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Biochemical characterization of garlic (*Allium sativum* L.) genotypes differ in total soluble solid content

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Abstract
Garlic (*Allium sativum* L.) possesses an important role as medicinal and spices, quality of garlic plays major contribution in the fulfilling of its role. After screening, twenty one genotypes were selected for study based on their total soluble solid content (10 had high soluble solid content and 11 were with low soluble solid content). Proximate parameters observed were total soluble solid content, total sugar, non-reducing sugar, reducing sugar, crude protein, dry matter, moisture, ash, crude fat, energy value which were 42.5°Brix, 4.6 mg %, 2.3 mg %, 2.3 mg %, 8.6%, 40%, 59.9%, 4.1%, 0.25%, 55.36 Kcal, respectively.

Keywords: Garlic, proximate parameters, total soluble solid, *Allium sativum* L

Introduction
Garlic (*Allium sativum* L.) is the second most important bulb vegetable grown and used as spice and flavoring agent for many foods (Velisek *et al.*, 1997) [12]. "*Allium*" is the largest and the most important representative genus of the *Alliaceae* family that comprises 700 species, widely distributed in the North America, North Africa, Europe and Asia (Tsiaganis *et al.*, 2006) [11]. It contains a higher concentration of sulfur compounds than any other *Allium*s species. The sulfur compounds are responsible both for garlic's pungent odor and many of its medicinal effects. Ancient Chinese and Indian medicine recommended garlic to aid respiration and digestion and to treat leprosy and parasitic infestation. These effects have been largely attributed to *i*) reduction of risk factors for cardiovascular diseases, *ii*) reduction of cancer risk, *iii*) antioxidant effect, *iv*) antimicrobial effect, and *v*) enhancement of detoxification of foreign compound (Leyla, 2014) [7]. At present keeping quality is a burning problem in storage of garlic. As garlic has an important role as medicinal and spices, quality of garlic plays major contribution in the fulfilling of its role. Many industries has been established for making powder from the garlic bulb. So, for getting higher dry powder, soluble solid content is a deciding criteria. Among 150 garlic genotypes, used for screening based on total soluble solid content, 21 genotypes were used for several biochemical analysis.

Experimental Methods
Sample collection
Total 150 genotypes of Garlic were screened and out of them, 21 genotypes were selected (Differ in total soluble solid content). The genotypes were collected from Vegetable Research Station, Junagadh Agricultural University, Junagadh.

Proximate parameters
Total soluble solids
An equal number of drops from the prepared garlic slice were placed onto the refractometer prism plate. A refractometer measures TSS as °Brix. The hand-held refractometer was used (Robert and Bradley, 2010) [9].

Total sugar content
Total Sugar content measured by Phenol Sulfuric acid method with some modifications. In hot acidic medium glucose is dehydrated to hydroxymethyl furfural. This forms a green coloured product with phenol and colour intensity read at 490 nm.

The total carbohydrate content was calculated with the help of a reference curve prepared by using glucose as standard and expressed as mg % (Dubois *et al.*, 1956) [6].

Reducing sugar

The reducing sugars was estimated by DNSA method. The absorbance read at 540 nm. The reducing sugar was calculated with the help of a reference curve prepared by using glucose as standardand expressed as mg % (Miller, 1959) [8].

Non-reducing sugar

The non-reducing sugar was calculated by difference of total sugar and total reducing sugar content and expressed as mg %.

Crude protein

Samples were analyzed for crude protein content according to the Kjeldahl's method as described in A.O.A.C. (2006) [1], which involved protein digestion and distillation.

The total organic nitrogen was then calculated using the formula:

% Nitrogen = (R-B) × N of acid × 0.014 × 100 / W.

Where, R = Required hydrochloric acid for sample to titrate sample, B = Volume (ml) of acid required to titrate the blank; N of acid= Normality of acid; W=Weight of sample (g).

Then, percentage crude protein in the sample was calculated from the % Nitrogen as % crude protein = % N x 6.25.

Total moisture

The moisture content of garlic samples was determined in a hot air oven through drying method according to the procedure described in A.O.A.C.(2006) [3] Method with minor modifications. The moisture content of the samples was determined by weighing 1 g of sample into a petri plate and dried at a temperature of 95 °C for 3 hour in hot air oven. The calculation of moisture content was done by using following formula.

Moisture (%) = [{(Wt. of fresh sample – Wt. of oven dried sample) / Wt. of fresh sample} × 100]

Ash

Ash is an inorganic residue remaining after the material has been completely burnt at a temperature of 600 °C in a muffle furnace. It is the aggregate of all nonvolatile inorganic elements (A.O.A.C., 2006) [2]. The % ash content in the garlic sample was calculated as follows: Ash (%) = (Wt. of ash / Wt. of sample taken) × 100

Crude fat

The crude fat in the sample was determined using Soxhlet extraction (A.O.A.C., 2006) [4].

Per cent fat in the sample was calculated using the formula:

Fat (%) = (Weight of flask + fat – Weight of empty flask) /weight of Sample (gm) × 100

Dry matter

Dry matter was calculated using the formula: Dry matter (%) =100-Moisture %

Energy value

The energy value of the sample was determined by multiplying the protein content by 4, carbohydrate content by 4 and fat content by 9 (Bhattacharjee *et al*., 2013) [5].

Energy Value= (Crude protein × 4) + (Total carbohydrate ×4) + (Crude fat × 9)

All the proximate and biochemical parameters were analyzed in three replications. The data obtained by proximate and biochemical constituents determination were subjected to simple completely randomized design (CRD) for study in the significance of various data (Snedecor and Cochran, 1967) [10].

Results

Total 150 genotypes were taken for screening on total soluble solid (TSS) content. The data observed ranged between 47.37to 36.17°Brix. Twenty one genotypes were selected for proximate study, Ten genotypes had high soluble solid content with 46.17°Brix (RGP-270) to 44.47°Brix (RGP-491) and 11 with low soluble solid content range from 36.43°Brix (RGP-474) to 40.20°Brix (RGP-607) as mentioned in Table 1.

Total sugar, reducing sugar and non reducing sugar content: The data observed on total soluble sugar are varied significantly and was ranged between 6.66-2.19 mg %. Which presented in Table 2. The highest value (6.66 mg %) of total sugar content found in the genotype RGP-1. while, the lowest value (2.19 mg %) of total sugar content was observed in the genotype RGP-7. Reducing sugar content differ significantly in the range of 4.46 to 1.05 mg % among the garlic genotypes. Genotype RGP-1 contained maximum value (4.46 mg %) for reducing sugar which was at par with RGP-77 (4.07mg%) while, genotype RGP-7 possessed the minimum value (1.05 mg %) for reducing sugar which was at par with RGP-602 (1.39 mg%), RGP-278 (1.40 mg%), RGP-607 (1.57 mg%) and RGP-270 (1.59 mg%). Non-reducing sugar content was found the highest (4.01 mg %) in the genotype RGP-270 which was at par with the genotype RGP-114 (3.79 mg%) and the lowest value (1.14 mg %) was observed in the genotypes RGP-7 and RGP- 224 which was at par with RGP-501 (1.29 mg%), RGP-513 (1.36 mg%) and RGP-276 (1.50 mg%). The mean value for non reducing sugar content varied significantly between 4.01 to 1.14 mg % among the genotypes.

Crude protein, dry matter, crude fat: The data on energy value, crude protein, dry matter are presented in Table 3. Crude protein were varied significantly ranged between 6.83 to 10.43%. Minimum value of crude protein was recorded in the genotype RGP-3 with 6.83% which was at par with the genotype RGP-513 (6.96%), RGP-66 (7.15%) and RGP-560 (7.26%) while, maximum crude protein content 10.43% was observed in the genotype RGP-585 which was at par with RGP-607(10.01%), RGP-7 (10.08%), RGP-182 (10.09%) and RGP-270 (10.13%). Dry matter varied significantly between 35.61 - 44.14% among the genotype. The genotype RGP-513 contained the highest value (44.14%) for dry matter which was at par with RGP-501 (42.73%) and RGP-224 (42.81%), while the genotype RGP-278 had the lowest value (35.61%) for dry matter which was at par with RGP-66 (36.16%). The value for crude fat content varied significantly among the genotypes and ranged between 0.112 to 0.592%. The maximum value for crude fat was observed in the genotype

RGP-114 with 0.592% which was at par with the genotype RGP-276 (0.502%) and the minimum 0.112% crude fat was recorded in the genotype RGP-224 which was at par with other 12 genotypes.

Total moisture, ash, energy value: Total Moisture content varied between 55.86-64.38% (Table 3). The significantly maximum value for moisture content was observed in the genotype RGP-278 with 64.38% which was at par with RGP-66 (63.84%) while, the genotype RGP-513 had the minimum (55.86%) value for moisture content. Ash content ranged between 3.05-6.92% among the genotypes. The lowest ash content was observed in the genotype RGP-491 (3.05%) which was at par with other 7 genotypes and the highest value 6.92% was observed in the genotype RGP-3. Energy value varied between 66-44.8 Kcal. The maximum energy value 66 Kcal was observed in the genotype RGP-182 and lowest energy value 44.86 Kcal was with the genotype RGP-66.

Conclusion

From ongoing discussion proximate parameters of twenty one garlic genotypes categorized as 10 with high soluble solid content and 11 with low soluble solid content ranged between 46.17 (RGP-270) to 36.43 (RGP-474). The information on genotypes with varied total soluble solid will facilitate in the selection of genotypes for getting higher dry powder. Biochemical constituent like Total sugar content, reducing sugar content, non-reducing sugar content, crude protein, total moisture, ash, crude fat, dry matter and energy value measured from 21 genotypes.

Table 1: Total Soluble Solids of Selected Genotypes of Garlic

Sr. No.	Name of genotypes with high TSS	Repre-sented as	TSS (°Brix)	Sr. No.	Name of genotypes with low TSS	Repres- ented as	TSS (°Brix)
1.	RGP-270	H1	46.17	1	RGP-474	L1	36.43
2.	RGP-245	H2	45.97	2	RGP-66	L2	37.13
3.	RGP-182	H3	45.87	3	RGP-7	L3	38.10
4.	RGP-278	H4	45.50	4	RGP-581	L4	38.30
5.	RGP-276	H5	45.43	5	RGP-602	L5	38.37
6.	RGP-1	H6	45.27	6	RGP-585	L6	38.87
7.	RGP-3	H7	44.73	7	RGP-513	L7	38.93
8.	RGP-501	H8	44.67	8	RGP-77	L8	39.33
9	RGP-114	H9	44.53	9	RGP-224	L9	39.83
10	RGP-491	H10	44.47	10	RGP-560	L10	40.13
				11	RGP-607	L11	40.20

Table 2: Total Sugar Content, Total Reducing Sugar, Non-Reducing Sugar, Crude Protein, Dry Matter and Crude Fat of different garlic genotypes

Sr. No.	Name of Genotype	Total Sugar (Mg %)	Reducing Sugar (Mg %)	Non-Reducing Sugar (mg %)	Crude Protein (%)	Dry Matter (%)	Crude Fat (%)
1	RGP-270	5.60	1.59	4.01	10.13	39.29	0.285
2	RGP-245	4.50	1.06	3.44	9.23	39.23	0.532
3	RGP-182	5.60	2.06	3.54	10.09	42.27	0.368
4	RGP-278	4.22	1.40	2.82	7.50	35.61	0.359
5	RGP-276	3.35	1.85	1.50	7.84	40.50	0.502
6	RGP-1	6.66	4.46	2.20	8.63	38.22	0.276
7	RGP-3	5.46	2.67	2.79	6.83	40.39	0.155
8	RGP-501	3.76	2.47	1.29	7.73	42.73	0.427
9	RGP-114	6.18	2.39	3.79	8.79	42.50	0.592
10	RGP-491	4.33	2.19	2.14	8.34	40.80	0.218
11	RGP-474	5.51	3.58	1.93	8.77	37.82	0.136
12	RGP-66	3.69	2.03	1.66	7.15	36.16	0.167
13	RGP-7	2.19	1.05	1.14	10.08	39.83	0.118
14	RGP-581	4.24	2.15	2.09	9.59	42.24	0.144
15	RGP-602	3.78	1.39	2.39	7.84	39.44	0.136
16	RGP-585	5.37	2.95	2.42	10.43	40.89	0.202
17	RGP-513	4.10	2.74	1.36	6.96	44.14	0.123
18	RGP-77	6.40	4.07	2.33	9.17	39.36	0.153
19	RGP-224	4.08	2.94	1.14	8.37	37.54	0.112
20	RGP-560	5.64	2.40	3.24	7.26	42.81	0.116
21	RGP-607	3.44	1.57	1.87	10.01	38.93	0.135
Mean		4.67	2.33	2.34	8.61	40.03	0.251
S.Em±		0.04	0.243	0.17	0.253	0.493	0.034
C.D. at 5%		0.11	0.682	0.47	0.75	1.48	0.110
C.V.%		5.84	3.14	3.42	0.145	0.56	0.612

Table 3: Ash, moisture and energy value of different garlic genotypes

Sr. No.	Name of Genotype	Ash (%)	Moisture (%)	Energy Value (Kcal)
1	RGP-270	5.18	60.70	65.48
2	RGP-245	5.25	60.76	59.70
3	RGP-182	4.02	57.72	66.07
4	RGP-278	3.74	64.38	50.11
5	RGP-276	3.80	59.50	49.27
6	RGP-1	4.18	61.78	63.64
7	RGP-3	6.92	59.61	50.55
8	RGP-501	3.94	57.26	49.80
9	RGP-114	5.96	57.50	65.20
10	RGP-491	3.05	59.20	52.64
11	RGP-474	4.27	62.18	58.34

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