IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 7, Issue 6 Ver. III (Jun. 2014), PP 34-39
www.iosrjournals.org

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

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Abstract: *Experiment was conducted on six varieties including two advanced line growing in large scale in Bangladesh. These varieties were evolved by BARI and work was conducted for evaluation of physicochemical parameters of the rapeseed and mustard. Among these varieties, the highest grain weight was obtained from BARI Sarisha-9 (4.9g) and lowest grain weight obtained from BARI Sarisha-15 (2.9g).The variety BARI Sarisha-15 was contained highest amount of moisture (9.55%) while lowest amount was found advanced line Din-2 (5.78%). Among all the treatments, highest dry matter contained was showed by Din-2 (94.22%) and lowest amount showed by BARI Sarisha-15 (90.55%). Highest amount of oil cake was given by BARI Sarisha-12 (59.95%) and lowest amount gave by BARI Sarisha-14 (57.75%). BARI Sarisha-14 possessed the highest amount of β-carotene (23.56µg) and lowest amount was observed by BARI Sarisha-9 (4.19µg). BARI Sarisha-14 possessed the lowest dry wt. of oil cake (49.70%) and highest dry wt. of oil cake was observed by BC-2193 (53.03%). The highest amount of saponification value was recorded by BARI Sarisha-14 (168.3) and lowest amount was recorded by BC-2193 (154.6).The highest amount of iodine value was recorded by BARI Sarisha-14 (110.2) and lowest amount was recorded by Din-2 (93.45). The highest amount of acid value was recorded by BARI Sarisha-14 (1.61) and lowest amount was recorded by BC-2193 (1.31).*

Keywords: *Grain Weight, Dry Matter, β-carotene, Oil Constant and Aflatoxin*

I. Introduction

Seed may be considered a small box containing nutrients for dormant embryo i.e., the miniature plant. These nutrients are also used by animals and humans for their dietary needs. Among all other constituents certain seeds are mainly used for their oil content, which are generally called oil seeds. The daily dietary requirements of oils could be fulfilled from the various oil seed crops [**1**]. Oils from plant seeds, called vegetable oil, are mostly edible and used in food preparations. Vegetable oils are preferred over the solid animal fats because of health benefits. Oils contain higher proportion of unsaturated fatty acids, while solid fats contain more saturated fatty acids, which increased the low density lipoprotein level of the blood, which is considered harmful for human health [**2**]. Vegetable oils are used as the preferable choice in food preparations. Our farmers grow different oil-seed crops. The oil obtained from these crops contains significant amount of linolenic acid [**3**]. An important segment of Bangladesh agriculture is oilseed crops. In our country about ten oilseed crops are grown. These are mustard, sesame, groundnut, linseed, niger, safe flower, soybean, sunflower and castor. Among these, Brassica oil crop is the most important species that supply major edible oils in Bangladesh [**4**]. Rapeseed and mustard is the third highest source of edible oil supply in the world after soybean and palm [**5**]. Oils in our diets are mostly needed for calories and vitamin absorbent. 1 gm of oil produces 9 kcal energy, comparison with other diets (carbohydrate and Protein). In a balanced diet for human health 20-25% of calories should come from fats and oils.

The Brassica oil-seed crops have been grown in Bangladesh since long. The tender leaves of these cultivars serve as vegetable, while the seeds as a source of lubricating and cooking oil. The mustard oil is not used only for cooking purpose but also is used for hair dressing, body massing and for different types of pickles preparation. It is also used as medicinal values. The residue left after oil extraction (i.e., oil cake or meal) being rich in protein [**6**] can be used as livestock feed [**7**]. The protein quality and quantity of *B. campestries* obtained oil cake is high. Oil cakes/oil meals are by-products obtained after oil extraction from the seeds. Oil cakes are of two types, edible and non-edible. Edible oil cakes have a high nutritional value; especially have protein content ranging from 15% to 50% (www.seaoWndia.com).Their composition varies depending on their variety, growing condition and extraction methods. Due to their rich protein content, they are used as animal feed, especially for ruminants and fish. Nonedible oil cakes such as castor cake, karanja cake, neem cake are used as organic nitrogenous fertilizers, due to their N, P and K content. Some of these oil cakes are found to increase the nitrogen uptake of the plant, as they retard the nitrification of soil. They also protect the plants from soil nematodes, insects, and parasites; thereby offer the great resistance to infection (www.itdgpublishing.org.uk).

In addition there are some cultivars viz. BARI Sarisha-9, BARI Sarisha-12, BARI Sarisha-14, BARI Sarisha-15, Din-2 and BC-2193 are now cultivating in different parts of the country. The oil quality of all these varieties is not yet analyzed. If the oil quality of rapeseed and mustard is known, its consumption as well as its multipurpose uses will be increased which play a vital role in improving the nutritional status of the people of Bangladesh.

II. Material And Methods

2.1. Materials and Measurement

The experiment was carried out at the Biochemistry laboratory of the Department of Biochemistry, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh and Post Harvest Technology Division BARI Joydebpur, Gazipur, Bangladesh. Four released varieties and two advanced line of mustard (*Brassica Campestries*) namely BARI Sarisha-9, BARI Sarisha-12, BARI Sarisha-14, BARI Sarisha-15, Din-2 and BC-2193 were collected from the Oilseeds Research Centre of BARI, Gazipur, Bangladesh. Seed were cleaned sun dried and stored into plastic container in a cool place until used for the chemical analysis. All the chemicals used were collected from Merck (Germany), Wako Pure Chemicals Industries Ltd. and JHD (China). These chemicals were analytical, spectroscopic grade and were used without further purification unless otherwise specified. The sample was weighted by electric balance (KEY: JY-2003; China) and heated in a muffle furnace (Nebertherm: Mod-L9/11/c6; Germany). The amount of *β*-carotene and aflatoxin were determined by spectrophotometer (HALO BD-20S; Germany).

2.2. Determination of Physical Properties of Mustard Varieties and Rapeseed

Seed were cleaned sun dried and stored into plastic container in a cool place until used for the chemical analysis. Therefore they are ready to be analyzed.

2.2.1. Determination of Grain Weight

Grain weight was determined by thousand seed sample weighted by electric balance. Grain weight is a very important character of rapeseed and mustard, where highest consideration is one of the seed yield. This character has been found to vary widely from genotypes to genotypes and from environment to environment.

2.2.2. Determination of Moisture and Dry Matter

Dry Matter was determined by keeping weighted quantity of sample in a thermostat controlled oven at 105ºC for 6 hours. The dry weight of each sample was taken in an electric balance. The percentage of the dry mater was then calculated by the following formula.

$$\textbf{Moisture (\%)} = \frac{\textbf{Initial Wt. - Final Wt.}}{\textbf{Original weight of sample}} \times 100$$

$$\textbf{Dry Matter (\%)} = \frac{\textbf{Wt. of oven dried sample}}{\textbf{Original weight of sample}} \times 100$$

2.3. Determination of Chemical Constant of Mustard Varieties and Rapeseed

2.3.1 Saponification Value

At first, 2 g fat was taken in 250 ml round bottom flask and 25 ml, 0.5 N alcoholic potassium hydroxide solution added in same flask. The flask was fitted with a long air condenser and heated solution at reflux temperature about 30 minutes. Finally, the flask was cooled and added 1 ml of 1% phenolphthalein solution and titrate the excess of the alkali against standard 0.5 N HCl acid. At the same time and under similar conditions carry out a blank titration without fat (25 ml, 0.5 N same alcoholic KOH solution was taken in another round bottom flask and heated in a similar way and titrated, against 0.5 N acid). 1 ml of 0.5 N HCl acid was equivalent to 0.02805g of KOH.

$$\textbf{Saponification value} = \frac{\textbf{(b-a)} \times 0.02805 \times 1000}{\textbf{Wt. of substance in g}}$$

Where,
a = mL of 0.5 N acid required in sample solution titration
b = mL of 0.5 N acid required in blank solution titration

2.3.2. Iodine Value

5 g of oil or fat was taken into 200 ml a glass stoppered bottle. 5 ml of CCl_4 was added to dissolve this oil after 25 ml of Wij's solution was added and to allow it at least 1 hour in a dark place. Then 5 ml of 10% potassium iodide solution and 50 ml water were added to each bottle and titrated against 0.1 N $Na_2S_2O_3$ using starch solution as the indicator, near the end point of titration the colour of solution becomes pale yellow. Blue colour disappears which indicates the end point. At the same time and under similar conditions carry out a blank titration without oil or fat.

$$\text{Iodine value} = \frac{100}{\text{Wt. of oil}} \times 0.0127 \times (V_1 - V_2)$$

Where,
V_1 = mL of 0.1N $Na_2S_2O_3$ used in blank titraion
V_2 = mL of 0.1N $Na_2S_2O_3$ used in the case of oil titration

2.3.3. Acid Value

5-7 g of oil was weighed in 250 ml conical flask and 50 ml denatured alcohol added and shaken well. 2 ml of phenolphthalein indicator was added and titrated with 0.25 N NaOH after vigorous shaking, completion of titration was appeared a permanent light pink color which persists at least 1 minute.

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

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

2.4. Determination of Chemical Characteristic and Aflatoxin Content of Mustard Varieties and Rapeseed

The quantity of aflatoxin was examined by using spectrophotometer [**8**]. For this purpose, the seeds of *Brassica campestris* were dried and put in polyethylene bags at 3 months. The quantity of *β*-carotene was examined by using spectrophotometer. The recorded data for each character from the experiments was analyzed statistically to find out the variation resulting from experimental treatments using MASTAT package program. The mean for all the treatments were calculated and analysis of variance of characters under the study was performed by F test. The mean differences were evaluated by Least Significance Difference Test.

III. Results And Discussion

3.1. Physical Characteristics of Mustard Varieties and Rapeseed

Table 1. Weight of 1000 seed, moisture, dry matter of the different varieties and advanced lines of *Brassica campestris*

Name of varieties (Treatments)	Weight of 1000 seeds (at 13% moisture level)	Moisture (%)	Dry matter (%)
BARI Sarisha-9	4.9a	7.57bc	92.44 bc
BARI Sarisha-12	3.3c	8.52b	91.48 d
BARI Sarisha-14	4.2b	7.21c	92.10 cd
BARI Sarisha-15	2.9d	9.55a	90.55 e
Din-2	3.3c	5.78d	94.22a
BC-2193	3.5 c	7.05c	92.95b
LSD $_{(0.05)}$	0.2436	1.031	0.724
CV (%)	3.81	7.85	0.46

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

Weight of thousand grain of different released varieties and advanced lines of *Brassica campestris* were showed in **Table 1**. It was found that seed weight varied with their size and shape. Thousand grain weights were determined at 13% moisture level. The highest thousand grain weight was found in BARI Sarisha-9 (4.9 g). This was significantly higher than all others released variety and advanced lines of *Brassica campestris*, followed by BARI Sarisha-14 (4.2 g). Statistically similar results were shown by BARI Sarisha-12 (3.3 g), Din-2 (3.3 g) and BC-2193 (3.5 g) but these values were significantly higher than the BARI Sarisha-15 (2.5 g) which showed lowest thousand grain weight. The present studies results were higher than the reported results of Mondal and Wahhab (2001) and Hossain *et al*. (1998) [**9**, **10**]. The Thousand grain weight reported by Siddiqui *et al*. (2004), Kumar and Singh (1994), Andarhennadi *et al*. (1991), Biswas (1989), Yin (1989), Chowdhury *et al*. (1987) and Kaul *et al*. (1986) were more/less similar to the present investigation [**11-16**].

In storage condition, the permeable moisture level of different oil seeds are 10-12%. Moisture content is important factor than other nutrients as they vary with it. It is also important for insect infestation and disease. The moisture content of different released variety and advance line of *Brassica campestris* was presented in **Table 1**. The moisture content of different released variety and advanced line was ranged from 5.78-9.55%. The variety BARI Sarisha-15 contained highest amount of moisture (9.55%), followed by BARI Sarisha-12 (8.52%)

and BARI Sarisha-9 (7.57%) and BARI Sarisha-14 (7.21%) which was statistically similar to BC-2193 (7.05%). This result agrees with BARI annual report (1987-88) which reported that moisture content ranges from 7.41-8.38%. These may be influenced by different level of sun drying after harvesting.

A statistically significant variation was observed for dry matter content of different varieties and advanced lines of *Brassica campestries* and that was presented in **Table 1**. Significantly highest amount of dry matter contained was recorded in Din-2 (94.22%), followed by BC-2193 (92.95%) and BARI Sarisha-9 (92.44%). The lowest amount of dry matter contained was found in BARI Sarisha-15 (90.55%) which was significantly lowest among all the variety. These variations might be due to environmental factor, soil and crop management practices.

3.2. Chemical Characteristics of Mustard Varieties and Rapeseed

Oil cake/meals are used for various purposes. Oil cake is a nutritious food items for cattle and fish. It is also used as a good organic fertilizer and ingredient of composts. The BARI Sarisha-12 contained significantly highest amount of oil cake (59.95%), followed BARI Sarisha-9 (59.47%) and BARI Sarisha-15 (59.25%). The lowest value was found in BARI Sarisha-14 (57.75%), followed by advanced line Din-2 (58.14%). The present values were supported by the reported values of Appelqvist *et al*. (1992) [**17**].

Table 2. Proximate analysis oil cake, dry wt. of oil cake and *β*-carotene content of different varieties and advanced lines of *Brassica campestris*

Name of variety (Treatments)	Oil cake (%)	Dry wt. of cake (%)	*β*-carotene (*μ*g %)
BARI Sarisha-9	59.47ab	51.90 ab	4.19e
BARI Sarisha-12	59.95a	50.61bc	14.51c
BARI Sarisha-14	57.75d	50.54 bc	23.56a
BARI Sarisha-15	59.25b	49.70c	19.64 b
Din-2	58.14cd	52.36 a	8.49d
BC-2193	58.66c	53.03a	15.11c
LSD $_{(0.05)}$	0.5365	1.511	2.25
CV (%)	0.53	1.71	9.06

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

Dry oil cakes are used to evaluate the content of different nutrient which are essential for our poultry feed, organic fertilizer and other various purposes. The dry weights of cake are presented in **Table 2**. The highest value was obtained from Din-2 (52.36%), followed by BARI Sarisha-9 (51.90%), BARI Sarisha-12 (50.61%), BARI Sarisha-14 (50.54%) and BC-2193 (53.03%). These treatments are statistically similar. The lowest value obtained from BARI sarisha-15 (49.70%) which was significantly lower than all the varieties.

Yellow mustard and rapeseed variety and advanced lines contained a remarkable amount of carotene which is the precursor of vitamin A. A small fraction of *β*-carotene was determined in this analysis. *β*-carotene content was genetically controlled and decreased with the increase of storage period. Yellow colored variety BARI Sarisha-14 contained 23.56*μ*g of *β*-carotene which was significantly higher than all other variety and advanced lines, followed by BARI Sarisha-15 (19.16*μ*g) **(Table 2)**.The variety BARI Sarisha-12 (14.51*μ*g) and advanced line BC-2193 (15.11*μ*g) gave the statistically similar results and there was no difference between them. These recorded values were supported by Gopalan *et al*. (1991) and Bressani *et al*. (1990) [**18**, **19**]. This variation might be due to variation among the varieties.

3.3. Chemical Constant of Mustard Varieties and Rapeseed Oil

Table 3. Chemical constant of oil of different varieties and advances lines of *Brassica campestris*

Name of the varieties (Treatment)	Saponification Value	Iodine value	Acid value
BARI Sarisha-9	167.3a	99.37c	1.40c
BARI Sarisha-12	167.3a	103.3b	1.49b
BARI Sarisha-14	168.3a	110.2a	1.61a
BARI Sarisha-15	164.7a	105.6b	1.52b
Din-2	155.8b	93.45d	1.45bc
BC-2193	154.6b	94.39d	1.31d
LSD $_{(0.05)}$	3.394	3.920	0.077
CV (%)	1.21	2.25	2.72

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

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 variety and advanced lines were ranges from 154-168.3 and presented in **Table 3**. There were no significant variation among the varieties, BARI Sarisha-9 (167.3), BARI Sarisha-12 (167.3), BARI Sarisha-14 (168.3) and BARI Sarisha-15 (164.7) but the values recorded for these varieties were significantly higher than Din-2 (155.8) which was statistically similar to BC-2193 (154.6).

Iodine value is defined as grams of iodine absorbed by 100 gm fats/oil. It is help to estimate the degree of unsaturation. The iodine values of different varieties and advanced lines of *B. campestris* were presented in **Table 3**. The highest amount of iodine value were observed in BARI Sarisha-14 (110.2), followed by BARI Sarisha-12 (103.3) and BARI Sarisha-15 (105.6). The lowest amount of iodine value recorded in advanced line Din-2 (93.45), followed by BC-2193 (94.39) and the treatments well statistically similar. 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 used in determining the rancidity due to free fatty acids.

Acid values of different variety/advanced lines *Brassica campestris* were presented in **Table 3.** Statistically similar values were recorded for BARI Sarisha-15 (1.52), BARI Sarisha-12 (1.49) and Din-2 (1.45). But these values were significantly higher than the BC-2193 (1.31) which was significantly lower than all other varieties. The present values were lower than the reported values of Richet *et al*. (1987) and Martin *et al*. (1995) [**20**, **21**].

3.4. Aflatoxin Content of Different Varieties and Advances Lines mustard and Rapeseed Oil

Two species of Aspergillus i.e., *Aspergillus flavus*, *Aspergillus parasiticus* produce aflatoxin in food grain. Aflatoxin presents in grain and enters human system causes health hazard. Data were collected on different varieties of rapeseed after 3 month of storage (**Table 4**). In this analysis, Aflatoxin completely absent in variety BARI Sarisha-9, BARI Sarisha-12, BARI Sarisha-14 and advanced line Din-2. On the other hand, trace amount of aflatoxin present in variety BARI Sarisha-15 and advanced line BC-2193. This may be due to sun drying after harvesting. The present analysis was supported by the reported value of Singh *et al*. (2001) and Shantha *et al*. (1997) [**22**, **23**].

Table 4. Estimation of aflatoxin presence in the different varieties and advanced lines of *Brassica campestris*

Name of varieties(Treatments)	Quantities of Aflatoxin (after storage in 3 months)
BARI Sarisha-9	Nil
BARI Sarisha-12	Nil
BARI Sarisha-14	Nil
BARI Sarisha-15	Trace
Din-2	Nil
BC-2193	Nil

IV. Conclusion

From the nutritional analysis, it was observed that none of the variety/advanced line of rapeseed performed the best by all nutrient parameters. BARI Sarisha-14 contained highest amount of saponification value, iodine value and acid value. Its indicates that oil of BARI Sarisha-14 was good in respect of unsaturated fatty acids content, age and extent. Aflatoxin was completely absent among all the varieties this may be due to different level of sun drying and storage system. Farmers are cultivating rapeseed and mustard in their field for the consumption oil & oilcake as food, feed and fertilizer. BARI Sarisha-9, BARI Sarisha-12, BARI Sarisha-14 and BARI Sarisha-15 can be grown in large scale as they contained the fair amount of nutrient contents.

Acknowledgements

The Oilseeds Research Centre of BARI, Joydebpur, Gazipur, Bangladesh is gratefully acknowledged for their kind cooperation regarding the supply the varieties seeds of *Brassica campestris*. I would like to gratefully acknowledged Biochemistry laboratory of the Department of Biochemistry, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh for financial support my M.Sc. research work.

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