JUST AGRICULTURE
multidisciplinary e-Newsletter

Quality Improvement in Rapeseed-Mustard

Hariom Kumar Sharma[1]*, V.V. Singh[2], H.S. Meena[2], Pankaj Sharma and P.K. Rai[3]

[1]Senior Scientist, [2]Principal Scientist and [3]Director

ICAR-Directorate of Rapeseed-Mustard Research, Sewar, Bharatpur-321303, Rajasthan

ARTICLE ID: 44

Introduction

Vegetable oils are important component of a healthy diet as they are rich source of unsaturated fatty acids, vitamin E, and contain no dietary cholesterol (Kumar, 2015; Jat *et al.*, 2019). Rapeseed mustard oil is important edible oil in India, especially in north-western and eastern parts. Oil content in Rapeseed-mustard varies between 36-42 % and average oil recovery from seed is about 34 to 35 % (Srinivasan, 2005). Oil quality depends on fatty acid composition. Indian mustard seed oil contains low amount (8%) of saturated fatty acids (palmitic acid and stearic acid) and a high amount (70%) of monounsaturated fatty acids (oleic, eicosenoic and erucic acids), and polyunsaturated (22%) fatty acids (linoleic and linolenic acids) (Kumar, 2015). Chauhan *et al.* (2007) studied the fatty acid composition and oil content in 96 released/pre-released varieties of rapeseed-mustard (Gobhi sarson, toria, brown sarson, yellow sarson, Indian mustard, Karan rai) in India. They reported oil content in rapeseed-mustard varieties varied from 34.9 (taramira) to 44.9% (Yellow sarson). Further, they found that average oleic acid (C18:1) and linolenic acid (C18:3) in Indian mustard varieties was less (11.9%, 18.8%) as compared to gobhi sarson (42.2%, 20%), respectively. Whereas, linoleic acid (C18:2) is more in Indian mustard (16.2%) as compared to gobhi sarson (11%) (Chauhan *et al.*, 2007).

After oil extraction, seed meal, is left which is used as animal feed and organic manure. The rapeseed-mustard seed meal mainly comprises proteins (35–40%), carbohydrates (14–15%), fibres (10–12%), moisture (6–8%), ash (4–6%), minerals and vitamins (1.0–1.5%), glucosinolates (2–3%), tannin (1.6–3.1%), sinapin (1.0–1.5%) and phytic acid (3– 6%). Among all the constituents, fibres, tannin, phytic acid, glucosinolate and sinapin lower the feed value of seed meal (Chauhan *et al.*, 2011). Because of healthy fatty acid profile mainly due to omega-3 fatty acid content, Indian mustard oil is also frequently used for blending with other vegetable oils (sunflower, soybean, corn etc.) to give better omega-3/omega-6 fatty acid balance. With

JUST AGRICULTURE
multidisciplinary e-Newsletter

increasing health concern, the demand of mustard oil will further increase in house hold consumption and in food industry to develop variety of value-added products (Jat *et al.*, 2019).

- **Anti-nutritional components of rapeseed-mustard**
- **Erucic acid:** Indian rapeseed-mustard varieties contain quite high level of erucic acid in oil. Chauhan *et al.* (2007) reported that, average erucic acid content in rapeseed-mustard species is >38% except gobhi sarson. Non quality varieties of gobhi sarson contain upto 34.7% erucic acid. Highest erucic acid has been reported in yellow sarson (39.6-57.3%) followed by Indian mustard (35.7-51.4%). As per the international standards erucic acid in rapeseed-mustard oil should be <2%, as less erucic acid will help in increasing the level of oleic acid in the oil. Furthermore, consumption of mustard oil with high erucic acid, in the diet, caused myocardial fibrosis, impaired myocardial conductance, lipidosis, *etc* and also increased blood cholesterol (Chauhan *et al.* 2007).
- **Glucosinolate:** Glucosinolates (GSLs) are a group of sulfur and nitrogen containing glycosides found abundantly in crops of Brassicaceae family (Fahey *et al.*, 2001). Chemically, they consist of a β-d-glycopyranose residue linked to a hydroximinosulfate ester by sulfur bridge, plus an R-group. The R-group is derived from one of eight amino acids and can be aliphatic (alanine, leucine, isoleucine, methionine, or valine), aromatic (phenylalanine or tyrosine), or indole (tryptophan) (Collett *et al.*, 2014; Bischoff, 2016). The crops under genus Brassica including oliferous species (*B. rapa*, *B. juncea*, *B. napus*, *B. carinata*, *B. nigra*) and vegetable species (*B. rapa*,*B. oleracea*) contain good amount of GSLs in seeds, leaves and other plant parts. More than 120 different GSLs have been identified and grouped into aliphatic, aromatic, and indole GSLs. The important function of GSLs is plant defense, as they provide protection against the herbivores and pathogens by forming toxic compound, isothiocyanates (ITCs) after hydrolysis by thioglucosidases. Most of GSLs are also associated with many beneficial effects to human health, such as anticancer, antibacterial, antidiabetic, antiobesity, antifungal, antioxidant, and antimutagenic activities (Gioia *et al.*, 2020). Apart from beneficial effects, GSLs and their hydrolysis by-products (nitriles, thiocyanates, goitrins, epithionitriles, and cyanides) are potentially toxic against animals, humans, and soil arthropods (Assayed & Abd El-Aty, 2009; van Ommen *et al.*, 2012; Gioia *et*

JUST AGRICULTURE
multidisciplinary e-Newsletter

al., 2020). Cleavage products from hydrolysis of glucosinolate reduce the feed palatability of rapeseed-mustard seed meal by affecting the iodine uptake by the thyroid glands, especially in non-ruminants including pigs and poultry (Chauhan et al., 2011). Chauhan *et al.* (2007) reported glucosinolate content in all of the rapeseed mustard varieties was high (>30 micro moles/g defatted seed meal). They observed that, most of the varieties have glucosinolate content between 75-100 micro moles/g defatted seed meal. Therefore, the amelioration of nutritional qualities of rapeseed-mustard by developing new varieties having alternative oil and meal characteristics has been an important objective in quality breeding of rapeseed-mustard.

Quality improvement in rapeseed-mustard

As per the international standards, erucic acid should be <2% in oil and glucosinolate should <30 micro moles/g defatted seed meal of rapeseed-mustard. However, breeding efforts were made in India since 1970 to reduce glucosinolate content in the seed of rapeseed-mustard varieties up to 30 micro moles/g defatted seed meal (low or zero) and erucic acid up to 2% (low or zero) as well as combining both to develop double zero/ double low/canola quality varieties (Chauhan *et al.* 2011). First low erucic acid variety of Indian mustard was Pusa Karishma which was notified in 2004. Later on, first double low variety (GSC 5) of *Gobhi sarson* was notified in 2005. First double low variety of Indian mustard (PDZ 1) was notified in 2016 for Delhi NCR region. However, it was again notified in 2018 for area expansion and recommended for the Zone-II (Punjab, Haryana, Delhi, Jammu and Northern Rajasthan). Presently, ten low erucic varieties (Pusa Karishma, PM 21, PM 22, PM 24, PM 29, PM 30, PM 32, PM 34, RLC1, RLC 2), three double low varieties (PDZ 1, RLC 3, PDZ 11) and one double low hybrid (RCH 1) have been notified in *B. juncea* (Table 1) till 2023. In gobhi sarson (*B. napus*), 8 double low (Hyola 401, GSC 5, TERI-Uttam-Jawahar, NUDB 26-11, GSC 6, GSC 7, PGSH 1699, PGSH 1707) varieties/hybrids have been notified (Table 1) (Rai et al., 2023). Double low varieties of gobhi sarson are also rich in oleic acid (>60%) as compared to non-quality varieties. Apart from the varieties, quality donors have been developed and registered by Plant Germplasm Registration Committee, New Delhi. In Indian mustard low erucic acid (Swarna {TERI (OE) M21}, PRQ-2005-1); low glucosinolate (NDUH-YJ-6), double zero (TERI- GZ-05, Heera, NUDH-YJ-5, BIO-YSR, DRMR 1-5, DRMRQ1-16-27) and high oil content (NDYR 8, NDYR10) germplasm have been registered (Table 1). Furthermore, in

JUST AGRICULTURE
multidisciplinary e-Newsletter

Gobhi sarson four genetic stocks with low erucic acid *viz*., TERI–Gaurav (TERI-00-R986); TERI-Garima (TERI-00-R985); Phaguni (TERI(OE) RO3); Shyamali (TERI(OE) RO9J)] and 03 genetic stocks with double low quality (NUDB-38; NUDB-42; TERI (00) R9903) have been registered (Table 1). Quality work is also going on at ICAR-DRMR, Bharatpur. Two genetic stocks (DRMR 1-5, DRMRQ1-16-27) of Indian mustard were developed and registered for canola quality by ICAR-DRMR, Bharatpur. These quality genetic stocks can be further used for development of canola quality rapeseed-mustard varieties. Besides common breeding tools, including conventional breeding strategies, modern techniques such as marker assisted breeding and genome editing are promising techniques for modulating GSL, erucic acid and oleic acid content in rapeseed-mustard.

With increasing incidences of heart attacks and increasing awareness through press, media and internet, peoples are now started using canola quality oil in rapeseed-mustard. So, there is a need to further develop more number of canola quality varieties. To further expand the area under quality mustard it is necessary that farmers should get premium price for quality mustard as these varieties yield less as compared to conventional rapeseed-mustard varieties.

Table 1: Quality varieties and germplasm of rapeseed-mustard developed in India (Source: compiled from Sharma et al., 2022; NBPGR website, accessed on 25 Nov, 2022; Rai et al., 2023)

Crop	Trait	Variety
Indian mustard (*Brassica junea*)	Low erucic acid (< 2%)	Pusa Karishma (LES 39), Pusa Mustard 21 (LES 1-27), Pusa Mustard 22 (LET 17), RLC-1 (ELM 79), Pusa Mustard 24 (LET 18), Pusa Mustard 29 (LET 36), Pusa Mustard 30 (LES 43), RLC 2 (ELM 123), Pusa Mustard 32 (LES 54), Pusa Mustard 34 (LES 60)
	Double low [Low erucic acid (<2%); low glucosinolate (30 micro moles/g defatted seed meal)]	Pusa Double Zero Mustard- 31 (PDZ 1), RLC-3, Pusa Double Zero Mustard 33 (PDZ 11), RCH 1(Hybrid)

JUST AGRICULTURE
multidisciplinary e-Newsletter

Gobhi sarson (*Brassica napus*)	Double low variety	Hyola-401 (Hybrid), GSC-5, TERI –Uttam-Jawahar [TERI (00) R 9903], GSC-6 (OCN-3), NUDB-26-11, GSC 7, PGSH 1699 (Hybrid), PGSH 1707 (Hybrid)
		Germplasm
Indian mustard (*Brassica junea*)	Low erucic acid	Swarna {TERI(OE)M21}, PRQ-2005-1
	Low glucosinolate	NDUH-YJ-6
	Double low	TERI- GZ-05, Heera, NUDH-YJ-5, DRMR 1-5, DRMRQ1-16-27
Gobhi sarson (*Brassica napus*)	Low erucic acid	Phaguni (TERI(OE) RO3), Shyamali (TERI(OE) RO9J)
	Double low	TERI–Gaurav (TERI-00-R986), TERI-Garima (TERI-00-R985), NUDB-38, NUDB-42, TERI (00) R9903

Reference

Assayed M.E., Abd El-Aty A.M. 2009. Cruciferous plants: phytochemical toxicity versus cancer chemoprotection. Mini Reviews in Medicinal Chemistry 9:1470e1478.

Bischoff K.L. 2016. Glucosinolates. In: Nutraceuticals: Efficacy, Safety and Toxicity. Ramesh C. Gupta (Ed.). Academic Press Publisher, Elsevier Inc. 551-554.

Chauhan J.S., Bhadauria V.P.S., Singh M., Singh K.H., Kumar A. 2007. Quality characteristics and their interrelationships in Indian rapeseed-mustard (*Brassica sp.*) varieties. Indian J. Agric. Sci. **77** (9): 616–20

Chauhan J.S., Singh K.H., Singh V.V., Kumar S. 2011. Hundred years of rapeseed-mustard breeding in India: accomplishments and future strategies. Indian J. Agric. Sci. 81:1093-1109.

Collett M.G., Stegelmeier B.L., Tapper B. 2014. Could nitrile derivatives of turnip (*Brassica rapa*) glucosinolates be hepato- or cholangiotoxic in cattle? J. Agric. Food Chem. 62 (30):7370–7375.

Fahey J.W., Zalcmann A.T., Talalay P. 2001. The chemical diversity and distribution of glucosinolates and isothiocyanates among plants. Phytochemistry 56:5e51.

Gioia F.D., Pinela J., Bailón Ad.H., Fereira I.C.F.R., Petropoulos S.A. 2020. The dilemma of "good" and "bad" glucosinolates and the potential to regulate their content. In:

Glucosinolates: Properties, recovery, and applications. Galanakis CM (Ed). Academic Press Publisher, Elsevier Inc. 1-45.

Jat R.S., Singh V.V., Sharma P., Rai P.K. 2019. Oilseed brassica in India: Demand, supply, policy perspective and future potential. OCL. 26:8.

Kumar S. 2015. Edible oils quality and nutraceutical aspects. Stadium Press (India) Pvt. Ltd.: New Delhi.

Rai P.K., Sharma H.K., Singh V.V., Singh K.H., Sharma P., Meena H.S., Meena B.L. 2023. Notified Rapeseed-mustard varieties in India. ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur-321303, Rajasthan, India. Pp 114. ISBN: 978-81-966257-1-9

Sharma H.K., Kumar A, Singh, V.V., Meena H.S., Priyamedha, Meena B.L., Sharma P., Rai P.K. 2022. Genetic Resources of Brassicas. In: Cash Crops. (Eds. P.M. Priyadarshan and S. Mohan Jain (Eds). Pp. 285-337. DOI: 10.1007/978-3-030-74926-2_1

Srinivasan P.V. 2005. Impact of trade liberalisation of India's oil seed and edible oils sector, Indira Gandhi Institute of Development Research (IGIDR). 20.

van Ommen A.E.E., Cornelis, K., Roelofs, D. 2012. Molecular and life-history effects of a natural toxin on herbivorous and non-target soil arthropods. Ecotoxicology 21:1084e1093.