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Physico- chemical characterisation of *Lepidium sativum* (Garden cress) GA-1 seed

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Abstract
The *Lepidium sativum* - GA1 variety seed was analysed for various physical and chemical characteristics. The average values for length, width, thickness were found to be 2.32 ± 0.17, 1.16 ± 0.09 and 0.88 ± 0.07 mm respectively while the geometric mean diameter and spherecity were 1.33±0.57 and 0.57±0.04 respectively. Weight of thousand grains was 1.51 ± 0.26g and the average values for true and bulk density were 1227.43 ± 41.60 and 724.07 ± 9.91 kg.m $^{-3}$. The value for porosity was 40.98 ± 1.41. The angle of repose (θ) and coefficient and friction for wood was 34.73± 0.45 and 0.57 ± 0.03. The seeds possess high nutritional value. The seed contains 5.67% moisture, 29.06% protein, 20.55% crude fat, 6.76% crude fibre, 5.8% ash and 38.26 % carbohydrate. The seed contains appreciable amount of essential Fatty acids (EFAs) with 29.79 % of linolenic acid, 11.16 % of linoleic acid and 12.89 % of arachidic acid. The seed contains various minerals with high amount of calcium (350.87mg/100g) and phosphorus (2313mg/100g).

Keywords: garden cress, brassicaceae, physical, chemical, fatty acids

Introduction
Lepidium sativum L. a medicinal plant belongs to *Brassicaceae* family. The plant is native to Egypt and west Asia and currently is growing in various parts of India, Europe and North America. The plant is commonly known as *Garden Cress* and in some regions of India, it is also known as *"Common cress", "Land cress*", "*Haliv*", "*Asalio*" or "*Chandrasur*" (Gokavi *et al.*, 2004) [9]. It is an annual, glabrous and erect plant having height upto 45 cm. Its flowers are white or pink in colour, arranged along a single central axis, pods are broad, rotund, elliptic, emarginated notched at apex and winged.
Due to its nutritional and therapeutic properties, the plant parts like leaves, roots as well as seeds of this plant are used in cooking. The Seeds of *Lepidium sativum* L. are small, oval shaped, about 2 - 3 mm long and 1 - 1.5 mm wide, pointed and triangular at one end, smooth, reddish brown, a furrow present on both surfaces extending up to two- thirds downward, a slight wing like extension present on the edges of seed.
Presence of certain volatile oils it has a pungent odour and was used in the past for the treatment of various conditions mainly for bone fractures, muscle pain, respiratory disorders and inflammation. Due to high nutritional value, Not only its leaves, but also seed and other arial parts have various bioactive compounds such as phenolics, alkaloids, flavonoids and glucosinolates which makes it useful for various therapeutic applications such as hepatoprotective, antihypertensive, diuretics, fracture healing, respiratory disorder healing, antimicrobial, milk production, anti-inflammation, antioxidant, laxative, chemoprotective (Falana *et al.*, 2014) [7]. Various research have been conducted to use its seed in preparation of various food such as biscuits (Zanvar and Devi, 2007) [17], ladoo and baal ahar (Agarwal and Sharma, 2011) [1], health drinks (Mohite *et al*., 2012) [12], protein isolate (Ali, 2013) [2] and many others.
The objective of the present study is to determine the physical properties of *Lepidium sativum* - GA1 so it can be useful in design and development of equipments for handling, cleaning and grading of the seed to minimize post- harvest losses and to study the nutritional composition of this particular variety so that it can be used in preparation of various food products to provide health benefits to the consumers.

Materials and Methods
A specific variety of *Lepidium sativum* - GA1 (Garden Cress) seeds were procured from Medicinal & Aromatic Plant Research Station, BACA, AAU. The seeds were cleaned to remove any extraneous matter and then stored in metallised aluminium pouches at ambient condition for further physico-chemical analysis by suitable method.

Physical Characteristics

Length, width and thickness of Garden Cress seeds

For determining the size of seeds, randomly 100 seeds were taken to measure three principle dimensions *viz*. length, width and thickness. Each seed was placed in its natural resting position on a sheet of paper**.** Measurements of dimension on the three mutually perpendicular axis were made, namely length, breadth and thickness using digital micrometre having the accuracy of 0.01 mm. The three parameters were later used to calculate geometric mean diameter and spherecity of garden cress seed (Mohsenin, 1986) [13].

$$\text{Geometric mean diameter } (D_g, \text{ mm}) = (L * W * T)^{\frac{1}{3}}$$

$$\text{Sphericity} = \frac{(L*W*T)^{\frac{1}{3}}}{L}$$

where, L is the length (mm), W is the width (mm) and T is the thickness (mm).

Note: Sphericity has no unit as it is the ratio of geometric mean diameter and largest diameter.

Weight of thousand grain

The thousand grain weight was determined by means of digital electronic balance having an accuracy of 0.01 g.

True density

The true density of garden cress seed was measured by using liquid displacement method. It is defined as the ratio of weight of grain to its volume displaced. In this method toluene was used in place of water because of its lesser absorbance tendency and low surface tension due to which it can fills even the shallow pores between the seed. True density was determined by filling up 50 ml of toluene in a 100ml graduated cylinder then approximaely 20g of seeds were slowly dipped in the toluene. The rise in volume of toluene was noted and the true density was calculated by using the formula given below (Mohsenin, 1986) [13].

$$\rho_t = \frac{W}{V} * 100$$

where, ρ_t is the true density (kg. m^{-3}), W is the weight of seeds taken (g) and V is the volume of displaced toluene (cm^{-3}).

Bulk density

Bulk density is defined as the mass of grain to its total volume and was determined by filling gently a cylinder of 50ml volume with seeds and taking the corresponding weight of seeds. No separate manual compaction of seeds was done. The whole process was repeated thrice and the readings were recorded (AOAC, 2012) [4]. The bulk density was calculated from weight of the seed and volume of the container.

$$\rho_b = \frac{W}{V} * 1000$$

where, ρ_b is the Bulk Density (kg. m^{-3}) W is the Weight of seeds (g) and V is the volume of the cylinder (cm^{-3})

Porosity

The porosity was calculated from bulk and true densities using the relationship as follows:

$$E = \left(1 - \frac{\rho b}{\rho t}\right) * 100$$

where, E is Porosity, (,%), ρ_b is Bulk density (kg. m^{-3}) and ρ_t is true density (kg. m^{-3})

Coefficient of friction

It is measured by placing approximately 250 g of seed on the tilting table made up of wood. The table is tilted from one side till half of the seed slips to the bottom and is measured by using the formula

$$\mu = \tan\theta = \frac{y}{x}$$

where, y is vertical distance and x is horizontal distance

Angle of repose

Angle of repose was calculated by using an apparatus containing a circular platform (100mm) surrounded by a metal funnel leading to discharge hole. Sufficient grains are filled up in the box above the circular platform and allowed to escape from the box, leaving a free-standing cone on the platform. The height of the cone is measured and angle of repose is calculated by the formula

$$\theta = \tan^{-1}\frac{2h}{D}$$

where, his height of the cone and D is the diameter

Color values

The colour of seeds was measured in accordance with CIE *L**, *a**, *b** colour space system with Lovibond Colorimeter (Model RT850i) based on the tri- stimulus value. It works on the principle of focusing the light and measuring the energy reflected from the entire visible spectrum. It expresses color as numerical values where *L** indicates whiteness (+) to darkness (-), *a** indicates redness (+) to greenness (-) and *b** indicates yellowness (+) to blueness (-). ΔE*ab is difference between two colours designated as two points in lab colour space which assigned to each of the L*, a* and b* attributes of two colours. The instrument was calibrated with white and black plate provided with the instrument. ΔE*ab value was taken for colour value of garden cress GA-1 seed. The experiments were conducted 3 times and the average values were reported.

Chemical Characterization

Standard AOAC procedures (AOAC, 2012) [4] were used for determination of moisture content (%), protein content (%), crude fat (%), cude fiber (%) and ash content (%).

Moisture content

The moisture content was determined by using hot air oven method in which 2g seed was dried in a clean, dry and pre-weighed moisture dish in the hot air oven (Make: NOVA Instruments Pvt. Ltd., Ahmedabad) at 105° ± 1°C till the final weight remained constant. The samples were cooled in desiccator and weighed after the sample attained room temperature. Three replications were taken and the data was recorded as the average values. The moisture per cent was calculated as

$$\text{Moisture content (\% w. b)} = \frac{W_1 - W_2}{W_1} \text{ X } 100$$

where, W_1 is the weight of seed (g) before drying and W_2 is the weight of seed (g) after drying

Fat Content

The seeds were ground in mixer and around 5g of sample was taken into a thimble and crude fat was determined by continuous extraction in a soxhlet assembly (Make: Pelican Equipments, Chennai) using hexane as a solvent for 8 hours until complete extraction was done. The solvent was then evaporated and fat content was determined gravimetrically using the formula given below

$$\text{Crude fat (\%)} = \frac{\text{Weight of fat}}{\text{weight of sample}} \times 100 \quad \text{…. (3.9)}$$

Protein content

Protein content of the seeds was determined by Micro-Kjeldahl method using Kel-plus automatic Micro- kjeldahl apparatus (Make: Pelican Equipments, Chennai). About 0.5-1g of sample was digested with digestion mixture (Potassium sulphate and Copper sulphate (5:1)) and 10 mL HCl at 420 ˚C. After distillation, the digested solution was distilled with 40 % NaOH and the liberated ammonia was trapped in 4% boric acid solution, using mixed indicator (Methyl red: Bromocresol green). The condensate was titrated with standard 0.1 N hydrochloric acid (HCl) until the blue green colour disappeared. For blank, the same procedure was followed except the sample. The per cent nitrogen was estimated and the protein content was quantified by multiplying with factor 6.25

$$\text{Nitrogen (\%)} = \frac{14 \text{ x N of acid x } (T - B) \text{ x } V^1 \text{ x} 100}{W \text{ x } V_2 \text{ x } 1000}$$

where, T is titre value burette reading (ml), B is blank burette reading (ml), N is normality of acid (N), W is weight of sample (g), V_1 is volume made up of digest (ml) and V_2 is aliquot of digest taken (ml)

Protein (%) = Nitrogen (%) x 6.25

Ash content

A known amount of sample was ignited in a slow flame using a burner and then incinerated in a muffle furnace at 550°C for 5-6 hours until grey ash was obtained. The percentage of total ash was calculated as follows:

$$\text{Ash (\%)} = \frac{W_2 - W_1}{W_3} \text{ X } 100$$

where, W_1 is weight of empty crucible (g) W_2 is weight of crucible + ash (g) and W_3 is weight of Sample (g)

Crude Fiber

Crude fiber was estimated in fat free system using Fibra-Plus equipment (Make: Pelican Equipments, Chennai). Approximately 1g of defatted sample was weighed in pre weighed fiber crucibles. The sample was then treated with 1.25% H_2SO_4 solution followed by 1.25% NaOH solution for 30 minutes. After each treatment, the sample was washed properly with distilled water to remove all the acid and alkali residues. The left-over residue in the crucible was dried in the hot air oven at 105 °C to a constant weight and then the sample was ignited in the muffle furnace. The loss in weight of the residue was used to calculate the percentage of crude fiber in the sample using the formula given below.

$$\text{Crude fibre (\%)} = \frac{W_2 - W_3}{W_1} \text{ X } 100$$

where, W_1 is weight of sample (g), W_2 is weight of crucible + sample after washing and drying (g) and W_3 is weight of crucible + ash (g)

Carbohydrates

Per cent carbohydrate content was determined by difference method by subtracting other constituents.

Carbohydrate (%) = 100- (Moisture + Protein + Fat + Ash+ Fiber)

Estimation of minerals

The analysis for mineral content was conducted at Micronutrient Research Centre, Anand Agricultural University, Anand using Inductive Couple Plasma-Optical Emission Spectrometry, ICP-OES (Model Optima 7000 DV). One gram of sample with 10 ml of concentrated nitric acid (HNO_3) was kept for digestion overnight. Diacid mixture (15 ml) of concentrated nitric acid and perchloric acid in the ratio 2:1 was added to the sample. The solution was heated inside the fume hood at 70° - 80° C until it becomes colorless. Then, the solution was cooled and filtered using muslin cloth. The volume of the filtrate obtained was made upto 50 ml using ultrapure water and finally the sample was used for the analysis

Fatty Acid composition of Garden Cress oil

Fatty Acid composition of Garden Cress oil was analysed at SICART, Sardar Patel University, V. V. Nagar by using Gas chromatography. The fatty acid methyl esters (FAMES) were prepared by using the method described by Christie (1992) and then analysis was done.

Results & Discussion

Physical properties of garden cress

The physical properties of the seeds are helpful in designing of machinery for harvesting, handling, dehulling drying, freezing etc. Size of the seed is important in designing screening and sieving machines.

The result of physical properties of *Lepidium sativum* GA- 1 variety is expressed in table 1.

Table 1: Physical characteristics of *Lepidium sativum* GA-1 seeds

Sr. No.	Parameters	Mean ± SD
1.	Length (mm)	2.32±0.17
2.	Width (mm)	1.16±0.09
3.	Thickness (mm)	0.88± 0.07
4.	Geometric mean diameter (mm)	1.33±0.57
5.	Spherecity	0.57±0.04
6.	Weight of thousand grains (g)	1.51± 0.26
7.	True density (Kg. m^{-3})	1241.58 ± 17.08
8.	Bulk density (Kg. m^{-3})	724.07± 9.90
9.	Porosity (%)	41.68 ± 0.45
10.	Angle of repose (θ)	34.73± 0.45
11.	Coefficient of friction	0.57 ± 0.03
12.	Color values	
	*L**	28.90 ± 1.13
	*a**	13.81 ± 0.80
	*b**	14.69 ±1.49
	*c**	20.18 ± 1.37
	h°	46.69 ± 2.80
	ΔE^* ab	3.00 ± 0.85

The minimum and maximum values for length, width and thickness were 2.05 and 2.80, 0.91 and 1.37 and 0.71 and 1.15 mm respectively. The average values for the same were 2.32 ± 0.17, 1.16 ± 0.09 and 0.88 ± 0.07 mm respectively. The geometric mean diameter ranged from 1.23 ± 0.59mm to 1.44 ± 0.60mm with average value of 1.33±0.57. The spherecity range were found to be 0.51 to 0.64 with average as 0.57 ± 0.04mm. The results were similar as that of Falana *et al.* (2014) [7] who reported that the seeds of garden cress are small, oval- shaped, triangular with pointing at one end. The seeds are smooth, 2-3 mm long, 1-1.5 mm wide and reddish brown in color.

Weight of thousand grains was observed as 1.51 ± 0.26g. The average values for true and bulk density were 1227.43 ± 41.60 and 724.07 ± 9.91 kg.m^{-3}. The value for porosity was 40.98 ± 1.41. The angle of repose (θ) was 34.73± 0.45 and the coefficient of friction for wood was 0.57 ± 0.03. The results were in the range of the values published by Razavi *et al.* (2007) [15] and Yenge (2017) [16]. The seeds were reddish brown in color with *L**, *a**, *b** values 28.90, 13.81 and 14.69 respectively.

Chemical properties

Proximate composition

The moisture content of *Lepidium sativum* GA-1 seed was found to be 5.67± 0.29 which was

The values for moisture content (%), protein (%) crude fiber (%), ash (%) and carbohydrate content of *Lepidium sativum* GA-1 seed were found to be in the range of 5.67± 0.29, 29.06 ± 0.81, 6.76 ± 0.43, 5.80± 0.0 and 38.26 ± 0.50 respectively. The results were in the range as reported by Gaafer *et al.* (2013) [8] except or the values of fat content. This variety contains less amount of crude fat (20.55±0.50) as compared to the reported ones.

Table 2: Chemical characterization of *Lepidium sativum* GA-1 seeds

Sr. No.	Analysis	Mean ± SD
1.	Moisture (%),	5.67± 0.29
2.	Protein (%)	29.06± 0.81
3.	Crude Fat (%)	20.55 ±0.50
4.	Crude Fibre (%)	6.76 ± 0.43
5.	Ash (%)	5.8 ± 0.18
6.	Carbohydrate (%)	38.26± 0.50

Values are represented as Mean ± SD (for n= 3)

The gas chromatography results (Table. 3) showed that the seed contains appreciable amount of essential fatty acids (EFAs) with 29.79 percent of linolenic acid, 11.16 percent of linoleic acid ad 12.89 percent of arachidic acid. Along with these EFAs, fatty acids such as oleic acid (22.80%), palmitic acid (9.28%), stearic acid (2.91) and palmitolic acid (0.21%) were also present. The results obtained were similar to the values reported by Gokavi *et al*. (2004) [9] except for oleic and arachidic acid which is higher than the reported values.

Table 3: Fatty acid composition of *Lepidium sativum* GA-1 seed oil

Sr. No.	Fatty Acid	Mean value (%)
1.	Linolenic Acid	29.79
2.	Oleic Acid	22.80
3.	Arachidic Acid	12.89
4.	Linoleic Acid	11.16
5.	Palmitic Acid	9.28
6.	Stearic Acid	2.91
7.	Palmitolic Acid	0.21
8.	Unknown Fatty Acid	10.96

The Inductive Couple Plasma-Optical Emission Spectrometry, ICP-OES results (Table 4.) showed that the *Lepidium sativum* GA-1 seed contains highest amount of Phosphorus (2313.3 mg/100g) followed by calcium (350.87mg/100g), iron (4.37 (mg/100g), zinc (3.73 mg/100g) and copper (0.27 mg/100g). The zinc and manganese values were similar as that of (Al-Jasass and Al-Jasser (2012) [3] and Zia-ul-Haq and his collegues (2012) [18] while the calcium and phosphorus content in this variety was found to be higher than the reported values.

Table 4: Mineral composition of *Lepidium sativum* GA-1 seed

Sr. No.	Mineral	Mean value (mg/100g)
1.	Iron (Fe)	4.37
2.	Manganese (Mn)	1.62
3.	Zinc (Zn)	3.73
4.	Copper (Cu)	0.270
5.	Calcium (Ca)	350.87
6.	Phosphorus (P)	2313.30

Conclusion

In conclusion *Lepidium sativum*– GA1 seeds can be considered as an oil seed with high nutritional value. The seeds provide good quality oil with significant amount of

essential fatty acids which is similar to other oil seeds such as sesame, sunflower, peanuts and soybean oil. Due to high protein, fiber and carbohydrate content and other minerals, the seeds can be utilised for development of various value added products.

The seed oil can also be considered as new valuable source of edible oil. The use of these underutilised seeds can provides a new opportunity and emerging market share to food industry not only in the field of new product development but also for other therapeutic uses.

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