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Physicochemical Properties of for New Genotypes of Guar Seeds (*Cyamopsis Tetragonoloba L.*)

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Abstract

The objective of this work was to study the physicochemical properties of four new guar genotypes (GM5, GM6, GM9 and GM34) collected from the experimental farm, University of Khartoum- Shambat. Proximate composition, Tannin content, One thousand Kernel weight, Hectoliter weight, seeds components and hard seeds percentage were carried out for the guar seeds. Result obtained showed that genotypes GM5 and GM34 significantly ($P \leq 0.05$) had a highest value of 1000-kernel weight compared to the genotypes GM6 and GM9. Genotype GM5 gave the significant ($P \leq 0.05$) lowest percentage for hard seeds (11.67%) fallowed by GM34 (17.67%) and GM6 (20.67%), while the genotype GM9 gave the highest value (24.33%). Proximate analysis of guar seeds showed that the genotype GM6 had a significant ($P \leq 0.05$) highest protein content (42.8%), while the genotype GM34 gave the lowest value, and also Genotype GM34 gave a significant ($P \leq 0.05$) highest value for ash content (5.54%), while carbohydrate (gum content) of GM5 gave significant ($P \leq 0.05$) highest value (38.58%) fallowed by GM9 and GM34, but the genotype GM6 gave a significant ($P \leq 0.05$) lowest value of carbohydrate (gum) content (30.26%). Tannin content was significantly ($P \leq 0.05$) lower in GM5 (0.030%) The GM5 and GM6 were ranked as the better genotypes in physicochemical properties.

Keywords

Genotype, Hectoliter, Guar Seeds, Kernel, Tannin, Hard Seeds, Physicochemical

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1. Introduction

The guar plant also known as Cluster Bean (*Cyamopsis tetragonoloba (L) Taub)*, is a drought hardy leguminous crops. Guar is being grown for seed, green fodder, vegetable and green maturing. It is annual plant, about 4 feet high, vertically stacked, with large leaves and clusters of pods. Each pod is about 5-8 cm long with an average 6-9 small greyish white pea shaped seeds. The pods are used as green vegetable or as cattle feed besides the industrial extraction of guar gum (Sharma, et al, 2007). The plant flower buds start out white and change to a light pink as the flower opens. The flowers turn deep purple and are followed by fleshy seed pods which ripen and harvested in summer (Whistler and Hymouitz, 1979). A growing season of guar is 15 to 16 weeks and requires reasonably warm weather and moderate flashing rainfall with plenty of sunshine (Sharma, et, al 2007).

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The Guar seed matured in 120-145 days depending on irrigation practices and location. The crop is sown after the first rain in June and July (Whistler and Hymowitz, 1979). Harvesting occurs 50-80 days after planting in October-November (Premsaker and Venkataraman, 1962). The Guar is a naturally rain fed crops. Depending on the monsoon rainfall, the total size of Guar Crop varies from year to year. After harvesting, when the pods become dry through sunlight, they are beaten off and during this process, the seeds come out of the pod (Whistler and Hymowitz, 1979). It is mainly grown in India, Pakistan, Sudan and USA. India produce 6.0 to 7.5 million tons of guar annually. It contributes to around 80% share in the world total production (Sharma et, al 2007).Various exporters and manufacturers export guar splits, Guar gum powder and its derivatives.

All over the World the major importing countries of guar gum and its derivatives are USA, Germany, Italy, China, Denmark, France and UK, (Sharma et, al 2007). In Sudan, the guar plant was tried at Gezira Research Station as early as 1930 ,(Flower man, 1987). When the guar crop was found as a wild plant in the Red Sea Mountains and Arashekol mountains at White Nile State. (Anon,1990). The Sudanese Guar Gum Company was established at Singa in 1996. The guar seeds are contained in pods each pod is about 5-8 cm long and has an average 6-9 small, greyish –white pea shaped seeds. The color of seed varied from green to brown color ,and the size of seeds ranged from small to large but the small seeds are not desirable (Whistler and Hymowitz ,1979). According to Eldaw,(1998), the thousand seeds weight of guar ranged from 21.5g to 32.65g .Sabah Elkhier ,(1999), found that the thousand seeds weight of guar ranged from 35.6g to 35.7g. The hectoliter weight it is the bulk density measurement that indicates the weight of seeds per unit volume (gram/litre).

Eldaw,(1998), reported that the hectolitre weight of guar seeds ranged from 830.30 (g/l) to 857.85(g/l). The hard seeds can affect the granulation of the powder and purification of gum fractions .Eldaw ,(1998), reported the hard seeds percentage of three cultivars of guar ranged from 5.98 to 13.60%, Sabah Elkhier,(1999), found that the hard seeds percentage ranged from 21.7 to 22.15%.

Guar seeds contain three parts: hulls (seed coat), germ and endosperm. The endosperm is the commercially available guar flour entering into ever-expanding industrial markets. The Guar Germ, or guar protein is potentially available for human consumption and could add significantly to the world's protein supply, which providing increased vegetable protein for human dietary need. Regrettable guar protein as germ is presently mixed with the hulls for sale as cattle feed (Whistler and Hymowitz, 1979). Surprisingly, although guar primary is grown for its gum contents, very little is known about the variable in the seed of *Cyamopsis tetragonoloba*, (Whistler and Hymowitz, 1979). According to Goldstein and Alter, (1959) the three major components of guar seeds are the seed coat (14-17%), endosperm (35-42%), and germ (43-47%), while, Whistler and Hymowitz, (1979) found that the endosperm components comprise 35-42% of the seed, (13.48-14.05%), endosperm (35.0-39.9%), and germ (43.3-44.2%). Also, Sabah Elkhier, (1999) found that the seeds consists of seed coat (30-33%), endosperm (27-30%) and germ (43-47%). The Germ contains most of the protein in the seed while the endosperm contains the galactomannan gum (Whistler and Hymowitz, 1979).

The objective of the study is to evaluate the four new guar genotypes (GM5, GM6, GM9 and GM34) and to study their chemical composition, and physical properties.

2. Materials and Methods

2.1. Guar Seeds

Four guar genotypes (new genotypes) GM5, GM6, GM9 and GM34 were obtained from Department of Agronomy Faculty of Agriculture, University of Khartoum, were used in this study. These genotypes were planted during (2007-2008) season at Shambat area, Experimental farm of the Faculty of Agriculture, U of K. After harvesting, guar seeds were subjected to remove broken seeds, soil particles and foreign materials.

2.2. Preparation of Guar Seeds for Analysis

Guar seeds were ground to fine particle size using milling machine and sieved by (0.4 mm mesh sieve) and stored in polyethylene bags and keep in refrigerator at 7°C for further analysis.

2.3. Methods

2.3.1. General Properties of Guar Seeds

1. Thousand kernel weight (g):

It was determined according to AOAC (1984).

2. Hectoliter weight (g/liter):

Using a test weight measuring device, the weight was measured and recorded in (g/liter) (ICRISAT, 1986).

3. Hard seeds (Percentage):

It was determined according to Hulse et al, (1977). Hundred seeds of guar were randomly taken, soaked in distilled water for about 12 hours, the hard seeds (un soaked) were selected, counted and then the hard seeds percentage was calculated as follows:

$$\text{Hard seeds}(\%) = \frac{\text{No. of Hard seeds}}{\text{Total No. of socked seeds}}$$

2.3.2. Determination of Guar Seeds Components

It was determined according to (Bureng 1996). Five grams of guar seeds were weighed, and then soaked in 100 ml distilled water for about 10 hours, and manually separated into hulls, endosperms and germs, then these were oven dried. Each parts (Hull, germ and Endosperm) were weighed separately until constant weight was reached, the percentage of each part was calculated as follows :

$$Part\ \% = \frac{X}{5} \times\ 100$$

Where:

X = weight of sample.

2.3.3. Chemical Composition of Guar Seeds

(i) Proximate analysis:

Moisture, lipid, ash, total nitrogen (micro-Kjeldahl) of guar seeds were determined according to AOAC (1995). Crude protein was calculated as N% × 6.25. Carbohydrate was calculated by difference Crude fiber content was determined according to the acid/alkali digestion method of AOAC(1984).

(ii) Tannin contents:

Vanillin - Hcl in methanol reagent method was used to assay tannin (Price & Butlet, 1977). Catechin was used as reference standard.

2.4. Statistical Analyses

Replicate of each sample was analyzed using statistical system, the analysis of variance was performed to examine the significant effect in all parameters, Least Significant Difference test (LSD test), was used to separate the means (Peterson, 1985).

3. Results and Discussion

3.1. Physical Properties of Guar Seeds

The physical properties of the four guar genotypes; GM5, GM6, GM9 and GM34, results are shown in Table (1) and (2).

Seeds Color and Size:

Table (1) shows the color and size of guar seeds. The color is glassy to greenish for all the samples. All genotypes have large seeds except GM6 which has large –medium size seeds, (plate 1,2,3 and 4).

3.2. Thousand Kernel Weight (Gram)

As can be seen from Table (2) the values of thousand kernel weight of different genotypes of guar were 31.57g (for GM5), 30.7g (for GM6), 30.8g (for GM9) and 31.3g (for GM34). It is noticed that there is insignificant difference (P≥0.05) in 1000-kernel weight among genotypes GM5 and GM34 and among genotypes GM6 and GM9, but significant difference (P≤ 0.05) between genotypes GM5 and GM34 (from one side, which gave highest values) and genotypes GM6 and GM9 on the other side (which gave lowest values) was observed. These results agree with the results reported by Eldaw, (1998) which read as the 1000-kernel weight of guar seeds to range from 21.5g to 32.65g, but were lower than those reported by Sabah Elkhier, (1999) which read a range of 35.6g to 35.7g. The variation in 1000-kernel weight among genotypes might be attributed to genetic variation and environmental conditions.

Table (1). Color and Size of Guar Seeds.

Genotype	Color	Size
GM5	Glassy-greenish	Large
GM6	Glassy-greenish	Large-medium
GM9	Glassy-greenish	Large
GM34	Glassy-greenish	Large

Table (2). Physical properties of guar seeds.

Genotype	1000-Kernel weight (g)	Hectoliter weight (g/L)	Hard Seeds (%)
GM5	31.57 (±0.34) [a]	848.7(±8.6) [a]	11.67 (±2.8) [c]
GM6	30.7 (±0.14) [b]	852.7 (±2.8) [a]	20.67 (±1.7) [b]
GM9	30.8 (±0.47) [b]	841.0(±2.1) [a]	24.33 (±3.4) [a]
GM34	31.3 (±0.08) [a]	848.8 (±6.4) [a]	17.67 (±0.47) [b]

*Means not sharing a common letter in the same column are significantly different (p≤0.05).
*Each value in the Table is a mean of three replicates ±S.D

3.3. Hectoliter Weight

Table (2) shown the values of hectolitre weight (gram/litre) of guar seeds genotypes: GM5, GM6, GM9 and GM34. It is observed that the variation in hectolitre weight is insignificantly (P≥0.05) different among genotypes. The values of hectolitre weight of guar seeds genotypes GM5, GM6, GM9 and GM34 ranged from 841.0(g/L) (GM9) to 852.7 (g/L) (GM6) which was comply with the values 830.30 to 857.85 (g/L) obtained by Eldaw, (1998).

3.4. Hard Seeds Percentage

Table (2) gives the degree of hard seeds percentage from guar seed genotypes. It is found that the variation in hard seeds percentage did not show significant (P≥0.05) difference between genotypes GM6 and GM34, but significant (P≤0.05) difference was noticed between them and genotypes GM9 and GM5, also a significant difference (P≤0.05) between

genotypes GM9 and GM5 was observed . The values of hard Seeds (%) of guar seeds genotypes were 11.67 for (GM5), 20.67 (for GM6), 24.33 (for GM9) and 17.67 (for GM34). These results are higher than the values reported by Eldaw, (1998), which ranged from 5.78-13.6%, while the values of genotypes GM5, GM34 and GM6 are lower than the values ranged from 21.75 to 22.15%, which reported by Sabah Elkhier, (1999), except the value of genotype GM9 which was higher than the values reported by the same authors. The variation in hard seeds percentage may be due to genetic factors.

3.5. Guar Seed Components

3.5.1. Hull

The average of hull percentage of genotypes was found to be 13.77%, 13.8%, 14.08% and 14.14% for GM6,GM5, GM34 and GM9 guar seeds genotypes respectively,(Table 3) .The results obtained from genotypes GM34 and GM9 were similar to the values ranged from 14-17% reported by Goldstein and Alter,(1959) ; Whistler and Hyniwitiz,(1979), but the values of genotypes GM5 and GM6 are higher than the values reported by the same authors. Results indicated observed were comparable to the values ranged from 13.48 to 14 .05% reported by Eldaw (1998), but were lower than the values (30-33%) reported by Sabah Elkhier (1999). It is observed that there were insignificant (P≥ 0.05) differences in the hull percentage between the genotypes studied.

3.5.2. Endosperm

The values of endosperm content (gum content) was found to be 37.04%, 37.08), 37.3% and 37.82% for GM5, GM34, GM6 and GM9, respectively (Table 3). It is noticed that the variation in endosperm contents, was insignificantly (P≥ 0.05) different among genotypes.

Table (3). Guar Seeds Components.

Genotypes	Hull (%)	Endosperm (%)	Germ (%)
GM5	13.80 (±0.29) [a]	37.03 (±0.5) [a]	48.60 (±0.00) [a]
GM6	13.77 (±0.12) [a]	37.3 (±0.08) [a]	48.86 (±0.08) [a]
GM9	14.14 (±0.28) [a]	37.82 (±0.33) [a]	47.90 (±0.54) [a]
GM34	14.08 (±0.08) [a]	37.08 (±0.6) [a]	48.03 (±0.54) [a]
L.S.D	0.40	0.79	0.70
C.V%	1.9	1.39	0,96
S.E±	0.08	0.15	0.13

*Means not sharing a common letter in the same column are significantly different (p≤0.05).
*Each value in the Table is a mean of three replicates ±S.D

These results are comparable to the values ranged from 35 to 42% as reported by Goldstein and Alter (1959); Whistler and Hymwitz (1979) and Eldaw, (1998), but were higher than the results obtained by Sabah Elkhier, (1999), which was ranged from 27 to 30%.

3.5.3. Germ

The values of germ content of guar seeds were found to be 47.9%, 48.03%, 48.6% and 48.86% for GM9, GM34, GM5 and GM6, respectively, (Table 3). It is observed that the variation in germ contents of genotypes seeds was insignificantly (P≥0.05) different among the four guar seeds genotypes. These results are higher than the results ranged from 43% to 47% obtained by Whistler and Hymowitz, (1979); Sabah Elkhier (1999), and Eldaw (1998); the variation of germ content of guar seeds may be due to genetic factors and environmental conditions.

3.6. Chemical Composition of Guar Seeds

3.6.1. Moisture Content (%)

Data in Table (4) shows that the moisture content of four guar seeds genotypes were found to be 7.25%, 9.5%, 9.75% and 10.66% for GM5, GM34, GM6 and GM9, respectively. It is clear that there were insignificant differences (P≥ 0.05) among genotypes GM6 and GM34, but a significant difference (P≤ 0.05) between them and genotypes GM9 and GM5 was noticed, and also significant difference (P≤ 0.05) between genotypes GM9 andGM5 was observed. These results are lower than the values ranged from 10% to 15% reported by Whistler and Hymowitz (1979), but higher than the means value 6% obtained by Thomas, et al., (1980), and values 5.5% to 5.9%, reported by Elsiddig and Khalid, (1999). Moisture content of genotypes GM6, GM34 and GM9 were comparable to the values ranged from 9.05% to 12.4% reported by Eldaw, (1998), but genotype GM5 value comply with the result reported by Sabah Elkhier (1999). The variation in the moisture contents of guar seeds of different genotypes may be due to genetic variation and relative humidity of the surrounding atmosphere at harvest and during the storage time.

3.6.2. Protein Content

Table (4) shows that the average of protein content of four guar seeds genotypes was found to be 42.80%, 38.73%, 38. 52% and 37.61% for GM6, GM9, GM5 and GM34, respectively. It is observed that the variation in protein content of guar seeds was insignificantly different (P≥ 0.05) between genotypes GM5 and GM9 but significant difference (P≤ 0.05) between them and genotypes GM6 and GM34, and also significant different (P≤ 0.05) between genotypes GM6 and GM34, was observed. These results are higher than the values ranged from 28.17% to 29.6 reported by Eldaw, (1998) and the range values of 16.7 - 20.5% reported by Elsiddig and Khalid, (1999). This value is relatively similar to the result ranged from 25.3% to 42% of proteins content for guar seed obtained by Thomas et al., (1980), it is also, same with the findings reported by Sabah Elkhier (1999). The variation

in protein content of the genotypes in this study may be attributed to genetic factors and environmental conditions .

3.6.3. Oil Content

Table (4) shows the analytical data of oil content of guar seeds for genotypes GM5 (2.21%), GM6 (2.77%), GM9 (2.43%) and GM34 (2.29%). It is observed that the variation in oil content of the different guar seeds is insignificantly (P≥ 0.05) different.

Table (4). Chemical Composition and Tannin content (%) of Gaur Seeds.

Geno type	Moisture (%)	Crude protein (%)	Crude oil (%)	Ash (%)	Crude fiber (%)	Carbohydrate (%)	Tannin (%)
GM5	7.253 [c] (±0.2)	38.524 [b] (±0.4)	2.214 [a] (±0.04)	4.757 [b] (±0.1)	8.675 [b] (±0.027)	38.578 [a] (±0.41)	0.0303 (±0.001) [b]
GM6	9.746 [b] (±0.05)	42.801 [a] (±0.2)	2.765 [a] (±0.04)	4.858 [b] (±0.11)	9.569 [a] (±0.13)	30.259 [c] (±0.26)	0.0638 (±0.002) [a]
GM9	10.658 [a] (±.006)	38.733 [b] (±0.39)	2.428 [a] (±0.25)	4.821 [b] (±0.08)	7.788 [c] (±0.04)	35.671 [b] (±0.45)	0.0611 (±0.0026) [a]
GM34	9.506 [b] (±0.38)	37.610 [c] (±0.043)	2.292 [a] (±0.01)	5.543 [a] (±0.05)	9.547 [a] (±0.20)	35.50 [b] (±0.82)	0.0594 (±0.00) [a]
L.S.D	0.16	0.72	0.34	0.32	0.585	0.977	0.00339
C.V %	1.86	1.20	9.49	4.33	4.32	1.84	0.35
S.E±	0.05	0.14	0.06	0.06	0.11	0.2	0.00068

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

These results are higher than the values ranged from 1.42 to 1.78% reported by Eldaw, (1998), but agree with the results reported by Thomas *et, al* (1980), which findings ranged from 0.87 to 5%, and relatively comply with the results 1.47 to 2.2% obtained by Elsiddig and Khalid, (1999), but lower than findings obtained by Sabah Elkhier, (1999) which ranged from 3.04 to 3.27%. The variation in the oil content may be controlled by genetic factors and environmental conditions.

3.6.4. Ash Content

As shown in Table (4) the ash content of four guar seeds genotypes was found to be 4.76%, 4.86%, 4.82% and 5.54% for GM5, GM6, GM9 and GM34, respectively. It is noticed that there were insignificant (P≥ 0.05) differences among genotypes GM5, GM6, and GM9 (with lower values), but a significant (P≤0.05) difference between them and genotype GM34 (higher value) was noticed. These results are higher than the values ranged from 0.5 to 1% reported by Elsiddig and Khalid (1999) and values 3.25 to 3.75% obtained by Eldaw(1998), but are agree with the results reported by Sabah Elkhier, (1999) which read as 4.25 to 9.99%. The variation in ash content may be due to genetic factors and environmental factors under which plant materials were tested.

3.6.5. Crude Fibre Content

Table (4) shows the crude fibre content of the seeds of four guar genotypes GM5 (8.68%), GM6 (9.57%), GM9 (7.79%) and GM34 (9.55%).It is observed that the variation in crude fiber content was insignificantly (P≥ 0.05) differences between genotypes GM6, and GM34, but significantly different (P≤ 0.05) between them and genotypes GM5, and GM9 and significantly different (P≤0.05) between genotypes GM5, and GM9. These results are lower than the values (12%to 13.8%) reported by Thomas et, al, (1980) but are relatively similar to the results 7.47 to8.95% reported by Elsiddig and Khalid, (1999).But are in agreement with the results reported by Eldaw, (1998) which read as ranging from 8.48 to 9.37%, crude fibre content of GM6 and GM34 are comparable to values ranging from 9.03 to 10.1% obtained by Sabah Elkheir, (1999).The variation in the crude fibre content among genotypes might be attributed to genetic variation and environmental conditions.

3.6.6. Carbohydrate Content

Data in Table (4) shows that the carbohydrate content of guar seeds was found to be 38.58%, 30.26, 35.67 and 35.50% for GM5, GM6, GM9 and GM34 genotypes, respectively. It is noticed that there were insignificant difference (P≥ 0.05) between genotypes GM9, and GM34, but significant difference(P≤ 0.05) between them and genotypes GM5 and GM6, and a significant (P≤ 0.05) difference between genotypes GM5 and GM6 was observed. These results are higher than the value 30% reported by Thomas et al, (1980), but lower than those ranged 44.8% - 47.1% reported by Eldaw, (1998), but is still lower than the value 58.5% to 60.7% obtained by Elsiddig and Khalid (1999). Also matching with the range of 26.47% to 40.48% reported by Sabah Elkhier (1999).Variation in carbohydrate (as glactomanan) content among the different genotypes might be attributed to genetic variation and environmental conditions.

3.6.7. Tannin Content

As shown in Table (4), the tannin content of guar seeds was found to be 0.030%, 0.064, 0.0611 and 0.059 for GM5, GM6, GM9 and GM34 genotypes, respectively. It is observed that the variation in the tannin content of four guars seeds genotypes was insignificantly ($P \geq 0.05$) different between genotypes GM6, GM9 and GM34, but significantly different ($P \leq 0.05$) from genotype GM5.This result is in conformity with the range of 0.024 to 0.95% obtained by Sabah Elhkier, (1999).The variation in the Tannin content of guar seeds may be due to genetic variation and environmental conditions.

4. Conclusion

The genetic variation and environmental conditions have affected on the chemical composition and physical properties of guar seeds. The genotype GM6 has a highest content of protein. The genotype GM5 has lowest content of tannin. The GM5 and GM6 were ranked as the better genotypes in physicochemical properties.

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