eltayeb, M. A. (2013). Physico-chemical characterization and isotherm studies of adsorption of Fe (II), from aqueous solution by using activated carbon prepared from Doum fruit waste. Arch Appl. Sci. Res. ;5 (5):149–158.

[19] ESPGHAN, (1992). Working Group Recommendations for composition of oral rehydration solutions for children of Europe. *J Pediatric. Gastroenterology Nutr*.; 14:113–115.

[20] Hetta, M.H. and N.Z. Yassin, (2006). Comparative studies on hypocholesterolemic effect of different fractions of Thebaica (Doum) in experimental animals. Pharmazie, 61: 230-232

[21] Hossam, S.; Heba, I. E.; Hany, M.; Yousef,N. and Fawz, E. M. (2018). Biological Activities of the Doum Palm (Hyphaene thebaica L.) Extract and Its Bioactive Components Biological Activities of the Doum Palm (Hyphaene thebaica L.) www.researchgate.net/ journal/0017- 3495 Grasas Aceites 61(1): 67-75

[22] Hsu, B. and Coupar, K. (2006). Antioxidant activity of hot water extract from the fruit of the Doum palm, Hyphaene thebaica. Food Chem;98(2):317–328.

[23] Issa, T.; Mohamed, Y.; Yagi, S.; Ahmed, R.; Najeeb, T.; Makhawi, A. andKhider, T. (2018). Ethnobotanical investigation on medicinal plants in Algoz area (South Kordofan), *Sudan J. Ethnobiol. Ethnomed*.,*14*, 31.

[24] Mohamed, A.A.; Khalil, A.A. and El-Beltagi, H.E.S. (2010). Antioxidant and antimicrobial properties of kaffmaryam *Anastatica hierochuntica* and Doum palm

Hyphaene thebaica. Grasas y Aceites.; 61:67-75

[25] Palombo, E. A. (2006). Phytochemicals from traditional medicinal plants used in the treatment of diarrhea: modes of action and effects on intestinal function. *Review Article Phototherapy recherché journal*.20, (9): 717-724

[26] Pignatelli, P. and Musumeci, S. (2003). Comparison of Three Oral Rehydration Strategies in the Treatment of Acute Diarrhea in a Tropical Country. Curr Ther Res Clin Exp. 2003 Mar; 64(3): 189–202