BOSE INSTITUTE, KOLKATA, INDIA (Estd. 1917)
A simple algorithm for phenomic identification of the ideal Sesame plant type with novel architecture and an image analysis based seed phenomics for predictive Sesame Marker Assisted Breeding

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Fantastic source of protein (especially rich in methionine and tryptophan)

- Unsaturated fatty acids (82%) as linoleic and oleic acid.
- Lignans – Sesamin & Sesamolin
  Related antioxidants - sesamol and sesamolinol. Hepatoprotective role studied in mouse model
  Cholesterol-free
  Low in carbohydrates
  Vitamins B1 and B2
  Minerals - Cu, Mg, Fe, Zn, Ca

Bitter taste – oxalic acid in hulls

Since seeds are the objects of interest (in an oilseed crop), it makes sense that these are the prime focus of modification. Seeds of domesticated sesame are generally smooth, not rough-textured, with high oil content and display a diverse array of colors: the lighter colored ones are generally preferred for the purpose of direct consumption and the quality of extraction of oil since the seeds with darker seed coat (testa) often leave an undesirable stain in the oil.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Area</td>
<td>micron$^2$</td>
<td>The area of each object (minus any holes). The area comprised of pixels having intensity values within the selected range is reported. An object is considered within a site if its centre of gravity lies within the site outline.</td>
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<td>Aspect</td>
<td>-</td>
<td>The ratio between the major axis and the minor axis of the ellipse equivalent to the object (i.e., an ellipse with the same area, first and second degree moments), as determined by Major Axis/Minor Axis. Aspect is always greater than 1.</td>
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<td>Perimeter</td>
<td>micron</td>
<td>Measurement to report the length of the outline of each object using a polygonal outline. The perimeter of interior holes is not included in this measurement.</td>
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<td>Roundness</td>
<td>-</td>
<td>The roundness of each object, as determined by the following formula: $(\text{Perimeter}^2) / (4\pi \times \text{Area})$. Circular objects will have a roundness = 1; other shapes will have a roundness &gt; 1.</td>
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<tr>
<td>Radius</td>
<td>micron</td>
<td>The maximum distance between each object's centroid pixel position and its perimeter.</td>
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This software aided image analysis approach applied to sesame seeds of wild species and cultivars allow the quantification of patterns of different qualitative morphological parameters amenable to mathematical interpretation.

Seeds from wild sesame species can conveniently be distinguished from cultivated varieties based on shape and architectural analysis.

Finally, to screen and evaluate an improved genotype of sesame with this approach it can be indicated that following parameters with respective ‘cut off’ values can be utilized: Shape of seed (ellipsoid with roundness factor >3, aspect value >1.5) and contour of seed (in the smoother direction) along with the conventional practice of selecting lighter colored testa.
Looking for ideal Sesame plant type…

The ‘target sesame’ with novel plant architecture was envisaged as a moderately tall, basally branched plant type of short duration nature containing more number of flowers / pods per axil with uniform maturity of pods and seeds of lighter testa colour. Furthermore, the desired ‘target sesame’ would have the unique assemblage of traits like trichomes in different plant parts and visually identifiable phenotypic marker in flower petals.
### Percent homology of the genotypes towards target sesame.xls

<table>
<thead>
<tr>
<th>Color grade with increasing value</th>
<th>Seed coat color</th>
<th>Plant height</th>
<th>Days to 50% flowering</th>
<th>Days to flower initiation</th>
<th>Seed coat texture</th>
<th>No. of capsules per plant</th>
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**Color grades**

- **1**: Harmful
- **2**: Harmful
- **3**: Harmful
- **4**: Very harmful
- **5**: Harmful
- **6**: Harmful
- **7**: Harmful
- **8**: Harmful
- **9**: Harmful
- **10**: Harmful

**Variables**

- Seed coat color
- Plant height
- Days to 50% flowering
- Days to flower initiation
- Seed coat texture
- No. of capsules per plant
- Corolla interior pigmentation
- Capsule shape
- Capsule length
- Capsule color
- Capsule trichome
- Floral trichome
- Calyx trichome
- Corolla trichome
- Exterior corolla color
- Branching habit
- Stems trichome
- Phytoalexin
- Leaf angle
- Petiole color
- Flowers per axil
- Foveola
- Capsule dehiscence
- Leaf trichome
- Interior corolla color
- Capsule color

**Trait Selection**

- Natural selection (favoured by nature)
  - Non-branching
  - Square
  - Hairy
  - Present
  - Horizontal purple
  - Drooping
  - Green-purple

- Artificial selection (favoured by human)
  - Branched
  - Round
  - Glabrous
  - Absent
  - Axile
  - Green
  - Glabrous
  - Glabrous
  - Light color
  - Light color
  - Colorless
  - Absent
  - Coloristic
  - Slender
  - Oblong
  - Glabrous
  - Long
  - Purple
  - Brown
  - Non-part-chafering
  - Two-gap
  - Vulv
  - Long
  - Less
  - Glabrous
  - Opposite
  - Less
  - More light
  - Smooth

**Target Sesame**

- Present
- Absent
- Axile
- Glabrous
- Light color
- Coloristic
- Slender
- Oblong
- Glabrous
- Long
- Purple
- Brown
- Non-part-chafering
- Two-gap
- Vulv
- Long
- Less
- Glabrous
- Opposite
- Less
- More
- Light
- Smooth
Indeterminate genotype

\[ P_1 \] x \[ P_2 \] \\
\[ F_1 \] \\

Development of mapping population

RIL (recombinant Inbred lines)

Marker Assisted Selection coupled with Phenomics to look for desirable recombinants

Identified SSR/SCAR marker linked to trait (QTL)
“To explore the real mystery of plant life, one must be extremely close to plant. That mystery is really complex and multifaceted.”

“How shall we be able to fathom the intrinsic change of plant?.....The only possible way...to measure the response of the plants, stimulated either naturally or artificially ”

“Whatever may be the way-out, two hurdles are to be overcome...firstly, to make the plant agreeable to say something about herself; and secondly, to document that vividly silent confession with state-of-art technologies. It is easier to make a child obey but it is immensely difficult to get answer from a plant.”

Sir J C Bose (1858-1937)
Abyakta (literal translation:
The Unexpressed)
Pp. 92-93