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# Biochemical characterization of different oilseed genotypes of *Brassica species*

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**Abstract**
To evaluate the biochemical characteristics of rapeseed-mustard oilseeds genotypes were studied their seed weight, moisture content, and oil content. Significant variation was observed among the genotypes for all the evaluated traits. The thousand seed weight was varied between 2.21 to 6.05 g. Among the varieties the highest thousand seed weight was found in GM3 and the lowest thousand seed weight was found in PBN2001. The highest moisture content was observed from PC5 (5.29%); whereas the lowest moisture content was found in BCRS3 (3.10%). The variety GM1 contained significantly highest amount of oil (41.67%) with GM1, GM3, and GDM4 identified as high oil content genotypes whereas the variety BHC-46 contained lowest amount of oil (17.51%), Substantial variation was observed among the genotypes, highlighting the potential for genetic improvement and selection in oilseed *Brassica* crops. GM3 exhibited the highest thousand seed weight and one of the higher oil contents, suggesting a possible positive association. Conversely, genotypes with lower seed weight and higher moisture content generally exhibited reduced oil yield, indicating complex interrelationships between these traits.

**Keywords:** *Brassica*, Moisture, Genotypes, Seed weight

## Introduction
*Brassica* is the most significant genus in Family *Brassicaceae* which includes 350 genera and ca. 3500 species. Species of genus *Brassica* had worldwide importance due to their medicinal, nutritional and pharmaceutical benefits. (Nawaz *et al*., 2018) [13]. The rapeseed-mustard group broadly includes Indian mustard, yellow sarson, brown sarson, raya, and toria crops. Indian mustard (*Brassica juncea* (L.) Czernj. & Cosson) is predominantly cultivated in Rajasthan, UP, Haryana, Madhya Pradesh, and Gujarat. Brown sarson (*B. rapa ssp* sarson) has two ecotypes lotni and toria. Yellow sarson (*B. rapa var*. trilocularis) is cultivated in Assam, Bihar, Orissa, and West Bengal as rabi crop. In Punjab, Haryana, UP, Himachal Pradesh, and Madhya Pradesh, it is grown mainly as a catch crop. Taramira (Eruca sativa) is grown in the drier parts of North-West India comprising the states of Rajasthan, Haryana, and UP. Gobhi sarson (*B. napus* L. *ssp. oleferia* DC. var annua L.) and karan rai (*Brassica carinata*) are the new emerging oilseed crops having limited area of cultivation. (Shekhawat *et al*., 2012) [16]. *Brassica spp*., commonly known as rapeseed-mustard, plays an important role in the Indian economy by providing edible oils, vegetables, condiments and animal feed (Jat *et al*., 2019) [11].

India is the 4th largest oilseeds producer in the world. India is ranked fourth after European Union, Canada and China sharing about 14.0 per cent of the global rapeseed-mustard production 88.39 million metric tonnes (mmt) during 2023-24 (USDA website). In India, groundnut, soybean, and rapeseed-mustard are the major oilseeds, contributing approximately 80% of oilseed production. The major oilseed *Brassicas* grown in India are *B. juncea, B. rapa, B. napus, and B. carinata*. These crops are grown in diverse agro-climatic conditions and are consumed as vegetables, fodder, oil sources, and condiments. In India, Rajasthan is the largest production (46.63%), followed by Madhya Pradesh (14.36%), Haryana (11.63%), Uttar Pradesh (8.81%), and Gujarat (4.27%) (Anonymous, 2022) [2].

*Brassica* play an important role in the world agriculture as oilseeds, vegetables, forage and fodder, green manure and condiments.

They are the main source of edible oil in Indian diet after groundnut. The important members of this group *viz.*, *B. napus*, *B. rapa*, and *B. juncea* are sources of canola and industrial oil. Thousand seed weight range observed in Indian mustard genotypes: 2.58-6.56 g (Tarkeshwar *et al*., 2022) [19]. Safe moisture levels range from 4-8 % for sealed storage and up to 10 % for conventional storage, as elevated moisture accelerates deterioration and fungal growth (Gawrysiak-Witulska *et al*., (2012) [7]. Oil content varies between 29 % and 52 %, shaped by genetic and agro-ecological conditions; edible quality is enhanced by low erucic acid and moderated glucosinolate levels. Breeding efforts focus on combining high TSW, low moisture content, and high oil percentage to maximize productivity, storage life, and market value in diverse growing environments.

Present study evaluates thirty *Brassica* genotypes to determine variability in thousand seed weight, seed moisture content, and oil content, thereby identifying best genotypes for breeding and industrial applications. Selection for higher seed weight and moderate moisture content can enhance oil yield and seed storage. The findings also emphasize the importance of considering trait interactions when evaluating genotypes for commercial cultivation

## Materials and Methods

**Experimental Material:** Seven oil seed *Brassica species* different genotypes (Table 1) were selected for the study. The seeds were collected from the Centre for Oilseeds Research of Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. Thirty genotypes of Brassica species were evaluated in a randomized complete block design (RCBD) with three replications.

**Thousand seed weight:** The analysis of thousand seed weight aims to determine the average mass of 1000 seeds in the sample. The mass was determined by randomly selecting 1000 seed from selected genotypes and weighing in an electronic balance of 0.0001 g sensitivity. The weight was then converted into 1000 seed mass.

**Moisture content:** Moisture content of mustard seeds were determined by drying the weighed sample of mustard seeds at 105°C in hot air oven for 3 hours and the loss of weight was expressed as moisture content (A.O.A.C., 2000). Two gram seed sample from each genotype was taken in pre-weighed petri plates and calculate the moisture by the following formula:

$$\text{Moisture (\%)} = \frac{(\text{Fresh weight} - \text{Dry weight})}{\text{Fresh weight}} \text{ X } 100$$

**Table 1:** List of selected genotypes of seven oil seed *Brassica species*

| Sr. No. | Genotypes | Sr. No. | Genotypes |
|---|---|---|---|
| ***Brassica juncea*** | | ***Brassica carinata*** | |
| 1 | GM-1 | 17 | BCRS-3 |
| 2 | GM-2 | 18 | DLSC 1 |
| 3 | GM-3 | 19 | PC 5 |
| 4 | GDM-4 | ***Erucas sativa*** | |
| 5 | GDM-5 | 20 | RTN-314 |
| 6 | Kranti | 21 | T-27 |
| 7 | PM-25 | *Brassica napus* | |
| 8 | SKM 1620 | 22 | HNS-0004 |
| 9 | SKM 1731 | 23 | NRCG-35 |
| 10 | SKM1744 | 24 | PBCM-2002 |
| ***Brassica campestris*** | | *25* | PBN- 2001 |
| 11 | BR-54 | ***Brassica nigra- black sarson*** | |
| 12 | NDTC-9502 | 26 | BHC-46 |
| ***Brassica rapa*** | | *27* | BSH-1 |
| 13 | GS-1 | 28 | NDYS-9504 |
| 14 | NRCY 93 | 29 | SSK-16 |
| 15 | NRCYS-219 | 30 | SSK-9205 |
| 16 | PS-66 | | |

**Oil content**

Oil content of *Brassica spp.* seeds was determined by Soxhlet method developed by Sadasivam and Manickam (1992) [15] and A.O.A.C (1965) method. Sample flour was prepared by using blender. Then two gram sample was taken into cellulose soxhlet extraction thimble. The cotton plug was placed at the top at thimble to evenly distribute the solvent as it drops on the sample during extraction. The thimble was put into the automated soxhlet and 80 ml petroleum ether (AR grade) was poured into the soxhlet flask. by automated soxhlet. Extract with petroleum ether (60-80 °C) at 145 °C temperature for 2 hours. When extraction of oil was completed turned off and permitted to cool. Thimble was removed from the soxhlet and dried the sample in normal air. Finally, oilcake (a byproduct after getting oil) was collected. The yield of sample oil was calculated by following formula.

**Calculation**

$$\text{Total Oil (\%)} = \frac{\text{Weight of oil (g)}}{\text{Weight of sample (g)}} \times 100$$


**Fig 1:** Soxhlet unit for oil extraction

**Statistical Analysis**
Analysis of variance (ANOVA) was performed to determine the significance of differences among genotypes using standard statistical software.

**Results and Discussion**
**Thousand Seed weight:** The significant variations were observed among the different varieties in terms of the effect on the thousand-grain weight (Figure 2 & Table 2). The highest weight of thousands grains was found in GM3 (6.05 g), which was followed by SKM1744 (5.91 g) and KRANTI (5.88 g). The lowest weight of thousands of grains was found in PBN2001 (2.21 g). The present values were consisted with the results reported by Tarkeshwar *et al.*, (2022) [19] which was ranged found of weight of thousand seed 2.58 g to 6.56 g among different sixty Indian mustard genotypes. Banga *et al.*, (2013) and Siddiqui and Firoz (2004) [5] found that the highest amount of 1000 seed weight were 5.15 g and lowest seed weight were 3.95 g.

**Moisture content:** Moisture content is important for the shelf life of seed. Moisture percent in thirty *Brassica species* oil seed genotypes varied from 3.20 per cent to 5.29 per cent with an average of 4.44 per cent (Figure 2 & Table 2). The significantly higher moisture per cent was observed in PC5 (5.29 per cent) which was at par with RTM314 (5.19 per cent) while the significantly lower moisture content was observed in BCRS3 (3.20 per cent). The results are in agreement with Hossain *et al.*, (2016) [9] who observed moisture content ranged from 4.0 per cent to 5.2 per cent in six varieties of rapeseed (*Brassica campestris* and *Brassica napus*) and mustard (*Brassica juncea*). Abul-Fadl *et al.*, (2011) [1] observed the two yellow and brown mustard varieties having the 5.05 per cent and 4.98 per cent moisture, respectively. Khan *et al.*, (2008) [12] found moisture content between 6 per cent to 7 per cent with a mean 6.27 per cent in different genotypes of *Brassica*.
Among thirty oil seed *Brassica* species genotypes the moisture content is in the ranged 3.20 per cent to 5.29 per cent. The moisture content of the sample seed oils in this study are generally low indicating that the seed oils could be stored for a long period. They also limit fungal and contamination effects. The result also revealed that genotype has a high moisture content of 4.83 per cent. It is known that products that have low fat values normally have high moisture contents.

**Oil content:** The total oil percent in the *Brassica species* genotypes ranged from 17.51 per cent to 41.67 per cent with an average of 29.09 per cent (Figure 2 & Table 2). The significantly higher oil percent was observed in GM1 (41.67 per cent) which was at par with GM3 (40.81 per cent), GDM4 (39.53 per cent), GM2 (39.15 per cent) and GDM5 (38.74 per cent) while the significantly lower oil content was observed in the genotype BHC46 (17.51 per cent) which was at par with PBN2001 (18.28 per cent), DLSC1 (19.02 per cent), HNS0004 (19.49 per cent) and PC5 (19.79 per cent). The results clearly showed that genotype GM1, GM3, GDM4, GM2 and GDM5 can be measured as better source of oil. This result was comparable with Singh (2002) [18] the *Brassica* oil content varied from 20.78 to 44.10 per cent. The present investigation was similar to the reported value (40.05 to 42.25 per cent). Ildiko *et al.*, 2006 [10] found that mustard seeds contain 28 to 32 per cent fat and 28 to 36 per cent proteins. The oil yield of mustard is 20.80 to 30.88 per cent which was in comparable range to those as reported in Nutritive value of Indian foods (Gopalan *et al.*, 1971). This showed that seed oil of mustard may be used economically and commercially.
The low-oil genotypes such as BHC46, PBN2001, DLSC1, HNS0004, and PC5 recorded oil contents below 20%. This variation is comparable with prior findings by Singh (2002) [18], Ildiko *et al*. (2006) [10], who reported oil contents in the range of 20.8% to 44.1%. The high-oil genotypes also tended to have relatively higher seed weights, suggesting a positive relationship between seed mass and oil accumulation.

**Interaction among Traits:** An interaction among seed weight, moisture content, and oil content was observed in this study. Genotypes like GM3, GM1, GM2, and GDM4, which showed high thousand seed weight, also recorded higher oil content, indicating a positive correlation between seed size and oil yield. On the contrary, genotypes such as PBN2001 and PC5, which had both lower seed weights and higher moisture content, exhibited significantly lower oil yields. This suggests a negative interaction between moisture content and oil yield. Thousand seed weight is a strong predictor of oil yield potential in *Brassica* species. Higher moisture levels, though sometimes associated with freshness, may be detrimental to oil accumulation and storage quality. Genotype selection for oil production should focus on maximizing seed weight while maintaining low to moderate moisture levels.

**Conclusion**
The significant variability among *Brassica* genotypes for thousand seed weight, moisture content, and oil yield. Genotypes GM1, GM3, GDM4, GM2, and GDM5 were identified as superior in terms of oil content, while GM3 showed the highest thousand seed weight. Genotypes with lower moisture content, such as BCRS3, are suitable for long-term storage. GM3 and GM1 emerged as superior genotypes in terms of both seed weight and oil content, suggesting their potential use in breeding programs. Selection for higher seed weight and moderate moisture content can enhance oil yield and seed storage. The findings also emphasize the importance of considering trait interactions when evaluating genotypes for commercial cultivation. These findings are useful for breeding programs aimed at enhancing oil yield and seed quality in *Brassica* species.

**Table 2:** Proximate analysis of all oil seed genotypes of *Brassica species*

| Sr. No. | Genotypes | 1000 seed weight (g) | Moisture% | Oil% |
|---|---|---|---|---|
| 1 | GM1 | 4.80 | 4.29 | 41.67 |
| 2 | GM2 | 5.53 | 4.63 | 39.15 |
| 3 | GM3 | 6.05 | 4.58 | 40.81 |
| 4 | GDM4 | 5.38 | 4.28 | 39.53 |
| 5 | GDM5 | 5.15 | 4.65 | 38.74 |

| | | | | |
|---|---|---|---|---|
| 6 | KRANTI | 5.88 | 4.53 | 35.56 |
| 7 | PM25 | 5.57 | 4.35 | 33.76 |
| 8 | SKM1620 | 5.43 | 4.56 | 37.91 |
| 9 | SKM1731 | 5.02 | 4.01 | 33.41 |
| 10 | SKM1744 | 5.91 | 4.37 | 35.05 |
| 11 | BR54 | 2.88 | 4.58 | 35.65 |
| 12 | NDTC9502 | 2.37 | 4.37 | 30.53 |
| 13 | GS1 | 4.96 | 4.30 | 30.11 |
| 14 | NRCY93 | 4.50 | 4.48 | 29.85 |
| 15 | NRCY219 | 3.57 | 4.13 | 30.77 |
| 16 | PS66 | 4.56 | 4.57 | 25.43 |
| 17 | BCRS3 | 2.80 | 3.20 | 27.96 |
| 18 | DLSC1 | 4.52 | 4.58 | 19.02 |
| 19 | PC5 | 2.61 | 5.29 | 19.79 |
| 20 | RTM314 | 3.76 | 5.19 | 26.44 |
| 21 | T27 | 4.25 | 4.29 | 26.92 |
| 22 | HNS0004 | 2.25 | 4.63 | 19.49 |
| 23 | NRCG35 | 3.25 | 4.58 | 20.63 |
| 24 | PBCM2002 | 2.35 | 4.28 | 24.32 |
| 23 | NRCG35 | 3.25 | 4.58 | 20.63 |
| 24 | PBCM2002 | 2.35 | 4.28 | 24.32 |
| 25 | PBN2001 | 2.21 | 4.65 | 18.28 |
| 26 | BHC46 | 4.42 | 4.53 | 17.51 |
| 27 | BSH1 | 4.28 | 4.35 | 22.15 |
| 28 | NDYS9504 | 3.52 | 4.56 | 22.32 |
| 29 | SSK16 | 3.70 | 4.01 | 26.08 |
| 30 | SSK9205 | 3.94 | 4.37 | 23.86 |
| | S.Em.± | 0.13 | 0.08 | 1.25 |
| | C.D. at 5 % | 0.37 | 0.24 | 3.53 |
| | C.V. % | 5.35 | 3.31 | 7.44 |
| | Average | 4.18 | 4.44 | 29.09 |

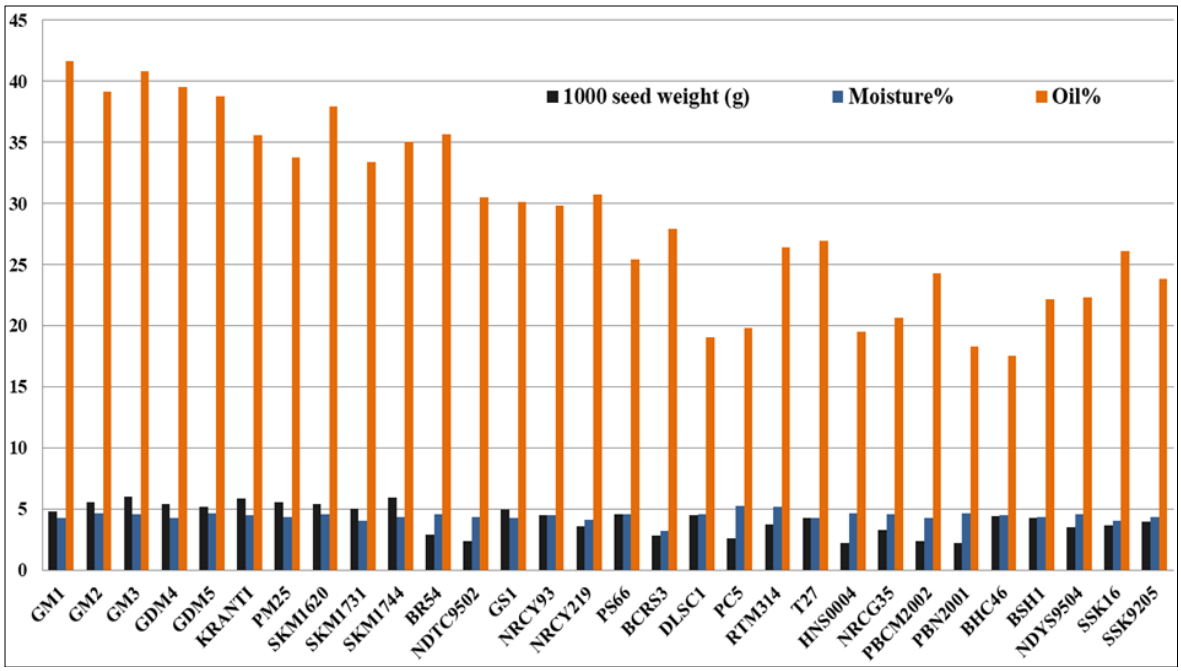


**Fig 2:** Correlation of proximate analysis of different oil seed genotypes of Brassica spp.

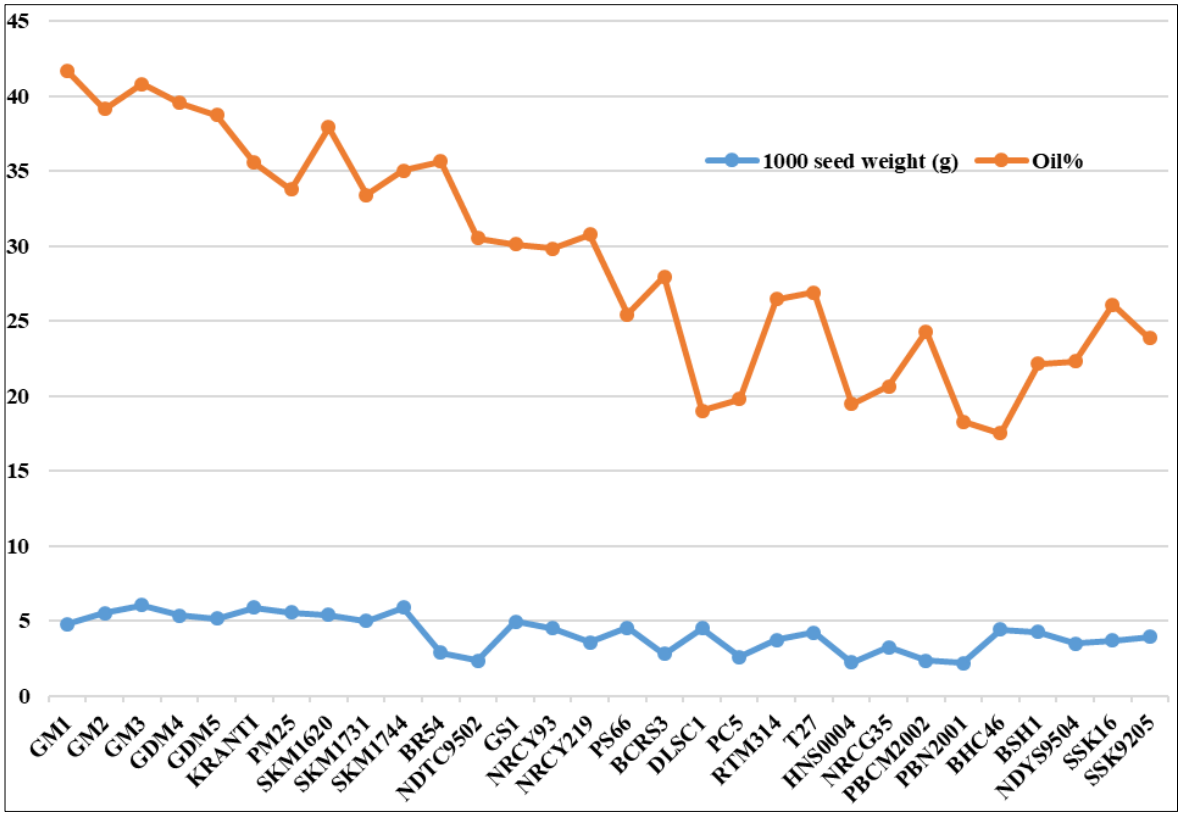


**Fig 2:** Interaction among seed weight and oil percent of different oil seed genotypes of Brassica spp.

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