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Comparative study of physicochemical characteristics of *Acacia gummiferae Gum* of Sudanese origin

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Abstract
Three composite samples of Gummeferae gum of positive specific optical rotation (+S.O.R) *A.nilotica* var. *tomentosa* season 2015, *A.nilotica* var *nilotica* season 2010, and *A.Orefota* season 2015, from Sinnar, Blue Nile states and El-Jazeera states were subjected to physicochemical analysis. The results showed moisture contents were (11.17%, 11.6%, and 12.5%), ash% (2.05%, 1.81%, and 1.48%), pH (5.2, 5.1, and 4.96), S.O.R+ (+90, +103, and +70), nitrogen and protein percent (0.06%, 0.025%, and 0.46%), and (0.35%, 0.16%, 2.85%),, intrinsic viscosity (10.88, 9.02, and 5.60), Mwt (5.3 $x10^6$, 2.94 $x10^6$, and 7.91$x10^6$ $gmol^{-1}$), acid equivalent weight (2105, 1984, and 3409), total glucouronic acid (9.22%, 9.8%, and 5.69%), and Colorific value (3.97 Kcal/g, 4.03 Kcal/g, and 4.04 Kcal/g) respectively. The relationship between Colour Gardner and tannin content was investigated. The results were found to be in average values, The Colour Gardner was directly proportional to the tannin content of all samples.

Keywords: gummeferae, physicochemical properties, colour gardner, tannin content, calorific value

1. Introduction
Acacia species cover about two – third of the area of the Sudan (EL Amin, 1977) [5]. They extend from tropical rainforests in the south through deciduous savanna woodlands in central Sudan, to the sub-desert and desert of Northern Sudan. These different habitats grading from humid tropical conditions to dry desert conditions, provide good scope for studying the genus, There are thirty one species of *Acacia* species in Sudan (EL Amin, 1977, Voget, 1995) [5, 8]. most of which yield gums (EL-amin,1990), species high distribution include *A.senegal* (Hashab), *A. seyal*(Talha), *A. polyacantha* (Kakamut), *A. laeta* (Shubahi), *A. mellifere* (Kitir), *A. sieberiana* (kuk), and *A. oerfota* (nubica, laot) (Abdel Nour, 1999) [1]. *Acacia* Orefota is widely distributed in Central, northern Sudan, and northern and East Africa, from Egypt southwards to Uganda, Kenya, Tanzania. Also semi-desert or dry savanna woodlands on dry hard clays; it also appears on denuded and over cultivated clay fields, *A. nilotica* (sunot) have three subspecies commonly found in the Sudan, namely *A. nilotica* var *tomentosa* characterized by the tomentose to pubescent pods and grows throughout Sudan, *A. nilotica* var *nilotica* that characterized by the glabrous pods to pubescent and grow along the White Nile, and *A. nilotica* var *adistringens* characterized by the broad pods and grow in western Sudan (Elkhalifa, K.F.,1996), (Elamin, 1973) [4].
A.nilotica an important sources of wood, gums, tannins, fuel and animals fodder. They have significant pharmacological and toxicological effects. In Africa and the Indian subcontinent; *A.nilotica* is extensively used as a browse, timber and firewood species (Gupta 1970, Mahgoub 1979) [10, 11]. The bark and seeds are used as a source of tannins (Shetty 1979, New 1980), it is also used for medicinal purposes. Bark of *A.nilotica* has been used for treating hemorrhages, colds, diarrhea tuberculosis and leprosy while the roots have been used as an aphrodisiac and the flowers for treating syphilis lesions (New,1980).The gum of *A.nilotica* is sometimes used as a substitute for gum Arabic (obtained from *A.senegal*) although the quality is inferior (Gupta 1970) [10]. Indian *A.nilotica* gum is sweeter in taste than that of the other varieties and is used in paints and medicine. *A.nilotica* is suitable for the production of paper and has similar pulping properties to a range of other tropical timbers (Nasroun, 1979) [14]. The tree is used for cold, bronchitis, diarrhea, dysentery, biliousness, bleeding piles and leucoderma (Ambasta S, 1986). The *A.nilotica* is traditionally used for tanning and retanning in tropical Africa, and is one of the most important tanning materials in Northern India (Sarkar, 1991). Local vegetable tannins such as Garad (from the pods of *A.nilotica*) are abundant, but they do not produce the same quality of leather as wattle bark.
The Physicochemical properties of *Acacia* gums, established as quality parameters, to differentiate between different *Acacia* gums. These properties vary with gums of different botanical sources, and even substantial differences in gum from the same species when collected from different locations and different ages of the tree. Several parameters are used in this study but the most important includes moisture, total ash content, pH value, intrinsic viscosity, specific optical rotation, molecular weight distribution, tannin content, nitrogen content, protein, amino acid, uranic acid.

2. Materials and methods
2.1 Materials
Two composite gum samples of *A. nilotica* subsp. *tomentosa* during, one composite sample of *A. nilotica* subsp. *nilotica*, *and A. Orefota* during, were collected from Sinnar, Blue Nile, and El-Jazeera states respectively Figure (2.1, and 2.2). They represent an important range of the natural distribution of these subspecies in the country. The original samples were authenticated by Soba Forestry Research Centre Herbarium,

and Sinnar, Blue Nile, and Kordofan states forestry corps.

2.1.1 Purification of crude gum

The gum samples were relatively pure; however, impurities such as wood pieces and sand particles were carefully removed by hand. Then each sample was reduced to a fine powder using mortar and pestle, then kept in labeled self-sealed polyethylene bags.

(A) (B) (C)

Fig 1: *A. Gummeferae gums samples, A.nilotica var tomentosa (A), A.nilotica var nilotica (B), and A. Orefota*

Fig 2: *A. seyal* var. *seyal* and *A. seyal* var. *fistula* trees from Sudan

2.2 Methods

2.2.1 Physicochemical Properties of gum

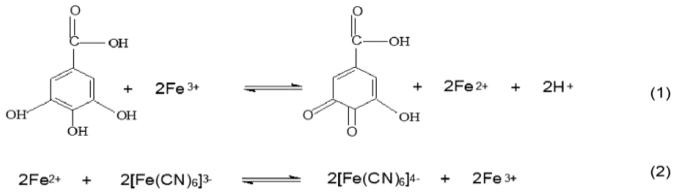
Methods of analysis used in studying the samples were adopted from (Osman. M. E, 1993) [15].

2.2.2 Determination of Colour Gardner

A calibrated Lovibond Spectrophotometer PFX-i series, colorimeter was used to determine colour Gardner of the *A.nilotica* var *tomentosa* gum samples. Measurements were carried out using 10 mm path length cell on 1% (w/v) gum solutions prepared in distilled water and filtered through 100 mm mesh filter. The Gardner colour scale is from 1 to 18 with 1 containing the least amount of colour and 18 with the maximum amount of colour. The Colour Gardiner was measured after 3 Hours, 24 Hours, and after 48 Hours.

2.2.3 Determination of tannin content

The tannin content was determined according to modification of Prussian blue assay originally devised by Price and Butler and subsequently, modified (Graham, 1992). Tannin content represents "total phenols" or more accurately the "Gallic acid equivalents" as Gallic acid 99% in purity was purchased from sigma Aldrich and used as analytical standard for determining the hydrolysable tannins. 500 µg/g Gallic acid was prepared in distilled water. and serial diluted to 400, 300, 200, 100, and 50 µg/g as standards. 0.10ml of each sample was dispensed in a 30ml universal. 3ml of distilled water was added vortex mixed for 30sec. 1.0 ml of 0.016M (0.526g/100ml, w/v) Potassium hexacyano ferrate(III) [$K_3[Fe(CN)_6$], was added fallowed by 1.0 ml of 0.02 (0.324g $FeCl_3$/100ml, deionized water 0.83ml HCl) Ferric Chloride ($FeCl_3$), and immediately mixed by vortex mixer 30sec. Exactly 15 min after adding the reagent to the sample 5 ml of stabilizer(10.0 ml of 85% phosphoric acid, ($H3PO_3$), 1.0 ml of 1% gum Arabic, and 30 ml of distilled water) was added and vortex mixed 30sec, then exactly after15 min The absorbance was read at 700 nm in triplicate for standard solutions, using (Perkin Elmer Lambda XLS+, UV/Vis spectrophotometer). The gum samples were also prepared by adding all reagents. The absorbance was read at 700 nm in triplicate for all using Perkin Elmer Lambda 40 UV/Vis spectroscopy. The error in measuring the tannins content was below 10% for all samples and the average was taken.



(1)

$$2Fe^{2+} + 2[Fe(CN)_6]^{3-} \rightleftharpoons 2[Fe(CN)_6]^{4-} + 2Fe^{3+} \quad (2)$$

2.2.4 Determination of Calorific value

The calorimeter IKA® C1 is used to determine the calorific value of solid and liquid materials according to national and international standards (e.g. DIN 51900, BS 1016 T5, ISO1928, and ASTM 5468, 5865, 4809). The system was calibrated by Benzoic acid tabs 1g (2 Tabs), of cal.val. 26461J/g, RSD 0.03%, and LOT SZBD2180V, at 19 C°, gas pressure of 30 bars, and the pump flow of 2700 rpm. 0.5g of gum samples were placed into a plastic bag C12A, big bag with cross cal. Val. 46383. The samples were combusted in an oxygen atmosphere. The calorific value of the sample was calculated, and the net cal. val, was calculated by adding moisture content calorific value.

3. Results and Discussion

Tables.3.1 show the physicochemical properties of all gum species studied. The results show the values of moisture content were (11.45% and 10.88%) respectively, which almost slightly different to that values obtained by Amira, *et al.*, (2011) [3] for *A.nilotica* var *nilotica*, and less value to those obtained by Mustafa, *et al.*, (2018) [7] for *A.Orefota gum.* Also show higher value to those obtained by, Karamallah (1999) for *A.nilotica*, and to those results of *A. seyal* var. seyal obtained by Rabeea, *et al.*, (2016), while Ash percentage 2.05% for booth states, which almost slightly different to those values obtained by Amira, *et al.*, (2011) [3] for *A.nilotica* var *nilotica*, also which almost higher value to those obtained by Mustafa, *et al.*, (2018) [7] for *A.Orefota gum,*, Karamallah (1999) for *A.nilotica* var *tomentosa, and E.A. Hassan, et al. (2005)* [6] *for stud of A.seyal* var *fistula, and A.seyal* var *seyal*, But they almost less to those results for *A. seyal* var. seyal obtained by Rabeea, *et al.*, (2016). pH value (5.24, and 5.15) respectively, which almost similar to those values obtained by Amira, *et al.*, (2011) [3] for *A.nilotica* var *nilotica*, and to those results obtained by Mustafa, *et al.*, (2018) [7] for *A.Orefota gum.* Also which almost show high value to those obtained by, Karamallah (1999) for *A.nilotica*, and to those results obtained

by Rabeea, *et al.*, (2016) for *A.seyal* var. seyal. while specific optical rotation value (+95, and +85) respectively, which almost less to those values obtained by Amira, *et al.*, (2011) [3] for *A.nilotica* var *nilotica*, and higher to those results obtained by Mustafa, *et al.*, (2018) [7] for *A.Orefota gum*, *E.A. Hassan, et al. (2005)* [6] for *stud of A.seyal* var *fistula, and A.seyal* var *seyal*, Al-Assaf *et al.* (2005) [2] for *A.nilotica* from Nigerian gum, and Rabeea, *et al.*, (2016) for *A. seyal* var. seyal. But they almost similar to those results obtained by, Karamallah (1999),

The nitrogen% and protein content value were (0.07%, 0.44% and 0.04, 0.26) respectively, which almost show high value to those obtained by Amira, *et al.* (2011) [3] for *A. nilotica* var *nilotica*. The results show more less value to those results obtained by Mustafa, *et al.*, (2018) [7] for *A.Orefota gum, and E.A. Hassan, et al. (2005)* [6] for study of *A.seyal* var *fistula*, and *A.seyal* var *seyal*, Figure (3.2), also show same value to those obtained by, Karamallah (1999) for *A. A.nilotica*. The intrinsic viscosity value were 10.35 ml/g, and 11.40 ml/g respectively, which almost show deferent value to those obtained by Amira, *et al.* (2011) [3] for *A. nilotica* var *nilotica*, and almost show higher value to those results obtained by Mustafa, *et al.*, (2018) [7] for *A.Orefota gum*, and less value to those obtained by *E.A. Hassan, et al. (2005)* [6] for *stud* of *A.seyal* var *fistula, and A.seyal* var *seyal*.

Table(3.1) shows the value of acid equivalent weight of *A.nilotica* var *tomentosa* gum from Sinnar and Blue Nile state, which were (2077, and 2133), which almost identical to those obtained by Amira, *et al.* (2011) [3] for *A. nilotica* var *nilotica* gum, and almost show lower value to those results obtained by Mustafa, *et al.*, (2018) [7] for *A.Orefota gum*. But showed higher value to those obtained by *E.A. Hassan, et al. (2005)* [6] *for stud of A.seyal* var *fistula, and A.seyal* var *seyal*, while uronic acid value of (9.34, and 9.09) which almost showed slightly low to those results obtained by Amira. *et al.* (2011) [3], for *A.nilotica* var *nilotica*, and low value to those obtained by *E.A. Hassan, et al. (2005)* [6] *for stud of A.seyal* var *fistula*, and *A.seyal* var *seyal*, but almost show higher value to those results obtained by Mustafa, *et al.*, (2018) [7] for *A.orefota gum*. The calorific value of *A.nilotica* var *tomentosa, and A. nilotica* var *nilotica* from Sinnar, and Blue Nile states were identical, which found to be (4.01 Kcal/g, 3.93 Kcal/g, and 4.00, 4.05) respectively, which almost identical to those results obtained by Mustafa, *et al.*, (2018) [7] for *A.Orefota gum*.

Table (3.2) show the value of tannin content of *A.nilotica* var *tomentosa gum* from Sinnar, and Blue Nile states samples were (0.042%, and 0.028%) respectively, which almost lower to those results obtained by Amira, *et al.* (2011) [3] for *A. nilotica* var. *nilotica*. and almost show same value to those results obtained by Mustafa, *et al.*, (2018) [7] for *A.Orefota gum*, Figure (3.4), also show lowest value to those obtained by, Karamallah (1999) for *A.nilotica.*

Figure (3.1, and 3.2) show Comparison of some physicochemical properties between some Gummiferae gum samples which represented by, *A.nilotica* var. *tomentosa* gum, *A.nilotica* subsp. *nilotica.* gum, *A.orefota* gum, *A.seyal* var *fistula*, and *A.seyal* var *seyal*, from Sudan

Table.3.3 show the effect of oxidation of polyphenol which determined by measuring the Colour Gardner after 3 hours, 24 hours, and 48 hours, of all Gummiferae gum samples was directly proportional to the tannin content. The colour Gardner increased with the time, and the high Gardner represent the sample which contains high tannin content as shown in Figure (3.3).

Table 1: Physicochemical properties of a composite samples of *A. Gummiferae gum*, *A. nilotica* var *tomentosa* gum 2015 season, *A. nilotica* var *nilotica* gum 2010 season, and *A.Orefota* gum 2015 season, Sudanese origin.

Physicochemical properties	***a***	***b***	***c***	***d***	***e***	***f***	***g***	***h***
Moisture %	11.45	10.88	11.69	11.51	12.5	12.5	-	--
Ash%	2.05	2.05	1.79	1.87	1.3	1.65	1.52	0.21
pH value	5.24	5.15	5	5.2	5.05	4.86	-	-
(+S.O.R) x 10	9.5	8.5	10	10.5	7	7	5	5.3
N%	0.07	0.04	0.024	0.025	0.42	0.49	-	-
Protein %	0.44	0.26	0.156	0.163	2.63	3.06	0.59	0.96
Intrinsic Viscosity	10.35	11.4	9.22	8.81	3.4	7.8	13.3	13.9
Mwt x 10^6	5.3	5.3	3.38	2.5	6.23	9.59	2.1	1.7
Acid E.W x 10^2	20.77	21.34	20.67	19	34.09	34.09	16.61	14.89
Uronic acid	9.34	9.09	9.39	10.21	5.69	5.69	10.75	11.88
Cal.val Kcal/g	4.012	3.93	4.006	4.047	4.067	4.021	-	-

a. *A.nilotica* var *tomentosa* gum from Sinnar state, Sudan, Seifeldawla, *et al.* (2017)
b. *A.nilotica* var *tomentosa* gum from Blue Nile state, Sudan, Seifeldawla, *et al.* (2017)
c. *A.nilotica* var *nilotica* gum from Sinnar state, Amira, Sudan, (2011) [3]
d. *A.nilotica* var *nilotica* gum from Blue Nile state, Amira, Sudan, (2011) [3]
e. *A.orefota* gum from Sinnar state, Sudan, Mustafa, *et al.* (2018) [7]
f. *A.orefota* gum from El-Jazeera state, Sudan, Mustafa, *et al.* (2018) [7]
g. *A.seyal* var *fistula* from Sudan, E.A.Hassan, *et al.* (2005) [6]
h. *A.seyal* var *seyal* from Sudan, E.A.Hassan, *et al.* (2005) [6]

Table 2: The oxidation of polyphenol, and tannin content of a composite samples of *A. Gummiferae gum*, *A. nilotica* var *tomentosa*, *A. nilotica* var *nilotica*, and *A.Orefota* gum, from Sinnar, Blue Nile, and El-Jazeera states.

Physicochemical properties	***a***	***b***	***c***	***d***	***e***	***f***
Tannin %	0.0422	0.0283	0.1227	0.0998	0.0268	0.0292
Col. Gardner 3h	0.4	0.4	0.8	0.8	0.1	0.2
Col. Gardner 24h	0.4	0.4	1.7	1.2	0.1	0.3
Col. Gardner 48h	0.5	0.4	1.7	1.4	0.3	0.3

i. *A.nilotica var tomentosa gum from Sinnar state, Sudan, Seifeldawla, et al. (2017)*
j. *A.nilotica var tomentosa gum from Blue Nile state, Sudan, Seifeldawla, et al. (2017)*
k. *A.nilotica var nilotica gum from Sinnar state, Amira, Sudan, (2011)* [3]
l. *A.nilotica var nilotica gum from Blue Nile state, Amira, Sudan, (2011)* [3]
m. *A.orefota gum from Sinnar state, Sudan, Mustafa, et al. (2018)* [7]
n. *A.orefota gum from El-Jazeera state, Sudan, Mustafa, et al. (2018)* [7]

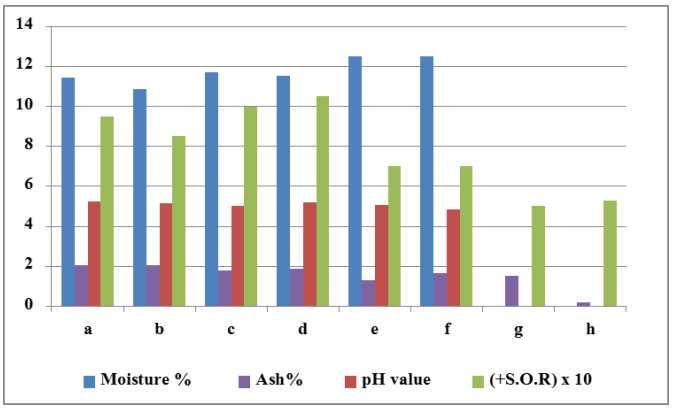


Fig 1: Analytical data of some physicochemical properties (moisture%, ash%, pH value, and +SOR) of some Gummiferae gum samples which represented by, *A.nilotica* var. *tomentosa* gum, *A.nilotica* subsp. *nilotica.* gum, *A.orefota* gum, *A.seyal* var *fistula*, and *A.seyal* var *seyal*, from Sudan

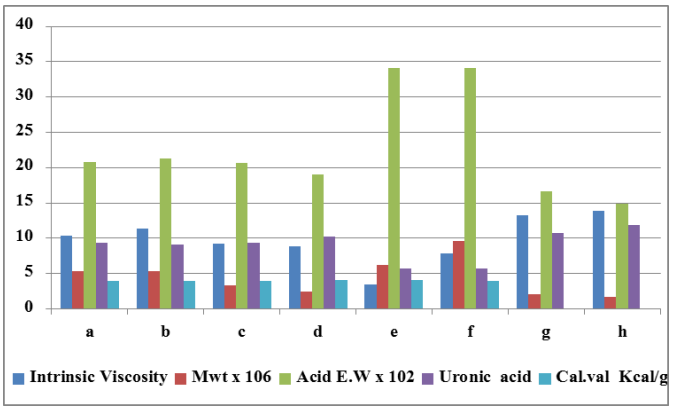


Fig 2: Analytical data of some physicochemical properties (intrinsic viscosity, Mwt x10^6,Acid E.W, uronic acid, and cal. Val Kcal/g) of some Gummiferae gum samples which represented by, *A.nilotica* var. *tomentosa* gum, *A.nilotica* subsp. *nilotica.* gum, *A.orefota* gum, *A.seyal* var *fistula*, and *A.seyal* var *seyal*, from Sudan

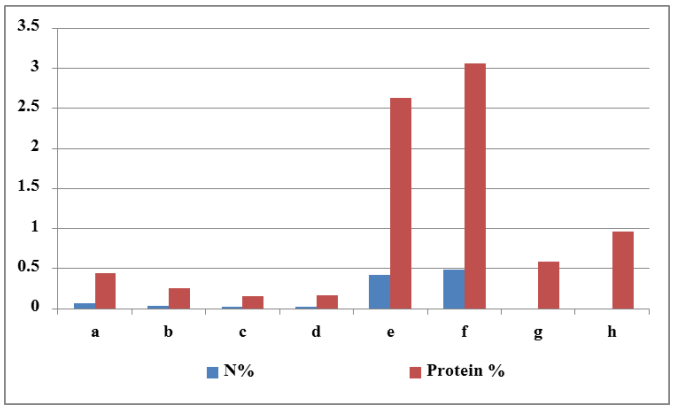


Fig 3: Analytical data of Nitrogen and Protein content of some Gummiferae gum samples which represented by, *A.nilotica* var. *tomentosa* gum, *A.nilotica* subsp. *nilotica.* gum, *A.orefota* gum, *A.seyal* var *fistula*, and *A.seyal* var *seyal*, from Sudan

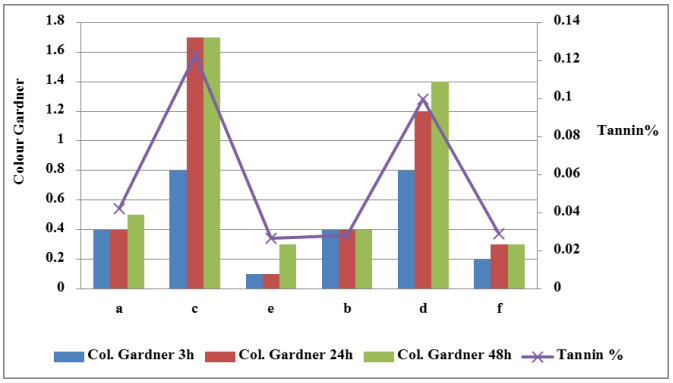


Fig 4: The relationship between Colour Gardner and tannin content of six composite samples of *A. Gummiferae gum*, *A. nilotica* var *tomentosa*, *A. nilotica* var *nilotica*, and *A.Orefota* gum, from Sinnar, Blue Nile, and El-Jazeera states.

4. Conclusion

Investigation of physicochemical three Gummiferae gum samples, (+S.O.R) which represented by, *A.nilotica* var. *tomentosa* gum, *A.nilotica* subsp. *nilotica*. gum, and *A.Orefota* gum show slightly deferent. The calorific values of Gummiferae gum in this study were suitable for human to use gum as food additives.

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6. References

1. Abdel Nour HO. Gum Arabic in Sudan. Production and socio-economic aspect in: Medical, Culinary and Aromatic Plants in near east. Proceeding of the international expert meeting organization by forest products division FAO forestry department and the FAO regional office for near east. Cairo, Egypt, 1999, P. 66-73.
2. Al-Assaf S, Phillips GO, Williams PA. Food hydrocolloids. 2005; 19:647.
3. Amira AS. Characterisation and Toxicological Study of Acacia nilotica var. nilotica GUM, Ph. D theases, Sudan University of Sceince and technology, Khartoum, Sudan, 2011.
4. Elamin HM. Sudan Acacias. Published by the publishing section information department. 1973; 15:46-47.
5. EL-Amin HM. Forest Administration, Forest Research Institute Bulletin, No, 2, Khartoum. Sudan, 1977.
6. Hassana EA, Al-Assafa bS, Phillipsa GO, Williamsd CPA. Studies on Acacia gums: Part III molecular weight characteristics of Acacia seyal var. seyal and Acacia seyal var fistula *Food Hydrocolloids*. 2005; 19:669-677.
7. Mustafa E, Ahmed Mohammed E, Osman Elfatih, Hassan

A. Charcterisation and Rheological behavior of the gum from Orefota, International Journal of Chemical Studies. 2018; 6(1):168-172.
8. Voget K. A field worker to the identification, propagation and uses of common trees and shrubs of dry land Sudan. Sos Sahel international (UK) – London, 1995.
9. Wickens GE. Role of Acacia Species in the Rural Economy of Dry Africa and the Near East. FAQ Conser• vation Guide No. 27, FAQ Rome, 1995.
10. Gupta RK. Resource survey of gummiferous acacias in western Rajasthan. Tropical Ecology. 1970; 11:148-161.
11. Mahgoub S. On the subspecies of Acacia nilotica in the Sudan. Sudan Silva. 1979; 4:57-62.
12. New TR. A Biology of Acacias. Oxford University Press, Melbourne, 1984, pp. 153.
13. Shetty KAB. Social forestry in Tamil Nadu. Indian Farming. 1977; 26:82.
14. Nasroun TH. Pulp and paper making properties of some tropical hardwood species grown in the Sudan. Sudan Silva. 1979; 4:22-32.
15. Osman ME. Ph. D. Thesis. Department of Chemistry and Applied Chemistry, University of Salford, 1993.