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Quantitative estimation of total protein, fatty oil and soluble sugar content in different mutant plant types of *Sesamum indicum* L

Sonali Dey (Sengupta) and Debjani Sarkar

Abstract
Quantitative estimation of protein, fatty oil and soluble sugar content is made in control and 21 different true breeding viable macromutant (induced by chemical mutagenesis) lines of sesame (*Sesamum indicum* L.) at M_4 generation. Results indicate that thick leaf mutant shows superiority over control for all the traits under study but many of them show increased content of protein, fatty oil and soluble sugar content than control. Some of the true breeding macromutants closely correspond to the ideotype being looked for in the species. More desirable plant types may be raised after intercrossing, followed by selection for increased benefits in the long run.

Keywords: *Sesamum indicum* L., macromutants, chemical mutagenesis, protein, fatty oil, soluble sugar

Introduction

Sesamum indicum L. (Family: Pedaliaceae; common name sesame), an oil yielding crop of commerce, in India, is not only confined in cooking and culinary purposes but also used extensively in cosmetics and pharmaceutical industries [1, 2]. The oil is highly priced in medicine as a carrier or suspending agent for antibiotics, vitamins and steroid hormones [3]. Sesame oil contains high percentage of fatty acids (85%) and two minor constituents namely sesamin and sesamolin. Besides fatty oil, sesame seeds also possess high percentage of dietary protein [4] (rich in methionine), carbohydrate, P, Mg, Ca and Vit. E as well as trace amount of Mo, Zn, Fe, Co and iodine [5] which gives nutraceutical (both nutritional and pharmaceutical) status to the crop [6]. Considering the potential importance of sesame, it is of utmost significance to keep the species under sustainable cultivation in regions conductive for its growth.

This highly valued crop offers little scope of genetic variation as it is a self-pollinated plant. Induction of mutation widens gene pool in a short span of time and can offer scope for raising desirable plant ideotypes being looked for in the species, primarily with high oil content and other additional characteristics. Keeping this in mind, the authors initiated induced mutagenesis programme in B-67 (most adaptive cultivar in West Bengal plains) [7, 8] cultivar of *S. indicum* to screen desirable plant type mutants and the present research investigation describes quantitative estimation of protein, fatty oil and soluble sugar content in control and 21 true breeding macromutants with a view to raise superior plant types regarding yield as well as fatty oil and protein content. Plant type mutations have been reported in different plant species [9-11] including sesame [12-14].

Material and Method

Seeds of B-67 cultivar of sesame (moisture content-6.446%) were obtained from Pulse and Oil Seed Research Station, Berhampur, West Bengal. Seeds were treated with different doses (0.25%, 0.50%, and 1.0% for 2, 4 and 6 hours) of chemical mutagens namely, ethyl methane sulphonate (EMS), di ethyl sulphate (DES), nitrous acid (HNO_2), hydroxylamine(NH_2OH), sodium azide (NaN_3), hydrogen peroxide (H_2O_2) and dimethyl sulphoxide (DMSO). Hundred seeds were treated in each lot of treatment. Control set was uniformly maintained. Control and treated seeds were sown in the experimental field plots of Department of Botany, Kalyani University during the months of February to June to raise M_1 generation. Distance between plants (20 cm) and rows (25 cm) was uniformly maintained. No fertilizer application was made during any time of the growth period.

First formed flower from each plant was selfed and seeds were kept in separate packets. Seeds were sown at M_2 in plant to progeny.

Macromutants were screened from seedling to maturity. First formed flower of each mutant was selfed and seeds were stored in desiccators. Selfed seeds of macromutants were sown at M_3 and subsequently true breeding mutants were raised at M_4. Quantitative analysis of protein, soluble sugar and fatty oil were made from seed samples of control (lines developed from mother stock through selfing) and in 21 true breeding macromutant lines (5 replicas in each case). Protein and soluble sugar were extracted following Osborne (1962) [15] and Clegg (1956) [16] respectively and estimated as described by Lowry *et al*. (1951) [17] and Dubois *et al*. (1951) [18] respectively.

Result and Discussion

Seeds rich in protein, soluble sugar and fatty oil are beneficial for both plants and humans. Results revealed that both protein and soluble sugar content are markedly increased in most of the mutants compared to control and fatty oil content is enhanced significantly in some of the mutants. (Table 1)

Viridis (28.54%), thick leaf (33.55%), dwarf (34.05%), diffused branching (26.34%), funnel (28.03%), late flowering (34.55%), elongated fruit (26.64%), dark reddish brown seed-coat I (30.52%) and bold seeded (29.05%) mutant plant types demonstrates significant increase in seed protein content than control (24.47%). Higher protein indicates higher growth and repair in plants. They are involved in processes such as catalyzing chemical reactions (enzymes), facilitating membrane transport, intracellular structure and energy generating reactions involving electron transport, just to name a few. In humans, plant proteins provides all the amino acids that the body cannot produce and lowers the risk of blood pressure, heart disease and cancer at a cost much lower than animal protein [19]. Among the mutants small flower (14.53%), reddish brown seed-coat I (19.03%) and broad leaf (19.83%) shows lower protein content as compared to control (Table 1).

Soluble sugar increases resistance in plants and helps them to overcome stressful conditions in addition to their normal metabolic and structural functions [20]. Human have appreciation for plant sugars as they provide all of the carbon and energy required for growth (cell division and expansion), differentiation and maintenance. Sugars can also be exploited industrially by microbial conversion of plant sugars into valued products such as ethanol [21, 22]. Soluble sugar content was observed to be 0.78% in control and it enhances significantly in most of the mutant plant types excepting diffused branching (0.77%), cluster flower (0.78%), white flower (0.81%) and dark reddish brown seed-coat I (0.86%). Soluble sugar content is found to be maximum in elongated fruit mutant (1.25%) (Table 1).

Plants store fatty oils in the form of triglycerides for later use. They contribute to cell structure and help in cell metabolism. Oil is useful for plants because it has more energy by weight than glucose which they store as starch. Fatty oil content is assessed to be 46.7% in control and it increases remarkably in diffused branching (61.50%), dark reddish brown seed-coat I & II (60.0%), globular fruit (60.0%), early flowering (56.7%) and thick leaf (56.7%) (Table 1). This is of great significance as sesame oil is used mainly for cooking and so greater amount of oil can be obtained from the above mentioned mutants. The oil also helps to improve hair and skin, increases bone growth in infants, increase heart health, reduce blood pressure, prevent cancer, manage anxiety and depression etc [23]. On the contrary, narrow leaf (36.7%), white flower (38.17%), small flower (40.0%), non shattering capsules (40.0%), bold seeded (40.0%) and elongated fruit (43.3%) revealed low amount of oil in seeds than control.

The results reveal that thick leaf mutant is superior over control for all the traits under study. Early flowering mutants, which are of utmost significance in breeding of sesame, has enhanced fatty oil and soluble sugar content; while marker viridis and dark reddish brown seed-coat I & II are with increased protein and fatty oil content respectively. Many of them show significant enhancement in one or two traits which may give rise to more desirable and beneficial plant types in sesame with improved agronomic managements.

Table 1: Quantitative estimation of protein, fatty oil and soluble sugar content in control and in different macromutant lines.

Plant Types	Total protein content(gm/ 100 gm of tissue) [Mean± S.E.]	Total soluble sugar content (gm/ 100 gm of tissue) (Mean ± S.E.)	Fatty oil content(%)#
Control	24.74 ± 0.39	0.78 ± 0.01	46.7
Viridis	28.54*** ± 0.32	0.91** ± 0.01	47.2
Broad leaf	19.83*** ± 0.50	0.9** ± 0.01	50.0
Thick leaf	33.55*** ± 0.43	1.23*** ± 0.02	56.7
Unforked narrow leaf	26.04 ± 0.51	1.01*** ± 0.03	36.7
Dwarf	34.05 ***± 0.41	0.86* ± 0.02	46.7
Diffused branching	26.34* ± 0.46	0.77 ± 0.02	61.5
Funnel	28.03** ± 0.57	0.96*** ± 0.01	50.0
Cluster flower	23.84 ± 0.52	0.78 ± 0.01	50.0
Early flowering	22.04* ± 0.45	1.23*** ± 0.01	56.7
Late flowering	34.55*** ± 0.42	1.14*** ± 0.01	43.3
Small flower	14.53*** ± 0.36	1.05*** ± 0.03	40.0
White flower	23.12 ± 0.24	0.81 ± 0.03	38.1
Globular fruit	26.18 ± 0.42	0.86* ± 0.02	60.0
Nonshattering capsule	23.10 ± 0.62	0.92** ± 0.01	40.0
Elongated fruit	26.64* ± 0.52	1.25*** ± 0.01	43.3
Reddish brown seed coat I	19.03** ± 0.41	0.94** ± 0.03	46.7
Reddish brown seed coat II	21.13*** ± 0.34	0.89* ± 0.01	46.7
Dark Reddish brown seed coat I	30.52*** ±0.39	0.86* ± 0.03	60.0
Dark Reddish brown seed coat II	25.19 ±0.40	1.0*** ± 0.01	60.0
Bold seeded	29.05*** ± 0.41	1.16*** ± 0.01	40.0
Large seeded	21.50*** ± 0.37	1.23*** ± 0.02	50.0

*, **, ***= significant at 5%, 1.0% and 0.1% level respectively

Average of five samples

Conclusion
This investigation of induced mutagenesis in *Sesamum indicum* L. has been undertaken with the objective to raise plant types of interest which would be rich in protein and oil content and the plant types evolved seem to be in the direction of the objective underlined and correspond very closely with the ideotypes being looked for in the species. It opens up the possibility of raising more desirable plant types for domestic and industrial use through intercrossing followed by rigorous selection.

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