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Comparative Study of the Composition of Gum and Germ in *Piliostigma reticulatum* (Carob) Seeds

Rugaia A. Mustifa*[1] Amin M. Baraka [2], Elfatih A. Hassan [3], Mohammed E. Osman [2]

*1.Department of Chemistry, Faculty of Education, El Fashir University, E-mail:
2. Department of Chemistry, Faculty of Science, Cairo University, Egypt.
3. Department of Chemistry, Faculty of Science , Sudan University of Science and Technology , P.O. Box. 407 Khartoum, Sudan.
Corresponding author: rugaia011@yahoo.com
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ABSTRACT
Thirty samples of mature dry seeds of *Piliostigma reticulatum* trees were collected from the area around Nyala town – southern Darfur state – Sudan during the seasons 2014, 2015 and 2016. They were then dehusked; the germ and gum were separated manually. The Physicochemical compositions of the gum and germ samples were determined. Results obtained showed that the mean value for the moisture, ash, crude lipid, crude fiber, crude protein, and total carbohydrate. For gum were: 4.03%, 3.09% ,2.35%, , 4.85%, 17.19 % and 68.59 %, respectively , while those for germ: 5.6% , 7.21 % , 5.04% , 2.07% , 68.38% and 11.74 %, respectively. The e elemental analysis determination using atomic absorption spectrophotometer shows that both the gum and germ are a good source of potassium, calcium, phosphorus, silicon and sulphur, and low a mounts for sodium, zinc and manganese. The water holding capacity of the gum and germ samples 2.64%, 1.93%, respectively. Both gum and germ are insoluble, in hot, cold water and organic solvents due to galactomannan of gum and protein of germ.

المستخلص:
جمعت البذور الجافة من ثلاثين شجرة الخروب من مناطق حول مدنية نيالا – ولاية جنوب دارفور بالسودان خلال مواسم 2014، 2015 و 2016 . تم نزع القشرة الخارجية للبذور وفصلت كل من الصمغ و نطفة . تم تحديد التركيب للعينات باستخدام الطرق الفيزيائية. أظهرت النتائج بأن قيم متوسط الرطوبه،الرماد، الدهن الخام ، خام الأليف ، البروتين الخام و الكربوهيدرات الكلية لصمغ الخروب كانت: 4.03% ، 3.09% ، 2.35% ، 4.85% ، 17.19% و 68.59% على التوالى و لنطفة الخروب 5.6% ، 7.21% ، 5.04% ، 2.07% ، 68.38% و 11.74% على التوالى. تمت دراسة قيم العناصر باستخدام جهاز طيف الامتصاص الذري للعينات حيث أبانت بان كلا من الصمغ و البروتين مصدر جيد لكل من عناصر البوتاسيوم ، الكالسيوم ، الفسفور، السيلكون، الكبريت والحديد و بكميات قليلة من العناصر الصوديوم ، الزنك و المنجيز. أظهرت الدراسة بان محتوى المائى لكل من الصمغ و نطفة الخروب 2.64% و 1.93% على التوالى ، وكما أن كلا عينتيى لا يذوبان لا فى الماء البارد و لا الساخن ولا المذيبات العضوية.

KEYWORDS: Water – holding capacity, galactomannan , galactose

INTRODUCTION
Piliostigma reticulatum is a leguminose ever green shrub or small tree which grows wild in the tropics . One of common species *Piliostigma* (Hochst) is a branched tree up to 8 m high in the drier savanna areas of central Sudan in south Kordofan and south Darfur [(1)] . The tree is perennial in nature and its petals are white with pink stripes. Fruit is an oblong,

straight, undulate or twisted, woody, seeds are contained in a pod. Seedling with epigeal germination [2]. Carob is the local name , others names include camel foot, Bauhinia reticulate DC and Bauhinia glauca A. Chev [1] .The seed has three main constituent, husk (30% - 33%), endosperm (42% - 46%) and germ (23% - 25%) covered with a tight fitting brown coat [3] . The seeds of *Piliostigma reticulatum* are used as fodder for animals [4], more recently the major interesting, use the carob tree has been the production of gum and germ from the seeds [5]. The seeds have their skins removed by acid treatment; (60% concentration Sulphuric acid). The germ is much more brittle and reduces in size easily when compared to the endosperm (gum) and it is rich in protein, which is used as protein supplementation in both food and feed [6]. The endosperm (gum) contains the polysaccharide, a galactom-annan in which the main chain consist of (1-4) linked β – D mannose residues, and the side chain are (1-6) linked α – D galactose [5]. Different parts of *P.reticulatum* have also been described medicinally for treating coughs, bronchitis, malaria, hepato – billiary ailments, hydropsy, ascites, sterility, kwashiorkor, etc[7] .

However there is the little information or data published on the subject.

The purpose of this work therefore, was to provide information on the proximate composition and functional properties of gum and germ of *Piliostigma reticulatum* seeds.

MATERALS and METHODS

Materials

They were 30 samples of *Piliostigma reticulatum* seeds Fig.1 obtained from the area around Nyala town – southern Darfur state – Sudan. About (100g) of the dried seeds were placed in 120 cm^3 of the 60% H_2SO_4 solution for 30 min and then in the water for 24h. The soft coat was then peeled off using the tip of the finger and the germ Fig .3 was separated from the endosperms (gum) Fig. 2 which were dried at room temperature [8]. The endosperms (gum) and germ were ground to obtain Piliostigma *reticulatum* gum and germ powder.

H_2SO_4 (Merck, K38346531).

Figure1: Piliostigma reticulatum seeds

Figure 2: Piliostigma reticulatum gum

Figure 3: Piliostigma reticulatum germ

Analytical Methods

The proximate composition of gum and germ was determined using AOAC procedures AOAC [9]

Water holding capacity (WHC) was determined following the method of [10]. Briefly, 1g of sample was weighed and then stirred into 10 cm3 distilled water for 1min in a vortex (Thermolyne vortexer). These fibrous suspensions were centrifuged at 2200 xg for 30 min and the volume of the supernatant t solution was measured. Water – holding capacity was expressed as g of water held per g of sample. The elemental analysis study using atomic absorption spectrophotometer. For solubility determination about 0.2g samples were placed in a test tube and 0.5 cm ^{3} of distilled water were added and stirred with a glass rod. This was allowed to stand at room temperature for 5min. The sample was stirred for another five min, to enhance solubility using a test tube shaker. This procedure was repeated using hot water, ethanol and acetone [11].

RESULTS and DISUSSION

Table (1) shows the proximate composition of *Piliostigma reticulatum* gum, germ and related galactomannan gums. The moisture content of *Piliostigma reticulatum* gum sample was 4.03 % whereas that of germ sample 5.6 %, they had a low moisture content which may be due to dry state of collection. The ash content of gum sample 3.09% , this was the higher value than for others galactomannan gums [12, 13] ,whereas the ash content of germ sample 7.21 % , this was the higher value than for Carob bean germ [14] .

Table 1: proximate composition (%) of gum, germ of Piliostigma reticulatum seeds and a bit abont galactomannan gums

Treat	*P.reticulatum* gum	Carob (bean) [12] gum	*Guar* [12] gum	*Cassia* [13] gum	*P.reticulatum* germ	Carob (bean) [14] germ
Moisture %	4.03 ±0.04	NR	NR	≤ 12	5.6 ±0.04	5.76±0.32
Ash %	3.09 ±0.04	≤ 1.2	≤ 1.5	≤ 1.2	7.21 ±0.04	6.34±0.15
Crude lipid %	2.35 ±0.1	NR	NR	≤ 2	5.04 ±0.1	2.26 ±0.13
Crude fiber%	4.85 ±0.03	NR	NR	NR	2.07 ±0.03	24.3 ±0.09
Crude protein%	17.19 ±0.1	≤ 7	≤ 10	≤ 7	68.38 ±0.1	48.2±0.24
Carbohydrate%	68.59 ±0.3	≥ 75	≥ 70	≥ 70	11.74 ±0.3	2.92±0.03

NR: not reported

Crude lipid of gum sample was 2.35% whereas that of germ sample was 5.04 % this is higher than that for Carob bean germ [14]. The crude fiber was found for both gum and germ samples (4.85%, 2.07%) respectively, the level of fiber is lower than for legumes and seeds [15]. The crude protein content of the gum sample was 17.19% , this value is higher than for others galactomannan gums [12,13], whereas crude protein for germ sample was 68.38 %, This value is higher than for Carob bean germ [14]. The carbohydrate of the gum sample 68.59% is lower than for others galactomannan gums [12,13] , whereas that of germ sample 11.74% This value is higher than for Carob bean germ [14].

Table (2)shows The element content (%) of gum and germ of *Piliostigma reticulatum* seeds, the gum and germ samples has recorded higher values for the elements potassium, calcium, phosphorus, sulphur and silicon except for sodium, zinc, manganese and copper, which, though is below measured levels. These values were high when comparable with values reported for some legumes [15].

Table 2: Elemental content (%) of gum and germ of Piliostigma reticulatum seeds

Elemental	Gum	Germ
Potassium	13.56 ±0.215	31.36 ±0.170
Calcium	14.36 ±0.166	12.81 ±0.104
Phosphorus	2.51±0.217	13.04±0.51
Sulphur	10.45±0.306	15.06±0.171
Silicon	8.91±0.459	2.69±0.173
Zinc	0.30±0.032	0.09±0.014
Sodium	0.5±0.02	0.4±0.014
Manganese	0.0006 ±0.002	0.07±0.032
Iron	2.55±0.0173	0.32±0.031
Copper	0.0003 ±0.008	0.04±0.032

Table (3) shows the water holding capacity and solubility of the gum and germ samples. The water holding capacity of the gum 2.64%, this was lower than which reported for polysaccharide gum[16], whereas the water holding capacity of germ sample 1.93% this was lower than what were reported for other flours[17] . The gum and germ samples are Insoluble, in cold, hot water and organic solvents, this was agreement for solubility of Carob bean gum[18] and plant polysaccharides gum [19] .

Table 3: The water holding capacity and solubility of the gum and germ of Piliostigma reticulatum seeds

Functional properties	Gum	Germ
Water- holding capacity	2.64%	1.93%
Solubility (g/cm^3)		
Cold water	Insoluble	Insoluble
Hot water	Insoluble	Insoluble
Ethanol	Insoluble	Insoluble
Acetone	Insoluble	Insoluble

CONCLUSION

From the results presented in this work, it is concluded that

• The gum is good source of carbohydrate (galactomannan).

•The germ is good source of protein.

• Both are insoluble in water and organic solvents.

• Both are good source of potassium, calcium, phosphorus, silicon and sulphur.

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