Original Research Article
Comparative Study on Quality Characteristics and Variations in Fatty Acid Composition of Different Varieties of Rapeseed and Mustard (*Brassica* spp.)

ABSTRACT

With a view to studying the qualitative features and the variations in fatty acid composition of 6 rapeseed (B. campestris and B. napus) and mustard (B. juncea) varieties, an experiment was conducted. Among these varieties, BARI Sarisha-14 presented the value of 168.4 which was recorded the highest. Both BARI Sarisha-11 and BARI Sarisha-14 was found with the highest iodine value of 39.44; and the highest amount of acid value was recorded from BARI Sarisha-11 (1.867). Gas-liquid chromatographic (GLC) method has been used to determine the composition of essential fatty acid in the seeds of *Brassica* spp. (L.). From the GLC analysis, it was found that erucic acid, oleic acid, linoleic acid and lenolenic acid were the prime fatty acids in all the varieties. Erucic acid was in the range of 41.11 – 51.28%, oleic acid was the highest both in BARI Sarisha-11 and BARI Sarisha- 13 contained (18.69%), while BARI Sarisha-9 contained the highest amount of the unsaturated linoleic (17.75%) and linolenic (15.83%) acids. Moreover, palmitic acid, stearic acid and archidic acid were also present in small amount.

Keywords: Quality; Fatty acid; Rapeseed; Mustard

1. INTRODUCTION

Mustard, a crop belonging to the family Bracicaceae has been a core matter of study traditionally for the plant breeders as well as oil chemists for its enrichment in oil content. After soybean and oily palm, these crops like rape (*B. campestris*L., and *B. napus*L.) and mustard (*B. juncea*) ranks the third position as a source of edible vegetable oils in the world. (FAO, 2011). In Bangladesh, the *Brassica* oil-seed crops have been being practised since long. While the tender leaves being served as vegetables, the seeds of these cultivars are

used to produce lubricating and cooking oil. . Mustard is a high yielding oilseed with a reasonably high content of oil (Riley, 2004). Rapeseed oil is a cholesterol-free product having a balance in the amount of unsaturated fatty acid and it has got the lowest level of saturated fatty acid as well, so it is considered as oil of high nutritional value. (Starner *et al*., 2002).The unsaturated fatty acid of considerable amount as well as 1% erucic acid content of the studied rapeseed varieties mark its oil quality better than animal fat or other herbal oils in the human diet. (Sanavi*et al.,* 2004). Rapeseed-mustard oil quality is determined by the constituent fatty acids including palmitic, stearic, oleic, linoleic, linolenic, eicosenoic and erucic acids; and highly affected by the variety type (Nasr *et al*., 2006; Javidfar *et al*., 2007). Not only the oil quantity but also the oil quality enhancement of rapeseed does fall into the category of the main breeding objectives. (Azizi *et al*., 1999). From nutritional point of view, the most important unsaturated fatty acid is linoleic acid. These essential fatty acids like linoleic acid and linolenic acids are not produced in our body, rather they are to be regularly supplied via daily diet. Moreover, oleic acid being an unsaturated fatty acid has the proved antioxidant effect. (Berry *et al*., 1997). Erucic acid, although, anti-nutritional and should be <2% in the edible oil, higher erucic acid is of considerable industrial importance(Kumar *et al.,* 2014).

2. MATERIALS AND METHODS

Six released varieties of rapeseed and mustard *(Brassica spp.*) namely BARI Sarisha-9, BARI Sarisha-11, BARI Sarisha-13, BARI Sarisha-14, BARI Sarisha-15and BARI Sarisha-16 were selected for the study. From *Brassicacampestris*were BARI Sarisha 9, BARI Sarisha 14, and BARI Sarisha 15. The *Brassicanapus*varieties were BARI Sarisha 13. Varieties BARI Sarisha 11 and BARI Sarisha 16 were from the *Brassicajuncea*group. The seeds were collected from the oilseeds Research centre of BARI, Gazipur. Seeds were cleaned sun-dried and stored in a plastic container in a cool place until used for the chemical analysis.

2.1 Chemical Analyses

2.1.1 Saponification Number:

Saponification number is the amount (mg) of KOH required to saponify one gram of oil or fat dissolved in a solvent. To calculate the saponification number the IUPAC procedure (IUPAC, Standard Methods, 1987, 7th edition) was followed. The procedure in short is, 2.5 gram oil is to be weighed as well as mixed with 25 ml (0.5 N) ethanolic KOH which is then refluxed for about an hour. After refluxing, the solution is to be titrated against HCl where

phenolphthalein is used as an indicator. Disappearance of pink colour is taken as the end-point. Then, maintaining the similar conditions, another blank titration is done.

Saponification number is calculated using the following formula:

$$\text{Saponification value} = \frac{28.1 \times N \times (X-V)}{W}$$

(*Where, N = the normality of HCl,*

X = the volume of HCl used in blank titration (ml),

V = the volume of HCl used in sample (ml),

W = the weight of oil sample in grams.

28.1 = the Equivalent weight of potassium hydroxide.*)*

2.1.2 Iodine value

The iodine values (IVs) were calculated from fatty acid composition by the method of Hashim *et al.*, [29] using the following formula:

IV = (% Oleic × 0.8601) + (% Linoleic × 1.7321)

2.1.3 Acid value

Acid value of oil is determined by titration of a known weight of it against N/.4 sodium hydroxide using phenolphthalein as the indicator. 5-7 g of oil was weighed in 250 ml conical flask and 50 ml denatured alcohol was added and shaken well. Then, 2 ml of phenolphthalein indicator was added and titrated with 0.25 N NaOH after vigorous shaking. completion of titration was marked after the appearance of a permanent light pink color which persisted for at least 1 minute.

$$\textbf{Acid value} = \frac{\textbf{a} \times \textbf{0.00561}}{\textbf{Wt. of oil}} \times \textbf{1000}$$

Where,
a = mL of N/4 NaOH used in titration

2.1.4 Estimation of fatty acid composition

Estimation of fatty acid composition was accomplished with the help of Gas-liquid chromatographic method (Uppstrom*et al*.1978).

2.2 Statistical Analysis:

The experimental treatments ended up in variations which were traced using the MSTAT package program after going through the statistical analysis of the recorded data for each

character from the experiments. Then, the mean for all the treatments was calculated and F variance test was done to do the analysis of variance of characters under the study. The mean differences were evaluated by least significance difference test.

3. RESULTS AND DISCUSSION

Rapeseed and mustard seeds of six varieties were taken for the determination of quality characteristics and variations in fatty acid composition. The seeds were stored in the storehouse under a suitable storage condition.

3.1 Saponification value

Saponification value of oil/fats refers to the number of mg of KOH required to saponify one gram of fats /oil is known as saponification value. It is inversely proportionate to the molecular weight or chain length of the fatty acids present in the fats/oil. Saponification values of different released varieties were ranges from 160.5 to 168.4 and have been presented in **Table 1**. The highest Saponification value was found in BARI Sarisha-14 (168.4). There was no significant variation among the varieties, BARI Sarisha-9 (167.3), BARI Sarisha-15 (165.7), BARI Sarisha-16 (165.8), but the values recorded for these varieties were significantly higher than BARI Sarisha-11 (160.5). The present values are lower than the reported values of Khan *et al*. (2013), Martin *et al*. (1995) and Richet *et al*. (1987). They determined that the Saponification value of the extracted mustard oils were >170,170 and 182.4 respectively. However, these values are supported by Chowdhury *et al. (*2014).

3.2 Iodine value

Iodine value is defined as grams of iodine absorbed by 100 gm fats/oil. Its help to estimate the degree of unsaturation. The iodine values of different varieties of rapeseed and mustard have been presented in Table 1. The highest amount of iodine value was observed in BARI Sarisha-11 and BARI Sarisha-13 (39.44), followed by BARI Sarisha-9 (38.52). The lowest amount of iodine value recorded in BARI Sarisha-14 (36.19), followed by BARI Sarisha-16 (37.49). The observed values were supported by the reported values of Chowdhury *et al. (*2014), Khan *et al*. (2013), Richet *et al*. (1987) and Martin *et al*.

3.3 Acid value

It is defined as the milligrams of KOH required to neutralize the free fatty acids present in 1 gm of fats/oil. This value is applied to determine the rancidity caused by free fatty acids. Acid

values of different varieties of mustard and rapeseed have been presented in Table 1. The highest acid value was found from BARI Sarisha-11 (1.867), followed by BARI Sarisha-13 (1.667); whereas the lowest acid value was found from BARI Sarisha-16 (1.240). followed by BARI Sarisha-9 (1.310). Chowdhury *et al. (*2014) and Khan *et al*. (2013) found the more or less similar result. Although the present values were lower than the reported values of Richet *et al*. (1987) and Martin *et al.* (1995).

Table 1. Chemical constant of oil of the different varieties of rapeseeds and mustard (*Brassica campestris)*

Name of the varieties (Treatment)	Saponification Value	Iodine value	Acid value
BARI Sarisha-9	167.3 ab	38.52 b	1.310 e
BARI Sarisha-11	160.5 c	39.44 a	1.867 a
BARI Sarisha-13	163.7 bc	39.44 a	1.667 b
BARI Sarisha-14	168.4 a	36.19 e	1.447 d
BARI Sarisha-15	165.7 ab	37.59 c	1.520 c
BARI Sarisha-16	165.8 ab	37.49 d	1.240 f
$LSD_{(0.05)}$	4.025	0.07116	0.05695
CV (%)	1.34	0.01	1.04

Figure in a column followed by a common letter do not differ significantly at 5% level by DMRT

3.4 Fatty acid composition

Table 2 presents the demonstration of the Gas chromatography results. The results marked out the significant difference found in between the studied rapeseed and mustard varieties in respective of their fatty acid composition. Thus, palmitic acid presence was highest recorded in BARI Sarisha-9 (2.88%). The next large amount of palmitic was found in BARI Sarisha-16 (2.216%) and BARI Sarisha-14 (2.208%). On the contrary, BARI Sarisha-13 (2.078%) was found with the lowest content of palmitic acid which was significantly similar to the palmitic acid content of BARI Sarisha-15 (2.084%) and BARI Sarisha-11 (2.087%). Now, stearic acid had the concentration range in between 1.042 and 1.397% and arachidic acid had the concentration range in between 4.482 and 7.391%. The highest recorded amount of oleic acid (18.69%) was found in both of the BARI Sarisha-11 and BARI Sarisha- 13; whereas it was recorded lowest in BARI Sarisha-9 (9.031% and this was the lowest amount in respect of all the varieties. Lenoleic acid had the concentration range between 13.49 and 17.75%. BARI Sarisha-9 had the highest percentage (17.75%) of linoleic acid and at the same time, it

was the highest recorded amount among all the varieties. But, both of the BARI Sarisha-11 and BARI Sarisha-13 contained the lowest amount (13.49%) of linoleic acid. The linoleic acid is mainly a significant content for its effectiveness in the synthesis of food products from the oil. These varieties also contained linolenic acid and erucic acid. The range of concentration of linolenic acid and erucic acid was 6.842-15.83% and 41.11-51.28% respectively. The amount of erucic acid was different among the varieties of rapeseed-mustard. The highest recorded amount of erucic acid was found in BARI Sarisha-13 (51.28%) followed by BARI Sarisha-16 (51.03%) and BARI Sarisha-9 (41.11%) was recorded with the lowest amount of it. Moreover, BARI Sarisha-9 was the lowest among all the varieties in respect of its erucic acid content. GLC analytical data reveals that there was a greater amount of unsaturated fatty acid ranging from 78.15 to 90.65% with only a minor presence of saturated fatty acid (7.663 to 10.70%) as found in the six varieties of mustard and rapeseed oils. Even the recent data reveals that it can be recommended for edible purpose because of its higher unsaturated fatty acid content. These findings are in conformity with the results by Mubashir (2012), Abul-fadl *et al.* (2011), Chauhan and Kumar (2011), Moser *et al*. (2009), Niraz*et al*. (2001) and Appelqvist (1980). Mubashir, (2012) stated that mustard oil contains 42% Erucic acid and 12% Oleic acid, 6% omega-3 alpha-Linolenic acid, 15% omega-6 linoleic acid along with 12% saturated fats. . Chauhan and Kumar, (2011), observed that the concentration of oleic acid (18:1), a beneficial monounsaturated fatty acid, ranges from 3.6-32.2% in rapeseed-mustard oil. Abul-fadl *et al*. (2011) reported that erucic acid was in yellow and brown mustard seeds oils was represented about 37.89 and 23.90%, respectively. Oleic acid was ranged between 19.08 to 20.24% of total fatty acid profiles in both yellow and brown mustard seed oils, respectively. Moreover, linoleic acid was recorded about from 12.37 to 21.36 in both yellow and brown mustard seed oils, respectively. Moser *et al*. (2009) stated that mustard oil has a speciality in its fatty acid composition. It contains about 20–28% oleic acid, 10–12% linoleic, 9.0–9.5% linolenic acid, and 30–40% erucic acid. Moreover, Appelqvist (1980) found that fatty acid composition of mustard varieties i.e., 3.0%, 0.8%, 9.9%, 13.5%, 9.8%, 6.3% and 52.3% for palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, eicosenoic acid and erucic acid, respectively.

Table 2. Fatty acid composition of the different varieties of rapeseeds and mustard (*Brassica campestris)*

Name of the	Percentage of fatty acids

variety (Treatments)	Palmitic Acid (C16:0)	Stearic Acid (C18:0)	Arachidic Acid (C20:0)	TSFA	Oleic Acid (C18:1)	Linoleic Acid (C18:2)	Linolenic Acid (C18:3)	Erucic Acid (C22:1)	TUSFA
BARI Sarisha-9	2.880 a	1.082 e	4.482 f	8.444 c	9.031e	17.75 a	15.83 a	41.11 f	83.73 e
BARI Sarisha-11	2.087 c	1.227 c	7.391 a	10.70 a	18.69 a	13.49 e	7.551 b	44.91 d	84.64 d
BARI Sarisha-13	2.078 c	0.9580f	4.627 e	7.663 f	18.69 a	13.49 e	7.188 c	51.28 a	90.65 a
BARI Sarisha-14	2.208 b	1.299 b	5.600 b	9.107 b	12.21 d	14.83 b	7.110 d	44.01 e	78.15 f
BARI Sarisha-15	2.084 c	1.397 a	4.737 d	8.218 e	15.19 b	14.16 d	6.925 e	50.67 c	86.95 b
BARI Sarisha-16	2.216 b	1.188 d	4.961 c	8.365 d	14.63 c	14.38 c	6.842 f	51.03 b	86.88 c
LSD $_{(0.05)}$	0.01707	0.02372	0.01801	0.03151	0.03639	0.03305	0.05081	0.03033	0.04068
CV (%)	*0.14*	*1.07*	*0.04*	*0.16*	*0.02*	*0.02*	*0.01*	*0.01*	*0.00*

Figure in a column followed by a common letter do not differ significantly at 5% level by DMRT

4. CONCLUSION

Of all these varieties, BARI Sarisha-14 was recorded with the highest saponification value of 168.4. Values recorded for all varieties were significantly higher than BARI Sarisha-11(160.5). The highest amount of iodine value was observed in BARI Sarisha-11and BARI Sarisha-13 (39.44) and the lowest amount of iodine value recorded in BARI Sarisha-14 (36.19). The highest acid value was found from BARI Sarisha-11(1.867); whereas the lowest acid value was found from BARI Sarisha-16 (1.240). Besides, palmitic acid was found highest in BARI Sarisha-9 (2.88%) and it was found lowest in BARI Sarisha-13 (2.078%). The concentration of stearic acid varied from 1.042 to 1.397%; whereas arachidic acid contents ranged from 4.482 to 7.391%. the highest amount (18.69%) of oleic acid was calculated in both of the of BARI Sarisha-11 and BARI Sarisha- 13, whereas the lowest amount was marked in the BARI Sarisha-9 (9.031%) and this is the lowest value recorded among all the varieties. Again, the linoleic acid was recorded highest in BARI Sarisha-9 (17.75%) and it was found lowest in both of the BARI Sarisha-11 and BARI Sarisha-13(13.49%). The concentration of linolenic acid wad between the range of 6.842 to 15.83%. Moreover, erucic acid was found highest in BARI Sarisha-13 (51.28%) and it was recorded lowest in BARI Sarisha-9 (41.11%) which was also the lowest recorded amount among all the varieties. Mustard and rapeseed contained a range of 78.15 to 90.65% unsaturated fatty acid and merely a range of 7.663 to 10.70% saturated fatty acid.

5. REFERENCES

Abul-Fadl, M.M.A, Badry, N. E. and Ammar M.S. (2011). Nutritional and chemical evaluation for two different varieties of mustard seeds. *World applied science journal*. **15**(9): 1225-1233.

Appelqvist, L.A. (1980). Fatty acid composition of the different varieties of *Brassica* seed oils. *J. Am. Oil chemt. Soc*. **48**(2): 852-853.

Azizi, M., Soltani, A., Khorsani, S.K., (1999). *Brassica* Oilseeds: Production and utilization, JehadDaneshgahi Press, Mashhad, Iran, 1,230.

Berry, E.M., Rivlin, R.S., Am, J. andNutr, C.(1997). **66**(4): 991-997.

Chauhan,J.S. and Kumar, S. (2011). Assessment of oil and seed meal quality parameters of rapeseedmustard group of crops. *Indian J Agricul Sci.* **81**: 140-144.

Chowdhury, M.F.N, Ahmed, K.U., Hosen,m.,Paul, R.K. and Bhattacharjya, D.K. (2014). Evaluation of Grain Weight, Moisture, Dry Matter, Oil Cake, *β*-carotene, Oil Constant and Aflatoxin Content of Different Varieties and Advanced Lines of Mustard and Rapeseed.*IOSR Journal of Agriculture and Veterinary Science*. **7**(6): 34-39.

FAO, Food Outlook, 2011. Available at: http://www.fao.org/giews/english/fo/index.htm.

Hashim, I.B., P.E. Koehler, R.R. Eitenmiller and C.K. Kvien, 1993. Fatty acid composition and tocopherol content of drought-stressed florunner peanuts. *Peanut Science,* 20: 21-24. S. C. Larsson and A. Wolk. 2007. More Magnesium-Rich Food for Less Diabetes.

IUPAC, Standard Methods: Standard Methods for the Analysis of Oils, Fats and Derivatives, 7th edition. (International Union of Pure and Applied Chemistry, Blackwell, Oxford, 1987).

Javidfar, F., Ripley, F., Zeinaly, H., Abdmishani, S., Tavakol, R., Afshari, Alizadeh, B. andJafarieh, E. (2007). Heritability of fatty acids composition in spring oilseed rape (Bassicanpus l.*)J. Agri. Sci.***17**(3): 57-64.

Khan, A., Sankhyan, P. and Kumar, S. (2013). Biochemical characterization of Mustard Oil (*Brassica campestris*L.) with special reference to its fatty acid composition. *Asian J. of Adv. Basic Sci*. **1**(1): 1-9.

Kumar, S., Singh, D. and Dutta, M.(2014)Quality characteristics in rapeseed-mustard and role of some anti-nutritional factors in plant defense: future strategies. *Journal of Oilseed Basic*. 5 (2): 87-95.

Martin, G. and Adre, E. (1995). Bulletin. *Chem. Soc.* France. **7**: 217-225.

Moser, B. R., Shah, S.N., Winkler, J. K., Vaughn, S.F. and Evangelista, R.L. (2009). Composition and physical properties of cress (*Lepidiumsativum*L.) and field pennycress (*Thlaspiarvense*L.) oils. *Industrial Crops and Products*. **30**(2): 199–205.

Mubashir, W., Bakshi, H., Ahmad, N., bhat and waheed-u-zaman. (2012). effects of seed-borne mycoflora on sugar, oil and fatty acid composition of three varieties of mustard (*brassica compestris*) viz,basanti, kalasona, kaveri ak-47. *Int. j pharm bio sci*. **3**(4): (b) 421 – 428.

Nasr, N. , Khayami, M., Heidary, R., Jamei, R. (2006).Genetic Diversity among Selected Varieties of Brassica napus (Cruciferae) Based on the Biochemical Composition of Seeds .*J. Sci. (JSUT)*.**32**(1): 37-40.

Niraj, K., Rajesh, K, Srivastava, S., Sahai, V.N. and Sinha, S.K. (2001). Oil content and fatty acid profile of late sown Indian mustard. Department of Plant Breeding.Rajendra Agricultural University. **10**(1): 5-7.

Richet, H., Raget, S. and Raquot, C. (1987). Chemical characteristics of oil. ITERG. **4**: 24-25.

Riley, W. W. (2004). The Canadian biodiesel industry: An analysis of potential feedstocks. Biodiesel Association of Canada. Report available at www.greenfuels.org. June 19, 2008.

Sanavi, S.A.M. , Daneshgar, G.H.R. (2004). In: S. Movafegh et al (Ed.), Proceeding of 8th Iranian crop production & breeding congress. 25-27, Rasht, Iran (Novin Press, Rasht 2004) 492.

Starner, D.E., Hamama, A.A., Bhardwaj, H.L. (2002). In: Janick J. and Whipkey, A.(Ed)Trends in new crops and new uses, Alexandria, VA, Egypt (ASHS Press, Alexandria, 2002) p.127-130.

Uppstrom, B., and Johansson, S.A. (1978). Methods for determination of fatty acids applied to a breeding program. In: Proceedings, 5th international rapeseed conference. Vol .1. Malmo, Sweden, pp.140-144.