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Physicochemical Characterization of Gum of Some Guar (*Cyamposis tetragonoloba L. Taup*) Lines

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Abstract

The objective of the present investigation was to determine the physical and chemical properties of five guar (*Cyamposis tetragonoloba L. Taup*) lines, planted in the experimental from of the Faculty of Agriculture, University of Khartoum. The results obtained from all lines studied, GM2, GM6, GM8, GM9 and GM34 were compared those from a known control cultivar, L53. Physical characterization of the guar gum extracted included the determination of pH, relative viscosity, refractive index, solubility and optical density, while the chemical studies involved the determination of the proximate chemical composition of the tested Guar lines namely: moisture, ash, oil, fiber, protein and carbohydrate. The physical properties showed significant differences ($P \leq 0.05$) in optical density, solubility and pH among lines and between lines and control, while no significant differences ($P \leq 0.05$) were observed in refractive index and viscosity. The thousand-seed weight ranged from 30.21 g-30.75 g, pH 7.16 to 7.40%, relative viscosity 0.1000 to 0.197 cps, refractive index 1.34% to 1.35%, solubility 76.67% to 89.83% and optical density 0.035 to 0.047. The results showed significant differences ($P \leq 0.05$) among lines and between lines and control in all physical parameters studied. The moisture content ranged from 8.37% to 8.80%, ash content 3.33% to 4.96%, fat content 1.70% to 2.47%, fiber content 10.53% to 11.83%, protein 25.80% to 30.52%, carbohydrate 43.80% to 48.77%. The results showed significant differences ($P \leq 0.05$) among lines and between lines and control in the various levels of guar lines chemical component. All five lines are characterized by possessing physical and chemical properties related to the control sample and to those from previous findings lines GM2 and GM6 proved to possess the best physical and chemical properties a among others and those reported from previous works.

Keywords: *Cyamposis tetragonoloba L. Taup*; Guar gum; Physicochemical properties

Introduction

Guar gum is one of the outstanding representatives of new generation of plant gums. It's source is an annual pod-bearing, drought resistant plant, called Guar, or cluster bean (*Cyamopsiste tragonolobuosr L. Taup*), belonging to the family Leguminosae, Genus Cyamposis and Species *Cyamposiste tragonoloba*. It has been grown for several thousand years in India and Pakistan as a vegetable, and a forage crop [1]. In the Sudan, guar plant Was known as a wild plant in the Red Sea mountains and Arashekol mountains of White Nile state. The advent of guar gum production in Sudan will pressurize gum Arabic to better commercial production and quality in order to compete in the national and international markets. The gum is contained within a portion of the seed known as the endosperm which is 35% to 42% of seed weight. The endosperm is ground into powder by the usual mechanical processing technique that does not produce completely pure endosperm. Therefore, the gum is not perfectly pure but contains small amounts of hull and germ, this contamination lower the gum quality, but does not harm its suitability as food additives [2]. Guar gum is a white to yellowish white powder and is nearly odorless. Guar gum is a natural high molecular weight hydro colloidal polysaccharide composed of galactan and mannan units combined through glycosidic linkages, which may be described chemically as galactomannan [3]. Guar gum is an economical thickener and stabilizer. The special properties of guar gum known in India make it most suitable for various industrial applications. Chemically, guar gum is a polysaccharide composed of the sugars galactose and mannose. The backbone is a linear chain of β 1, 4-linked mannose residues to which galactose residues are 1, 6-linked at every second mannose, forming short side-branches. Guar Gum is known as one of the best thickening additives, emulsifying additives and stabilizing additives [4], it has a polymeric structure, containing several hydroxyl groups. The various derivatives or industrial grades of guar gum are manufactured by reaction of these hydroxyl groups with chemicals [5]. There are more than 300 industrial applications of guar gum it is mainly used as natural thickener, emulsifier, stabilizer, bonding agent, hydrocolloid, gelling agent, soil stabilizer, natural fiber, flocculants and fracturing agent. Guar gum is soluble in cold water but insoluble in most organic solvents and has strong hydrogen bonding properties [1]. It has excellent thickening, emulsion, stabilizing and film forming properties. It is compatible with a variety of inorganic and organic substances including certain dyes and various constituents of food [6]. The seeds of guar are split and the endosperm and germ can be separated from the endosperm by sieving. Through heating, grinding and polishing process the husk is separated from the endosperm halves and the refined guar gum split are obtained. The refined guar splits are then treated and converted into powder [1]. The objective of this study was to extend the knowledge concerning the physical and chemical properties of guar gum. The attainment of this objective required the determination of the physical and chemical properties of five guar lines (GM2, GM6, GM8, GM9 and GM34) as compared to a known control sample (L53).

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Materials and Methods

Materials

Guar samples: Seeds of five guar lines (GM2, GM6, GM8, GM9 and GM34) together with a known control (L53) sample were obtained from the Department of Agronomy, Faculty of Agriculture, University of Khartoum. These lines were planted in the experimental farm of the faculty of Agriculture university of Khartoum (Shambat area). After harvesting, guar seeds were sieved to remove broken seeds, soil particles and foreign material.

Methods

Preparation of the samples: Guar seeds were ground to fine particle size, using milling machine, sieved by 0.4 mm mesh sieve, stored in polyethylene bags, and kept in a refrigerator at 4°C for further analysis.

Guar gum extraction: Gum extraction was carried out according to AOAC [7]. Guar seeds were soaked in distilled water for about 10 hours. The seeds were swollen and the outer layer (Hull) was removed easily. It was observed that twenty-four hours are required for the seed coat to be removed from the seed. The hull was opened into two separate parts the medium layer (endosperm) and the inner portion (germ). Then these extracts were put in an oven and dried at a temperature of 100°C for 20 minutes. After extraction, the endosperm was ground to fine particle size using milling machine sieved by 0.4 mm mesh sieve and stored in polyethylene bags.

Determination of physical properties: The determination of the physical properties namely pH, relative viscosity, refractive index, and optical density were done according to AOAC [7], while solubility was determined accord to the procedure of Osman [8].

Proximate chemical composition: The proximate chemical composition from the guar gums were carried out according to AOAC [7]. Carbohydrates were determined by difference.

Statistical analysis: Data were subjected to Duran's Multiple Range Test to evaluate the statistical significance using Analysis of Variance (ANOVA), and the significance was established at $P \leq 0.05$.

Results and Discussion

General properties of guar seeds

Thousand kernel weight (gram): The 1000 kernel weight (gram) of the five samples under study as well as of the control sample was determined. The obtained results are presented in Table 1. The values of thousand kernel weight of the five guar lines ranged from 30.21 g to 30.75 g, while that of the control sample (L53) was 30.61g, lying within same range. The values obtained from all samples, including the control, were significantly different ($p \leq 0.05$). The values of the 1000 kernel weight of the five guar lines, under study, and the control sample are in agreement with the lower limit of the range from 30.75 to 31.57 g reported by Eldirany [8], while they were lower than the range 35.6 g- 35.7 g reported by Sabah Elkhier [9].

Guar Lines	1000 kernel weight (g)
GM2	30.25^{e} (± 0.31)
GM8	30.51^{c} (± 0.29)
GM34	30.75^{a} (± 0.27)
GM9	30.37^{d} (± 0.30)
GM6	30.21^{f} (± 0.34)
L53 (control)	30.61^{b} (± 0.23)
L.S.D	0.09
*Means not sharing the same letters in the same Column are significantly different ($P \leq 0.05$). *Each value in the table is mean of three replicates ±S.D.	

Table 1: Thousand kernel weight (gram) of guar lines as compared to the control sample.

Physical properties of guar gum: The physical properties of the guar samples investigated were viscosity, pH, refractive index, optical density and solubility. The results obtained are presented in Table 2.

pH: The results showed that the pH-values of the solution prepared from five lines investigated ranged from 7.16 to 7.40. The highest value (7.40) was obtained from line GM9, while the lowest value (7.16) was from line GM2. There were no significant differences ($P \leq 0.05$) in pH-value observed among the tested lines except in line GM2 which was significantly different from all other lines. The pH-value of the control sample was significantly different ($P \leq 0.05$) from all samples. Results obtained in this study are higher than the values of 4.07 to 5.99 reported by Sabah Elkhier [9], and lower than the range from 7.5 to 10.5 and 8.00 to 9.00 reported by Loggale [10], and Eldow [11]. The variation of pH values might be attributed to genetical variation.

Relative viscosity: The results showed that the relative viscosity of the five lines investigated ranged from 0.100 cps-0.197 cps. All samples showed the same relative viscosity (0.197 cps) with the exception of line GM9 which gave 0.1000 cps. The relative viscosity of the standard commercial cultivar was 0.197cps, a value which was similar to values obtained from four of the lines studied. Relative viscosity obtained from all samples was not significantly different ($P \leq 0.05$). The relative viscosity values obtained in this study were lower than the value 1.30 cps reported by Loggale [10]. The variation in relative viscosity might be attributed to genetical variations.

Refractive index: A narrow range from 1.34 to 1.35 refractive index was obtained for the five lines under study. The control sample gave a refractive index of 1.34. GM2 and GM8 were not significantly different ($P \leq 0.05$) in their refractive index. GM34, GM9 and GM6 were also not significantly different, however these were significantly different ($P \leq 0.05$) from the two lines, GM2 and GM8. The results obtained are close to the same value reported by both Eldirany [8] and Sabah Elkhier [9] which was 1.3237.

Solubility: The results showed that solubility of the five lines investigated ranged from 76.67 to 89.83%. The highest value (89.83) was obtained from line GM34, while the lowest value (76.67) was found in line GM2. There was no significant difference ($P \leq 0.05$) in solubility among the tested samples except that from line GM2 which is significantly different ($P \leq 0.05$) from all other tested lines. The solubility of the standard commercial line was 86.51; a value which is not significantly different ($P \leq 0.05$) from the values obtained from the five lines investigated. The results of this study showed higher values than those ranging from 70.53 79.1% reported by Eldirany [8]. Earlier finding showed solubility in guar gum to range from 75.23 to 85.55 and 72.67 to 81.88 as reported by loggale [10] and Eldow [11] respectively. The small variation in solubility between the extracted guar gum and the values reported earlier might be attributed to genetical factors.

Optical density: The results showed that optical density of the five lines investigated ranged from 0.035 to 0.047. The highest value (0.047) was found in line GM2, while the lowest value (0.035) was obtained from line GM34. There were no significant difference ($P \leq 0.05$) in optical density observed among all tested samples. The optical density of the standard commercial cultivar was 0.037, a value which is lower than that obtained from the five lines, under study with no significant

Lines	pH	Relative Viscosity (cps)	Refractive index	Solubility (%)	Optical density
GM2	7.16^{a} (± 0.07)	0.197^{a} (± 0.04)	1.35^{a} (± 0.30)	76.67^{c} (± 0.21)	0.047^{a} (± 0.20)
GM8	7.24^{ab} (± 0.05)	0.197^{a} (± 0.06)	1.35^{a} (± 0.16)	80.00^{d} (± 0.23)	0.042^{c} (± 0.34)
GM34	7.25^{bc} (± 0.04)	0.197^{a} (± 0.07)	1.34^{b} (± 0.07)	89.83^{a} (± 0.09)	0.035^{f} (± 0.31)
GM9	7.40^{bc} (± 0.07)	0.1000^{a} (± 0.03)	1.34^{b} (± 0.20)	83.38^{c} (± 0.15)	0.040^{d} (± 0.24)
GM6	7.21^{bc} (± 0.10)	0.197^{a} (± 0.02)	1.34^{b} (± 0.13)	79.97^{d} (± 0.14)	0.045^{b} (± 0.21)
L53(**Control**)	7.32^{c} (± 0.05)	0.197^{a} (± 0.03)	1.34^{b} (± 0.14)	86.51^{b} (± 0.12)	0.037^{e} (± 0.31)
L.S.D	0.1196	0.1196	0.01	0.473	0.0014

*Mean not sharing the same letter in the same Colum is significantly different (P ≤ 0.05)
*Each value in the Table is a mean of three replicates ± S.D
* Viscosity = 0.1 % solution

Table 2: Physical characteristics of guar gum as lines as compared to the control.

Genotype	Moisture %	Ash %	Oil %	Fiber %	Protein %	Carbohydrate %
GM2	8.80^{a} (± 0.07)	3.33^{e} (± 0.04)	1.93^{bc} (± 0.30)	10.67^{c} (± 0.21)	30.52^{a} (± 0.20)	44.74^{d} (± 0.41)
GM8	8.63^{b} (± 0.05)	3.72^{bc} (± 0.06)	2.30^{ab} (± 0.16)	11.37^{b} (± 0.23)	25.80^{e} (± 0.34)	4818^{c} (± 0.36)
GM34	8.53^{c} (± 0.04)	4.96^{a} (± 0.07)	2.27^{ab} (± 0.07)	11.83^{a} (± 0.09)	28.60^{b} (± 0.31)	43.80^{e} (± 0.42)
GM9	8.50^{c} (± 0.07)	3.43^{d} (± 0.03)	2.47^{a} (± 0.20)	11.33^{b} (± 0.15)	25.97^{d} (± 0.24)	48.31^{c} (± 0.35)
GM6	8.37^{d} (± 0.10)	3.80^{b} (± 0.02)	1.70^{c} (± 0.13)	10.53^{d} (± 0.14)	26.83^{c} (± 0.21)	48.77^{b} (± 0.51)
L53 (Control)	8.23^{e} (± 0.05)	3.63^{c} (± 0.03)	2.30^{ab} (± 0.14)	10.73^{c} (± 0.12)	25.30^{f} (± 0.31)	49.80^{a} (± 0.43)
L.S.D	0.0636	0.0935	0.3723	0.1344	0.1261	2.22814

*Means not sharing the same letter in the same Colum are significantly different (P ≤ 0.05).
*Each value in the table is a mean of three replicates ± S.D
*Carbohydrate by difference

Table 3: Chemical composition of guar seed from different lines as compared to control sample.

differences (P ≤ 0.05) between all tested samples and the control. The results obtained in this study lie within the range from 0.020 to 0.095, reported by Sabah Elkhier [9], however they are comparable to the values ranging from 0.031 to 0.044 reported by Eldirany [8]. The small variations in optical density of extracted guar gum might be attributed to genetical factors.

Chemical composition of guar gums: The chemical components determined were moisture, protein, oil, ash, crude fiber and carbohydrate. The values obtained for these components in each of the five lines studied and the control sample are presented in Table 3.

Moisture content (%): Table 2 shows that moisture content of all lines investigated ranged from 8.37 to 8.80%. The highest value of moisture content (8.80%) was found in line GM2, while the lowest value (8.37%) was found in line GM6. There was no significant difference (P ≤ 0.05) in moisture content among the tested lines, however lines GM34 and GM9 did not show significant difference (P ≤ 0.05) in their moisture content. The moisture content of the standard commercial cultivar was 8.23%, a value lower than those obtained for each of the five lines and was significantly different (P ≤ 0.05) from all lines under study. The values of moisture obtained in this study are higher than the range of 7.10% to 8.19% reported by Sabah Elkhier [9] in guar gum and the values from 5.5% to 5.9% lower than values obtained by Elsiddig and Khalid [12].

Ash content: Table 3 shows that the ash content of the five lines ranged from 3.33% to 4.96%, with line GM34 having the highest value and line GM2 the lowest value. Significant differences (P ≤ 0.05) in ash content were observed among the tested lines. The ash content of the control was 3.63%, which was not significantly different from all lines. Lower values ranging from 0.5% to 1% were reported by Elsiddig and Khalid [12]. Values within the range obtained in this study were found by Eldow [11] who reported ash content ranging from 3.25% to 3.75% in guar seed. Higher values of ash were found by Elsiddig and Khalid [12] who reported a range from 5% to 6.5%. Higher ash content ranging from 5% to 5.54% were also reported by Eldirany [8]. The variation in ash content may be due to genetic factors and environmental factors under which plant was grown.

Oil content: Oil content ranging from 1.70% to 2.47%, were obtained from the five lines. The highest value 2.47% was from line GM9 while the lowest value 1.70 was from line GM6 (Table 3). The difference in oil content was significant (P ≤ 0.05), among the lines, however lines GM8 and GM34 did not show significant difference (P ≤ 0.05) between them. The oil content of the control was 2.30% a value relatively like that obtained from the five lines under study. GM8 and GM34 were not significantly different (P ≤ 0.05), however a significant difference (p ≤ 0.05) was found between GM2 and the other five lines. The results of oil content obtained are comparable to the values of 1.47 to 2.2% reported by Elsiddig and Khalid [12]. The obtained values were lower than the values found by Saba Elkhier [9] who reported ranges of 3.04% to 3.27% and 0.87% to 5% respectively. The variation in the oil content may be affected by genetic factors and environmental condition.

Crude fiber content: The results (Table 3) showed that crude fiber content of all lines investigated ranged from 10.53% to 11.83%. The highest value of fiber content (11.83%) was found in line GM34, while the lowest value (10.53%) was found in line GM6. Significant differences (P ≤ 0.05) in crude fiber content were observed among the tested lines, however lines GM8 and GM9 showed no significant difference (P ≤ 0.05) in their crude fiber content. On the other hand the control sample crude fiber was significantly different (P ≤ 0.05) from all tested samples with the exception of line GM2. Earlier findings showed crude fiber content in guar seeds to range from 12% to 13.8%, 9.03% to 10.1%, 8.48% to 9.37%, and 7.78% to 9.56% [8,9,11] respectively. The variation in the crude fiber content among genotypes might be attributed to genetic variation.

Protein content: The results showed that protein content of the five lines ranged from 25.80% to 30.52%. The highest value of protein (30.52%) was found in line GM2, while the lowest value (25.80%) was in line GM8. Significant differences (p ≤ 0.05) were observed among all lines and between lines and control while gave the lowest protein

content. The results obtained in this study are lower than value of protein ranging from 37.6% to 42.80% reported by Eldirany [8] and higher than the values ranging from 16.6% to 20.5% reported by Elsiddig and Khalid [12]. Sabah Elkier [9] found crude protein of guar seed in the range from 25.3% to 26.62%. Values ranging from 28.17% to 29.62% from guar seed were reported by Eldaw [11]. The variation in protein content obtained from the five lines and those reported from each line wish could be attributed to genetical variation.

Carbohydrate content: The carbohydrate content of the lines investigated ranged from 43.80% to 48.77%. The highest value of carbohydrate content (48.77%) was found in line GM6, while the lowest value (43.80%) was found in line GM34 (Table 3). significant differences ($P \leq 0.05$) carbohydrate content were observed among the tested lines. However, lines GM8 and GM9 did not show significant difference ($P \leq 0.05$) in their carbohydrate content. The carbohydrate content of the control was 49.80%, a value which was higher than the tested lines carbohydrate content. The results obtained in this study concerning carbohydrate content were higher than the values ranging from 30.25% to 38.57% reported by Eldirany [8] in guar gum and is lower than the values ranging from 58.5% to 60.7% reported by Elsiddig and Khalid [12]. Eldaw [11] reported carbohydrate content in guar seed to range from 44.8% to 47.1%. The variation in carbohydrate (as glactomanan) content among the different genotypes might be also attributed to genetical variation [13-16].

Conclusion

In conclusion, all five lines investigated are characterized by possessing physical and chemical properties related to those of the control sample and those found in earlier reports. Line GM2 and GM6 showed the best physical and chemical properties related to those of the control sample and those reported earlier from previous findings.

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