Effect Of Different Genotype Of Oilseed On Physico-chemical Characteristics

RAKIBUL HASAN SHARIF

Sher-e-Bangla Agricultural University
Library
Accession No.....
Sign..... Date :.....

DEPARTMENT OF BIOCHEMISTRY
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
SHER-E-BANGLA NAGAR, DHAKA-1207.

JUNE, 2015

Effect Of Different Genotype Of Oilseed On Physico-chemical Characteristics

BY

RAKIBUL HASAN SHARIF

REGISTRATION NO. : 08-03025

A Thesis

Submitted to the Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka,
in Partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE (MS)

IN

BIOCHEMISTRY

SEMESTER: JANUARY - JUNE, 2015

Approved by

.....
(Prof. Dr. Kamal Uddin Ahmed)
Supervisor

.....
(Prof. Md. Nuruddin Miah)
Co-Supervisor

.....
(Prof. Md. Nuruddin Miah)
Chairman
Department of Biochemistry
Sher-e-Bangla Agricultural University

Sher-e-Bangla Agricultural University
Library
Sher-e-Bangla Nagar, Dhaka

DEPARTMENT OF BIOCHEMISTRY
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207

PABX: +88029144270-9
Ext. 309 (Off.)
Fax: +88029112649

Memo No.: SAU/AS

Date:

CERTIFICATE

This is to certify that the thesis entitled "**Effect Of Different Genotype Of Oilseed On Physicochemical Characteristics**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN BIOCHEMISTRY,** embodies the result of a piece of bonafide research work carried out by **RAKIBUL HASAN SHARIF,** Registration No. **08-03025** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

Date: 10.08.2016

Dhaka, Bangladesh

Professor Dr. Kamal Uddin Ahmed
Supervisor

DEDICATION

DEDICATED TO

THIS THESIS IS LOVINGLY DEDICATED

TO

MY PARENTS

ACKNOWLEDGEMENTS

All praises to Almightly and Kindfull trust on to "Almighty Allah" for His never-ending blessing, the researcher deems it a great pleasure to express his profound thankfulness to his respected parents, who entiled much hardship inspiring for prosecuting his studies, receiving proper education. The researcher likes to express his deepest sense of gratitude to his respected supervisor, ***Dr. Kamal Uddin Ahmed****, Professor and Chairman, Department of Biochemistry, Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh for his scholastic guidance, support, encouragement and valuable suggestions and constructive criticism throughout the study period and gratuitous labor in conducting and successfully completing the research work and in the preparation of the manuscript writing. The researcher also expresses his gratefulness to his respected Co-Supervisor,* ***Md. Nuruddin Miah,*** *Professor, Department of Biochemistry, SAU, Dhaka for his scholastic guidance, helpful comments and constant inspiration, inestimable help, valuable suggestions throughout the research work.The researcher also express heartful thanks to all the teachers of the Department of Biochemistry, SAU, for their valuable suggestions, instructions, cordial help and encouragement during the period of the study.The researcher would like to gratefully acknowledged* ***Bangladesh Agricultural Research Institute (BARI)*** *for supply seed to study this research. Oil seed Research Centre and soil science Division, BARI, Joydebpur, Gazipur is gratefully acknowledged for their kind cooperation regarding the provide Laboratory facilities for Biochemical analysis of the rapeseed and mustard varieties. The researcher expresses his sincere appreciation to his brother, sisters, relatives, well wishers and friends for their inspiration, help and encouragement throughout the study period.*

June, 2015 **The Researcher**

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

Effect Of Different Genotype Of Oilseed On Physico-chemical Characteristics

ABSTRACT

In order to evaluate the physicochemical characteristics of oilseeds, three varieties of mustard and three varieties of groundnut seed were collected and studied their seed weight, moisture, ash, carbohydrates, protein, fat, total energy and minerals composition. Among the varieties the highest grain weight was found in BARI Chenabadam-7 (127.90g) and the lowest thousand grain weight was found in BARI Sarisha-15 (3.173g). The highest moisture content was observed from BARI Sarisha-15 (4.52%); whereas the lowest moisture content was found in BARI Chenabadam-7 (3.70%). The variety BARI Chenabadam-9 contained significantly highest amount of oil (49.51%) whereas the variety BARI Sarisha-16 contained lowest amount of oil (40.95%). BARI Sarisha-16 contained highest amount of ash (14.20%). Significantly highest amount of protein was obtained from BARI Chenabadam-8 (34.50%) and the lowest amount of protein obtained from BARI Sarisha-17 (22.57%). BARI Sarisha-17 contained highest amount of carbohydrate (18.85%), whereas BARI Chenabadam-8 contained the lowest amount of carbohydrate-8 (2.55%). BARI Chenabadam-9 contained highest amount of Ca (2.58%) and Cu (14.04%).BARI Sarisha-16 contained highest amount of Zn (66.80%). Highest amount of Fe contained BARI Sarisha-15 (170.260%). Mustard varieties contained erucic acid (51.35-50.67%), whereas groundnut varieties contained no erucic acid. Highest amount of total saturated fatty (TSFA) acid obtained from BARI Chenabadam-17 (16.65%) and the lowest amount obtained from BARI Sarisha-17 (8.27%). BARI Chenabadam-9 contained highest amount of total unsaturated fatty acid (TUSFA) (94.21%), whereas BARI Chenabadam-8 contained lowest amount (83.43%). Highest saponification value found in BARI Chenabadam-8 (183.4) and lowest saponification value was found in BARI Sarisha-15 (157.6). The result of the reviewed work confirms the groundnut varieties seed to be of good quality and can be used for food preparation. The knowledge of this study could be utilized for various food preparation and selection for breeding purpose.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	ACKNOWLEDGEMENTS	i
	ABSTRACT	ii
	LIST OF CONTENTS	iii
	LIST OF TABLES	v
	LIST OF FIGURES	vi
	LIST OF APPENDICES	vi
Chapter 1	**INTRODUCTION**	01
Chapter2	**REVIEW OF LITERATURE**	04
Chapter3	**MATERIALS AND METHODS**	24
	3.1 Materials	24
	3.1.2 Brief description of varieties	24
	3.2 Physicochemical Properties	25
	3.2.1 Determination of 1000 grain weight	25
	3.2.2 Determination of moisture	25
	3.2.3 Determination of ash	26
	3.3 Chemical Analyses	27
	3.3.1 Estimation of oils/fats	28
	3.3.2 Estimation of total protein content	29
	3.3.3 Chemical constant	30
	3.3.3.1 Saponification value	30
	3.3.3.2 Iodine value	31
	3.3.3 Estimation of fatty acid composition	32
	3.3.4 Estimation of Carbohydrate	33
	3.3.5 Estimation of minerals	33
	3.3.6 Estimation of Energy	36
	3.4 Statistical Analysis	36
Chapter4	**RESULTS AND DISCUSSION**	37
	4.1 Physical characteristics of Oilseed varieties	37
	4.1.1 Grain weight	37
	4.1.2 Moisture	38
	4.1.3 Oil content	39
	4.1.4 Oil cake	40
	4.1.5 Dry weight of cake	40
	4.2 Chemical characteristics of Oilseed varieties	41
	4.2.1 Chemical constant of oil	41

CHAPTER	TITLE	PAGE
	4.2.2 Fatty acid composition	43
	4.3 Analysis of oil cake	44
	4.3.1 Ash	47
	4.3.2Protein	48
	4.3.3 Carbohydrate	49
	4.3.4 Minerals	50
	4.4 Gross energy	53
Chapter5	**SUMMARY, CONCLUSIONAND RECOMMENDATION**	56
	REFERENCES	60
	APPENDICES	76

LIST OF TABLES

TABLE	TITLE	PAGE
1.	Weight of 1000 seed, Moisture mustard oilseed varieties	39
2.	Weight of 1000 seed, Moisture groundnut oilseed varieties	39
3.	Proximate analysis of oil content, oil cake and Dry wt. of cake of the different oilseed varieties	41
4.	Chemical constant of oil of different mustard oilseed varieties	43
5.	Chemical constant of oil of different groundnut oilseed varieties	44
6.	Fatty acid composition of the different oilseed varieties	47
7.	Proximate analysis of protein, ash and carbohydrate content of the different oilseed varieties (Dry weight basis)	50
8.	Proximate analysis of minerals content of the different oilseed varieties	52
9.	Proximate analysis of minerals content of the different Oilseed varieties	54
10.	Proximate analysis of Gross energy from carbohydrates, Proteins and oils of the different varieties of oilseed	55

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

LIST OF FIGURES

FIGURE	TITLE	PAGE
1.	Saponification value and Iodine value of different oilseed mustard oilseed varieties	44
2.	Saponification value and Iodine value of different oilseed groundnut oilseed varieties	45
3.	Percentage of total saturated and unsaturated fatty acid of oil of the different varieties of oilseed	48
4.	Gross Energy of the different oilseed varieties	55

Chapter 1

INTRODUCTION

Sher-e-Bangla Agricultural University
Library
Sher-e-Bangla Nagar, Dhaka

Sher-e-Bangla Agricultural University
Library
Accession No.....
Sign..... Date :.....

Chapter I

INTRODUCTION

Oilseed crops have occupied an important place in human nutrition as they remain the major sources of calories and proteins for a large proportion of the world population. Oilseeds are those seeds that contain considerably large amounts of oil. The most commonly known oilseeds (conventional oil seeds) are groundnut, soybean, palm kernel, cotton seed, olive, sunflower seed, rapeseed, sesame seed, linseed, safflower seed, etc (Ajala & Adeleke, 2014; Akintayo & Bayer, 2002; Adeyeye *et al.*, 1999; Aremu*et al.*,2007). Generally, oils and fats from seeds and nuts constitute an essential parts of man's diet. The chief important of the vegetable oils lies in their food value. Vegetable oils derived from plant seeds have been playing vital roles to provide comfort in human lives in various aspects, they are essential in meeting global nutritional demands and are utilized for many food and other industrial purposes (Idouraine *et al.*,1996). In a balanced diet for human health 20-25% of calories should come from fats and oils. Herbal oils are the main sources of fats and fat-soluble vitamins, which have a substantial role in the human diet (Stuchlik,2002). After cereals, oily seeds are the second food sources throughout the world, whose oil is of rich fatty acid types (Siavash, 2005).

Mustard seeds have been highly prized medicinal as well as culinary spice being in use since ancient times. The seeds are obtained from mustard plant (*Brassica spp.*) which also include cabbage, broccoli, Brussels sprouts, etc. Mustard seeds have high energy content, having 28-32% oil with relatively high protein content (28-36%).Well refined mustard oil has a yellow to brown color and its smell and taste are enjoyable. Mustard oil has a special fatty acid composition: 20-28% oleic acid,10-12%linolic,9.0-9.5% linolenic acid and 30-40% erucic acid.The protein quality and quantity of *B. campestries* obtained oil cake is high(Chowdhury *et al.*,2014).Mustard seeds contain 28-32% protein by weight, although these values can vary slightly between varieties, growing

regions and crop years (Canadian Grain Commission, 2012).The amino acid composition of mustard protein is well balanced, it is rich in essential amino acids. Rapeseed and mustard contain relatively lower amount carbohydrate. It consists mainly glucose, sucrose and fructose crude fiber, dry mustard seeds contained 20-23% carbohydrate. Mustards are rich source of many health benefiting minerals. Calcium, manganese, copper, iron, selenium and zinc are some of the minerals especially concentrated in these seeds. Calcium helps to build bone and teeth. Manganese is used by the body as a co-factor for the antioxidant enzyme superoxide dismutase. Copper is required in the production of red blood cells while iron is required for the red blood cell formation and cellular metabolism (Sarwar *et al.*, 2009). Its ground seeds act as a laxative, stimulant to gastric mucosa and increase intestinal secretion (Sarwar *et al.*, 2009; Sarwar, 2004).These crops, including rape *(B. campestris L., and B. napus L.)* and mustard (*B. juncea*) are the third major source of edible vegetable oils in the world, after soybean and oily palm (FAO, 2011). The residue left after oil extraction (i.e., oil cake or meal) being rich in protein (Durrani and Khalil, 1990) can be used as livestock feed.

Groundnut or peanut (*Arachis hypogaea*), is a species in the legume family Fabaceae, native to South America, Mexico and Central America (Gibbon and Pain, 1985). Groundnuts have been known to man as an important food crop for many centuries. However, they acquired economic importance only 130 years ago and even as late as 60 years ago in the developed and developing countries (Demba, 1985). China, India and USA are the main producers of groundnuts to the rest of the world (Campos-mondragon *et al.*, 2009). In Bangladesh, groundnut (*Arachis hypogaea L*) is the 2nd important oil seed crop next to mustard (*Brassica spp.)* on the basis of annual production, and it stands 3rd next to sesame (*Sesamum indicum L.*) on the basis of acreage among the major oil crops. It is a major source of edible oil and protein meal and considered highly valuable for human and animal nutrition especially in the developing world. Groundnut is grown mainly for its oil, protein, plant residue and seed cake. Being a legume crop, Groundnut seed contain 44-56% oil and

22-30% protein on a dry seed basis and is a rich source of minerals (phosphorus, calcium, magnesium and potassium) and vitamins (E, K and B group) (Savage and Keenan, 1994). The nutritive value of food is high as the groundnut is affordable and serves as good source of oil and protein (Atasie *et al.*, 2009). Groundnut oil is composed of mixed glycerides and contains a high proportion of unsaturated fatty acids, in particular, oleic (50-65%) and linoleic (18-30%) (Young, 1996). Nuts are a good source of oil containing higher unsaturated fatty acids (UFAs) to saturated fatty acids (SFAs) ratio. Groundnut cake, a by-product of oil extraction, is an excellent livestock feed because of its high protein content. The cake contains 45-60 protein, 22-30% carbohydrate, 3.8-7.5% crude fiber and 4-6% minerals (Desai *et al.*, 1999). The oil of groundnut is one of the most important vegetable oil in regions where other oily vegetables cannot grow up (Norman *et al.*, 2005; Smart, 1994). In our country fried or roasted groundnut is popular snacks.

Oilseed crops are critically needed in many developing countries where protein-energy malnutrition remains a major health hazard, especially among children. They are grown primarily for the oil contained in seeds. The protein quantity and quality, caloric value, and overall nutrient content of oilseeds are quite good. Some oil seed cultivars viz. BARI Sarisha-15, BARI Sarisha-16, BARI Sarisha-17, BARI Chinabadam-6,BARI Chinabadam-7,BARI Chinabadam-8 are widely cultivated throughout the country. If the nutritional status of oil seed is known, their consumption and multipurpose uses will be increased. The characteristics of oils from different sources depend mainly on their compositions and no oil from a single source can be suitable for all purposes, thus the study of their constituents is important. Hence the physicochemical properties of these popular selected varieties was undertaken to ensure their nutritional status with following objectives:

I. To determine the oil content;
II. To determine the protein, carbohydrate of oil cakes;
III. To determine the minerals content of oil cakes;

Chapter 2

REVIEW OF LITERATURE

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

Chapter II

REVIEW OF LITERATURE

Vegetable oils and fats constitute an important component of human diet, ranking third after cereals and animal products. Oilseeds are leading suppliers of superior quality and specialty vegetable oils to nutritional products, natural food and premium snack food worldwide. Mustard and Groundnut are considered to be the most important source of vegetable and protein rich meal worldwide. Oilseeds add important nutritional value to the diet due to high quality protein and or vegetable oil, together with oil soluble vitamins like vitamin A. As a high energy component of food, edible oil is important for meeting the caloric requirement. Physical properties, chemical analysis, estimation of minerals and total energy of different types of Mustard and Groundnut varieties observed by other researcher are described in this section.

Grain Weight

Chowdhury *et al.*, (2015) experimented the Comparative Study on Chemical Composition of five varieties of groundnut (A*rachis hypogaea*) and found the highest grain weight of BARI Chinabadam-7 (128.3g) and lowest seed weight was found in Dhaka-1(66.76g).

According to Abdulrazak *et al.*, (2014) groundnut shell contained moisture 8.00%.

Chowdhury *et al.*, (2014) found that seed weight varied with their size and shape. The highest thousand grain weight was found in BARI Sarisha-9 (4.9 g) and BARI Sarisha-15 (2.5 g) showed the lowest thousand grain weight.

Damian (2014) said that, 1000 seed mass of the mustard seeds increased from 4.3g to 5.1g, as the moisture content increased from 7.0 to 15.99 %(d.b.).

Banga *et al.*, (2013) observed the seed yield in different genotypes was mainly governed by seed yield per plant. The 1000-seed weight was the maximum in RL-1359 (5.15g) whereas it was at par in other genotypes. The experiment consisted of four genotypes of Indian mustard (RL-1359, TAC-437, Kranti and NRCDR-601).

Yari *et al.*, (2013) carried out an experiment on soyabean cultivars to determine the mean comparison of effect of planting date and quality traits and found highest 147g of 1000 seed weight on planting date 21 May and lowest 112.56g of 1000 seed weight on planting date 20 June.

Gashti *et al.*, (2012) conducted an experiment to determine the effect of potassium and calcium application on yield, yield components and qualitative characteristics of peanut (*Arachis hypogaea L.*) in Guilan province, Iran. He observed that the highest 100 kernels weight obtained in 90 kg ha-1 of calcium that had considerable difference than the others.

Ayoola *et al.*, (2012) conducted an experiment on Chemical evaluation of food value of groundnut (*Arachis hypogaea*) seeds the result showed that the groundnut seeds (raw ,sundried and roasted) contain moisture content of 7.40%, 3.40%, 1.07%;

Premarani *et al.*, (2011) carried out an experiment to evaluate the nutritional potential of soyabean (hawaijar). Based on the proximate analysis results, some differences in chemical compositions between three days fermented soybean and stored hawaijar and observed hawaijar (3 days fermented soybean) contained 62.1% moisture.

Ingale *et al.*, (2011) carried out an experiment on Proximate composition, anti-nutritional and nutritional value of seeds of new variety of groundnut (*Arachis hypogaea L*) JL-24 and found groundnut seed contain moisture (5.529%).

Mustard intended for long-term storage should be kept at less than 9% moisture. If the mustard needs to be dried for safe storage, the drying air temperature and seeds' temperature should not exceed 65 and 45^{0}C, respectively (Barrozo *et al.*, 2008).

Rahman (2006) worked on the effect of calcium and Bradyrhizobium inoculation of the growth, yield and quality of groundnut (*A. hypogaea L.*) and reported that 100 seed weight of groundnut varied significantly with calcium application. The heaviest seed in 1979-98 was produced with 150 kg Ca ha-1, which produced at par weight with 100 kg Ca ha-1. Other treatments produced significantly poorer weighed seed and were identical with the control and the lightest seed was obtained in control. In 1998-99, a similar result was also obtained excepting that only 50 kg Ca ha-1and control produced identical results.

Siddiqui *et al.*, (2004) introduces some important characteristics of *Brassica carinata* cultivars (IGC-01 and *Pusa Gaurav*), *B. juncea* cultivars (Jagannath, Kranti, Rohini, and TERI (OE) M21-Swarna) and *B. napus* cultivars (Hyola PAC-401) in case of grain weight. They reported that highest grain weight observed TERI (OE) M21-Swarna (3.95g) among these cultivars.

Mondal *et al.*, (2001) found that weight of 1000 seeds varied from variety to variety and species to species. They found that thousand seed weight of 2.50-2.65 g in case of improved Tori-7 (*B. campestris*) and 1.50-2.80 g in Rai-5 (*B. napus*).

Huda (2001) conducted an experiment the moisture content of rapeseed mustard varieties. They suggest that seeds having moisture content from 8-10% stored well and safe moisture content for sealed storage is 4-8%.

Karim *et al.*, (2000) reported that varieties showed significant difference in weight of thousand seeds. They found higher weight of 1000 seed in J-3023 (3.43 g), J-3018 (3.42g) and J-4008 (3.50 g).

Karim *et al.*, (2000) reported that varieties showed significant difference in weight of thousand seeds. They found higher weight of 1000 seed in J-3023 (3.43 g), J-3018 (3.42g) and J-4008 (3.50 g).

According to Kumar and Singh (1994) in *B. juncea,*Kudla (1993) in sewede rape, Andarhennadia *et al.*, (1991) in brown mustard, Biswas (1989) in *B. campestris*, Labowitz (1989) in B. rapa, and Chowdhury *et al.*, (1987) in *B. rapa* found different degrees significant variations of thousand seed weight due to variable genotypes.

Hossain *et al.*, (1998) observed significant variation in 1000 seed weight as influenced by different varieties. They found Hyda-401 had the highest thousand seed weight (3.43 g) and the lowest thousand seed weight was recorded in Tori-7 (2.1 g).

Blamey and Chapman (1982) reported that liming increased 100-kernel mass of groundnut.

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.

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

BARI (1987-88) carried out an experiment to determine the moisture content of rapeseed-mustard varieties. They reported the moisture content of different varieties i.e., 7.06%, 8.36%, 7.66%, 7.98%, 7.41%, 8.38%, 7.81%, and 7.82% for SS-75, Krisna, PT-303, Varuna, TS-72, Kranti, S-5 and Tori-7, respectively.

Moisture

According to Sarker *et al.*, (2015) moisture content of black and yellow mustard cakes were 9.20 ± 0.5% and 9.73 ± 0.6%. The results of the moisture content were slightly higher than the moisture content 8.3 ± 0.2% reported in literature. (Mahmud *et al.*, 2012; Marnoch and Diosady, (2006).

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.

According to Sarker *et al.*, (2015) moisture content of black and yellow mustard cakes were 9.20 ± 0.5% and 9.73 ± 0.6%. The results of the moisture content were slightly higher than the moisture content 8.3 ± 0.2% reported in literature.(Mahmud *et al.*, 2012; Marnoch and Diosady, 2006).

According to Chowdhury *et al.*, (2015) the range content moisture of groundnut varieties were 1.230% to 5.120%.

Ingale *et.al.*, (2011) conducted an experiment to determine the Nutritional study of new variety of groundnut (*Arachis hypogaea L.*) JL-24 seeds and he found the highest moisture content of 5.529% and the lowest moisture content of 1.149%.\

Mustard intended for long-term storage should be kept at less than 9% moisture. If the mustard needs to be dried for safe storage, the drying air temperature and seeds'temperature should not exceed 65 and 45^{0}C, respectively (Barrozo *et al.*, 2008).

Huda (2001) conducted an experiment the moisture content of rapeseed mustard varieties. They suggest that seeds having moisture content from 8-10% stored well and safe moisture content for sealed storage is 4-8%.

BARI (1987-88) carried out an experiment to determine the moisture content of rapeseed-mustard varieties. They reported the moisture content of different varieties i.e., 7.06%, 8.36%, 7.66%, 7.98%, 7.41%, 8.38%, 7.81%, and 7.82% for SS-75, Krisna, PT-303, Varuna, TS-72, Kranti, S-5 and Tori-7, respectively.

Ash

Ash is the residue that remains after the complete combustion of the organic compound of a food product. The estimation of ash content in oil crops enables the classification of oil.

Sarker *et al.*, (2015) observed that, ash content of black and yellow mustard cakes were 7.10 ± 0.3% and 5.90 ± 0.3% respectively. (AMB Express 5:22) .These data are comparable (7.12 ± 0.12%) to the results reported in literature (Datta*et al.*, 2013).

Abul-Fadl *et al.*, (2011) observed that the tested mustard seeds of both yellow and brown varieties containing an adequate percentage of ash, dietary fiber and total carbohydrates which were found to be as 4.08, 5.87 and 16.60% in yellow variety and 3.88, 6.34 and 16.49% in brown variety; respectively.

The ash content was variable among the five oil seed samples. *B. napus* (Durr-e-NIFA) contained the maximum amount of ash (6.93%) followed by *B. juncea* (NIFA-Raya) (6.73%) and sunflower (Gulshan 98), (6.00 %). While cotton seed (Niab, 98) contained (4.56%) and the least amount was found in corn (Jalal), i.e., (1.50%). The results were in agreement to those reported by Besbes *et al.*,(2003).

Sosulski *et al.*, (1991) conducted an experiment to evaluate ash content of different rapeseed-mustard varieties. They reported that ash content of *B. campestris* and *B. rapa* ranges from 7.0-8.4% and 7.3-8.0%, respectively.

Nehrins *et al.*, (1990) reported that ash content of Canadian wild mustard and rapeseed were found to be 4.38% and 7.3%, respectively.

Kaul *et al.*, (1986) carried out an experiment to evaluate partial analysis of India cruciferous oilseeds. They found that ash content of *Brassica campestris* variety dichotoma BS-2 and Toria T-36 were 3.74% and 3.22

Oil

Chowdhury *et al.*, (2015) conducted a Comparative Study on Chemical Composition of Five Varieties of Groundnut (A*rachis hypogaea*) found the oil content range from 49.20% to 50.79%.

Ayoola *et al.*, (2012) determined the of crude fat of groundnut seeds on dry weight basis and found raw ,sundried and roasted groundnut seeds contained 46.10%, 43.80%, 40.60% of crude fat.

Arif *et al.*, (2012) carried out an experiment to evaluate potential nutrients of oil seeds and they observed highest amount of crude oil in B. *juncea* (Durr-e-NIFA) and *B. napus* (NIFA Raya) i.e., 45.67% and 43.87% respectively.

Gadei *et al.,* (2012) conducted an experiment to evaluate composition and physical properties of different oil seeds. They observed that Mustard seeds have high energy content, having 28–32% oil with relatively high protein content (28–36%). B.R. Moser *et al.*, (2009) also found the similar result.

Asibuo *et al.,* (2008) carried out an experiment to examine the nutritional quality of 20 groundnut varieties grown in Ghana results from these analyses showed Virginia cultivars which belong to subspecies *hypogaea* had higher oil content (49.7%).

Siddiqui *et al.,* (2004) introduced some features of *B. carinata* (IGC-01 and *Pusa Gaurav*) cultivars, *B. juncea* cultivars (Jagannath, Kranti, Rohini and TERI (OE) M21-swarna) and *B. napus* cv. (Hyola PAC-401). They reported that cultivars *Pusa gaurav* recorded the highest oil content (40%) among these.

Sengupta *et al.,* (2003) evaluated that oil content of rapeseed-mustard varieties. The results indicated that oil content of mustard seed ranges from 40-41.5% and Kernel 45-47.1%.

Bhowmik (2003) experiment conducted on some released rapeseed and mustard varieties and their oil content. Results revealed that oil content of brown sarson, yellow sarson and toria ranges from 44-45%, 42-46% and 42.44%, respectively.

Mandal *et al.*, (2002) said that one of the most remarkable characteristics of Brassica species is the high oil content in the seeds, ranging in wild types from about 21.5-46.7%;but according to Kumar and Tsunoda, (1980) it is range from about 17>40%.

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

Rathore (2000) reported that oil content of different released rapeseed-mustard varieties. Results stated that oil content of sarson, toria and rai ranges from 43-45%, 30-35% and 31-35%, respectively.

BARI (2001) reported that variable amount of oil are present in different rape seed mustard varieties. Results showed that oil content of different varieties i.e., 40-42%, 41-42%, 44-45%, 40-41% and 43-44% for Tori-7, Kalyania (TS-72), Sonali (SS-75), BARI sarisha-10 and BARI Sarisha-11, respectively.

Tyagi *et al.*, (2001) was analyzed proximate composition of oil and crude protein. The highest amount of oil (38.96%) and crude protein (46.23%) were recorded for ToriaKranti and Toriashgamgarh, respectively.

Ullah *et al.*, (1997) said that twelve varieties of rape seed mustard including three species, namely *B. campestris; B. juncea*and *B. napus*; significant differences were found among the varieties in respect of oil yield. They reported that *B. campestris* produced highest amount of free and bound oil where as lowest was found in *B. juncea.*

Niraz *et al.*, (2001) evaluated 21genotypes of Indian mustard. Results indicated that considerable variation in oil content was found and ranging from 36.49% to 40.19% at per with vardan (39.14%) and varuna (38.13%).

Mazzoncini *et al.*, (1993) described seed oil content of *Brassica carinata* ranged from 32.5% to 40.6%. They reported that seed oil content was higher in rape ranging from 40.5% to 47.3%.

Vijay *et al.*, (1992) evaluated the oil contents in 65 varieties of rapeseed-mustard. The result indicated that many varieties have high oil content (more then 40%) and particularly RH, RK and DIRA had low oil content, mostly in the range of 35-38%.

BARI. (1986-87) carried out an experiment on oil content of 14 *Brassica campestries* genotypes. Results showed that highest oil content i.e., 42.87% and 42.69% for the line OTBC-0893 and OTBC-1493 and others advanced lines were not significantly different from the first line.

BARI (1992-93) determines the oil content of eight brown seeded *B. campestris* lines. Oil content of different advanced line is 41.77%, 42.40%, 42.43%, 41.37%, 41.75% and 41.88% for BC-2192, BC-2493, BC-2592, BC-2693, BC-2892 and BC-2093. Results revealed that there was no significant difference among the advanced lines with respect to its oil content.

BARI (1992-93) determined the oil content of seven yellow seeded *B. campestris* lines including two check varieties. Results revealed that there was no significant difference among the lines with respect to its oil content (41.99 to 42.52%).

Oil cake

Chowdhury *et al.*, (2014) conducted an experiment to evaluate the percentage of oil cake of different varieties and advanced lines of mustard and rapeseeds and they found that 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%). Oil cake is the nutritious feed items for cattle and fish. It is also used as a good organic matter.

Appelqvist *et al.*, (1992) reported that typically rape seed oil (Kind of mustard seed) contain 58% cake.

Carbohydrate

Rapeseed and mustard contain relatively lower amount carbohydrate. It consists mainly glucose, sucrose and fructose crude fiber is also considerate as a constituent of carbohydrates.

Chowdhury *et al.* (2015) experimented a Comparative Study on Chemical Composition of Five Varieties of Groundnut (A*rachis hypogaea*) found the range of carbohydrates content from 6.275% to 1.218%.ituent of carbohydrates.

Bachheti *et al.*, (2012) conducted an experiment to study physico-chemical properties of some conventional food oils and found that mustard seeds contain 23.8% carbohydrate.

Bachheti *et al.*, (2012) conducted an experiment to study physico-chemical properties of some conventional food oils and found that mustard seeds contain 23.8% carbohydrate. Gopalan *et al.*, (1981) in Nutritive value of Indian foods stated that dry mustard seeds contained 20-23% carbohydrate.

Ayoola *et al.*, (2012) determined the carbohydrates of groundnut seeds on dry weight basis and found raw, sundried and roasted groundnut seeds contained 17.41%, 27.19%, 36.11% carbohydrates

Ingale *et al.*, (2011) carried out an experiment on Proximate composition, anti-nutritional and nutritional value of seeds of new variety of groundnut (*Arachis hypogaea L*) JL-24 and found groundnut seed contain 21.26% carbohydrates.

Gopalan *et al.*, (1981) in Nutritive value of Indian foods stated that dry mustard seeds contained 20-23% carbohydrate

Fatty acid composition

Mustard and rapeseed oil has a special fatty acid composition. It contains different types of saturated and unsaturated fatty acid. oleic acid, linoleic acid, linolenic acid, palmitic acid and stearic acid are the most important and essential fatty acids in rapeseed oil.

Chowdhury *et al.,* (2015) experimented a Comparative Study on Chemical Composition of Five Varieties of Groundnut (A*rachis hypogaea*) found the highest amount of total saturated fatty acid of 17.47% and the lowest amount of 10.92%.The highest amount of total unsaturated fatty acid of 94.50% and the lowest amount of 81.13%.

Hussain *et al.,* (2014) investigated the Peanut oil yield and the physico-chemical properties of extracted oil on different temperatures (50, 55, 60 and 65 °C) and sun drying and results showed that the free fatty acid (FFA) content were 12.76 mg/g and 2.94 mg/g at 60 °C and 50 °C.

Amir *et al.,* (2012) ,in their study, identified fatty acids in the seed oil of studied spring and winter rapeseed varieties were oleic acid (63.62-67.38%), linoleic acid (15.87-19.06%), linolenic acid (7.55-9.76%), palmitic acid (3.55-4.51%) and stearic acid (1.54-2.3%), respectively. Moreover, arachidic acid, erucic acid, gadoleic acid and palmitoleic acid were among fatty acids with the lowest percentages (Less than 1%) of rapeseed varieties.

Mustard oil possess 60% monounsaturated fatty acids of which 42% erucic acid and 12% Oleic acid, it has also 21% polyunsaturated of which 6% is the omega-3 alpha-Linolenic acid and 15% omega-6 linoleic acid along with 12% saturated fats.(Wani Mubashir, 2012).

Abul-fadl *et al.*, (2011) reported that, erucic acid was predominant fatty acid in yellow and brown mustard seeds oils, which was represented about 37.89 and 23.90%, respectively. Both yellow and brown mustard seeds oils contained a little amounts (ranged between 8.45 to 8.94%) of saturated fatty acids as compared to the other edible oils. Oleic acid was the prevalent unsaturated fatty acids, which was ranged between 19.08 to 20.24% of total fatty acid profiles in both yellow and brown mustard seed oils, respectively

Ingale *et al.*, (2011) reported that The major saturated fatty acid in groundnut seed oil was palmitic acid (6.20%); the main unsaturated fatty acids were oleic acid (16.28%) and linoleic acid (16.35%).

The concentration of oleic acid (18:1), a beneficial monounsaturated fatty acid, ranges from 3.6-32.2% in rapeseed-mustard oil (Chauhan and Kumar, 2011).

Moser *et al.*, (2009) observed that, mustard oil has a special fatty acid composition, it contains about 20–28% oleic acid, 10–12% linoleic, 9.0–9.5% linolenic acid, and 30–40% erucic acid, which is indigestible for human and animal organisms.

Pospišil *et al.*, (2007) concluded that the fatty acid compounds in rapeseed hybrids and its double low varieties were affected by varieties to a great extent. In the new rapeseed varieties, instead of erucic acid, the level of other fatty acids such as oleic acid (more than 60%) and linoleic acid (10-20%) increased, while the level of linolenic acid had decreased (less than10%).

In the study by Nasr *et al.* (2006), five important fatty acids, i.e. oleic acid, linoleic acid, linolenic acid, stearic acid and palmitic acid were commonly found in 10 rapeseed varieties which oleic acid and stearic acid had the highest and lowest percentages, respectively.

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

Siddiqui *et al.*, (2004) carried out some nutritional analysis on different rapeseed varieties such as B. carinata cultivars (IGC-01 and *Pusa Gaurav*), *B. juncea* cultivars (Jagannath, Kranti, Rohini and TERI (OE) M 21-Swarna and *B. napus* CV. (Hyola PAC-401). They reported that Jagannath, Kranti and Rohini content highest amount of linolenic acid (22.76%), erucic acid (43.30%) and palmitic acid (5.63%).

Sengupta *et al.*, (2003) conducted an experiment on fatty acid composition in seven edible oils. They reported that mustard seed content saturated, mono-unsaturated and poly-unsaturated fatty acid was 6.73 and 21 respectively. They noted that amount of linoleic acid (18:2) was ranges from 11-22%.

Bhowmik (2003) reported that Indian rapeseed and mustard oils are inferior in quality as they contain high amount of erucic acid (28.0-53.0%) and linolenic acids (8.5-22.7%) although they also reported seed oil contain linoleic (12.0-21.0%) and oleic acid (10.0-24.0%) which are nutritionally good.

Niraz *et al.*, (2001) evaluated 21 genotypes of Indian mustard. They reported that considerable variation was found in fatty acid profile and low amount of erucic acid was observed in many genotypes ranging from 40.12 to 49.7%.

Ullah *et al.*, (1997) conducted an experiment on twelve varieties of rapeseed mustard including three species namely *B. campestris, B. juncea* and *B. napus*. They reported that newly introduced variety Nap-8509 (*B. napus*) contained lowest (36.4%) erucic acid and tradition Tori-7 contained lowest amount of linoleic acid.

Mazzoncini *et al.*, (1993) conducted an experiment in different rapeseed varieties and reported that seed oil contained a high percentage of erucic acid (34-35%), linoleic acid (21-22%) and linolenic acid (18-19%).

BARI (1992-93) carried out an experiment on fatty acid composition of eight brown seeded *B. campestris* lines (BC-2192, BC-2492, BC-2592, BC-2692, BC-2892 and BC-2092) and seven yellow seeded *B. campestris* lines including two check varieties. Results revealed that there was no remarkable variation in fatty acid composition.

Sanches *et al.*, (1990) reported that lipid content of different rapeseed varieties ranges from 36.8 to 41.35% with significant differences between cultivars. Palmitic acid comprised 50-70% of total saturated fatty acid; oleic acid comprised 64.7 to 72.1% of mono-unsaturated fatty acid and linolenic acid 13.0 to 17.5% of total poly unsaturated fatty acid. Erucic acid ranged from non-detectable to 1.08%.

Wahhab *et al.*, (1980) introduced some features with low content of erucic acid in rape seed-mustard varieties. Results revealed that one seed was identified containing as low as 29.61% of erucic acid. Either oleic or linoleic acid has replaced erucic acid content as a major constituent.

Appelqvist (1980) conducted an experiment to determine the fatty acid composition. He 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.

Rollet *et al.*, (1995) determined the composition of French rape oil (Brassicasp.). They reported that fatty acid content in rape seed oil was 51%, 29%, 16%, 1%, 1.5% and 1.5% for erucic acid, oleic acid, linoleic acid, lenolenic acid, palmitic acid and lignoceric acid respectively.

Protein

Around 28-32% of the mustard seed total weight is composed of proteins. Proteins are polymers of amino acids. Proteins form the structural elements of cells and tissue in the human body and are considered as the basis of life, but they are also essential components in different food systems.

In study by Sarker *et al.,* (2015), the protein contents in black and yellow mustard cakes were 38.17% and 28.80% and their pepsin digestibility was 80.33% and 77.43%, respectively. The proteins were extracted at different pH and maximum proteins (89.13% of 38.17% and 87.76% of 28.80% respectively) isolated from black an d yellow mustard cakes at pH 12.

Chowdhury *et al.,* (2015) experimented a Comparative Study on Chemical Composition of Five Varieties of Groundnut (*Arachis hypogaea*) found the highest amount of protein content of 38.88% and lowest amount of 36.60%.

The Crude protein content of mustard cakes obtained were 38.17% and 28.80% which were lower (45.0% and 34.0%) than those reported by many other authors (Marnoch and Diosady, 2006; Prapakornwiriya and Diosady, 2004). However, Chowdhury *et al.*, and Kumar ent al. reported comparatively equal amount of crude protein in mustard cakes (Kumar et al., 2002; Chowdhury *et al.*, 2010). The variation observed could be because of the variety of mustard raised and the differences in sampling adopted, influence of season of harvest etc. Mean ether extract content of black and yellow mustard cakes were also low compared to many other authors (Latif *et al.,* 2008; Ramachandran *et al.,* 2007).

Al-Jasass *et al,.* (2012) reported that Cress, mustard, black cumin and black pepper contain higher protein contents ranging from 26.61 to 25.45%, as compared to fenugreek (12.91%) and clove (6.9%).

Mustard seeds contain 28-32% protein by weight and 30-35% of oil, although these values can vary slightly between varieties, growing regions and crop years (Canadian Grain Commission, 2012).

Ayoola *et al.,* (2012) determined the of crude protein of groundnut seeds on dry weight basis and found raw ,sundried and roasted groundnut seeds contained crude protein of 24.70%, 21.80%, 18.40%.

There are two main types of storage proteins present in mustard seeds: legumin type globulins (11S, cruciferins), and napin-type proteins (2S, napins), which are water soluble and have an isoelectric point around a pH value of 7 (Wanasundara, 2011).

Abul-Fadl *et al.,* (2011) carried out an experiment to compare of protein content of mustard seeds between yellow and brown varieties . They noticed that the yellow mustard seed had a higher content of protein (36.73%) than this found in brown mustard seed (32.48%).

Ingale *et al.,* (2011) analyzed the proximate composition, anti-nutritional and nutritional value of seeds of new variety of groundnut (*Arachis hypogaeaL*) JL-24 and found groundnut seed contain crude protein of 25.20%.

Asibuo *et al.,*(2008) carried out an experiment to examine the nutritional quality of 20 groundnut varieties grown in Ghana results from these analyses showed the mean protein content of subspecies *fastigiata* was however higher (25.69%) than subspecies *hypogaea* (22.78%).

Sengupta *et al.*, (2003) reported that protein content of rapeseeds variety was variable laboratory analysis revealed that protein content of rapeseed were ranges from 44.2-44.7%.

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

Of the proteins in mustard seed, around 70% is composed of storage proteins, cruciferin and napin, which are found inside the protein bodies and have no catalytic functions. Up to 10% is considered to be oleosin, a main structural component of the membrane surrounding the oil bodies (Bell *et al.,* 1999).

Mirza *et al.* (1998) carried out an experiment to evaluate the protein content of rapeseed oil. They noted significant differences were found among protein contents which are negatively correlated with oil content.

Mineral

Unlike other nutrient elements, mineral cannot be synthesized by living organism. Mineral are inorganic elements required by the animal body for maintenance of vital processes essential for life. The general functions of minerals are structural component of body organ and tissues, constituents of body fluids and tissues, electrolytes, and catalysts in enzyme and hormone system. The major minerals are calcium, magnesium, phosphorus, potassium and sulpher and trace minerals are iron, manganese, zinc and boron.

Chowdhury *et al.*,(2015) experimented a Comparative Study on Chemical Composition of Five Varieties of Groundnut (A*rachis hypogaea*) found the range of Ca, Mg, Cu percent from 2.28% to 2.40%, 0.7340% to 0.72%, 10.68ppm to 11.88ppm .

Ayoola *et al.,* (2012) determined the of crude protein of groundnut seeds on dry weight basis and found raw ,sundried and roasted groundnut seeds contained minerals included; Sodium(0.71%, 0.69%, 0.57%), phosphorus (0.68%, 0.65%, 0.69%), potassium (0.47%, 0.51%, 0.55%), zinc(0.44%, 0.42%, 0.50%), iron (0.40%, 0.47%, 0.43%).

In study by Arif *et al.*, (2012), a higher (0.01%) of potassium (K) was found in corn (Jalal) variety while *B. juncia* and, *B. napus* contained the next higher same amount of (0.005%) of K. Cotton (Niab 98) contained (0.004%) K, while least amount was determined in sunflower (Gulshan 98), i.e., (0.003%). *B. napus* (Durr-e-NIFA) and sunflower (Gulshan, 98) contained the same high amount of P (0.86%) as compared to other oil seeds. Corn (Jalal) was poorest with respect to its P content (0.53%).

Bachheti *et al.*, (2012) conducted an experiment to study physico-chemical properties of some conventional food oils and found that mineral content of mustard seed oil(*Brassica Compestris*) i.e , 694.3(g/100g), 4.86(g/100 g), 492.1(g/100g), 0.034(g/100g), 0.019 (g/100g), 0.007(g/100 g),8.11(g/100g) and 0.84(g/100g) for P, Zn, Ca, Mg, K, Na, Fe and Cu respectively.

Rao and Shaktawat (2005) conducted an experiment to study the effect of organic manure, phosphorus and gypsum on nutrient uptake in groundnut and they found that the highest Ca content in shell (0.55 %) was recorded from treatment (250 kg ha-1gypsum, half at sowing + half at 35DAS) and the lowest Ca content in shell (0.51%) was recorded from the control treatment.

Sengupta *et al.*, (2003) carried out an experiment to determine the minerals content of rapeseed and mustard varieties. They found that minerals content of rapeseed in 100g edible portion was 4.2 gm (calcium 490 mg, phosphorus 700 mg and Iron 17.9 mg and other minerals were present in negligible quantity).

Josefson (1988) evaluated the mineral content of defatted rapeseed meals. He found that mineral content of rape seed varieties i.e., 1.72%, 1.10%, 0.70%, 1.61%, 68 ppm and 18 ppm for sulpher, phosphorus, calcium, potassium, zinc and Iron, respectively

Kaul *et al.,* (1986) conducted an experiment to evaluate minerals content of different oilseed varieties. They found that different varieties content variable quantity of minerals i.e., 5.76%, 0.49%, 0.93%, 0.82% and 0.25% for N, P, K, Ca and Mg, respectively.

Chemical properties of Oil

The chemical characteristics of oil determine the quality and stability of oil. Chowdhury *et al.,* (2014), determined the chemical constant of mustard and rapeseed oil. They found that, Saponification values of different released variety and advanced lines were ranges from 154-168.3; Iodine values of different released variety and advanced lines were ranges from 93.45-110.2 and acid values of different released variety and advanced lines were ranges from 1.31-1.61.

In study by Khan *et al.,* (2013), chemical analysis of the mustard oil showed that the saponification value, iodine number, acid value are >170, >100 and <0.5 respectively.

Nkafamiya *et al.,*(2010) conducted an experiment to determine the percentage oil yield and physicochemical properties of five different groundnut species and found the range of saponification values from 179.50 ± 0.36 to 184.30 ± 0.20 in case of refined oil.

Martin *et al.,* (1995) extracted oil from rapeseed to evaluate the physico-chemical parameters of the oil. They reported that iodine value, saponification value, acid value and unsaponifiable matter were 112.0, 170.0, 2.6 and 0.66, respectively.

Sher-e-Bangla Agricultural University
Library
Sher-e-Bangla Nagar, Dhaka

Chapter 3

MATERIALS AND METHODS

Chapter III

MATERIALS AND METHODS

3.1 Materials

Three varieties of mustard *(Brassica spp.)* namely BARI Sarisha-15, BARI Sarisha-16, BARI Sarisha-17 and three released varieties of groundnut (*Arachis hypogaea*) namely BARI Chenabadam-7, BARI-Chenabadam-8, BARI Chenabadam-9, were selected for the study. The seeds were collected from Oil Seed Research Center, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, Bangladesh. Seed were cleaned sun dried and stored into plastic container in a cool place until used for the chemical analysis.

3.1.1 Brief description of varieties

BARI Sarisha-15: This is a composite variety evolved by Bangladesh Agricultural Research Institute (BARI). Its grain color is yellow and oval in shape. The grain is small in size.

BARI Sarisha-16: This is a composite variety evolved by Bangladesh Agricultural Research Institute (BARI). Its grain is brownish in color and round in shape. The grain size is large.

BARI Sarisha-17: This is a composite variety evolved by Bangladesh Agricultural Research Institute (BARI). Its grain is brownish in color and round in shape. The grain size is large.

BARI Chenabadam-7: This is a composite variety evolved by Bangladesh Agricultural Research Institute (BARI).The nuts are round, medium in size, and seeds are light brown in color.

BARI Chenabadam-8: This is a composite variety evolved by Bangladesh Agricultural Research Institute (BARI). The shells are smooth and whitish in color and soft in nature, seeds are reddish brown in color.

BARI Chenabadam-9: This is a composite variety evolved by Bangladesh Agricultural Research Institute (BARI). The shells surface slightly rough and shells" vine and sub vine are prominent, seeds are light brown in color.

3.2 Physicochemical Properties

The nutritive value of a food-grain is indicated by its composition shown by chemical analysis. The degree to which the chemical analysis indicates the nutritive value is dependent on the constituents determined. Some constituents are determined fairly easily and rapidly, while others require much more time and analytical ability. Consequently, most laboratories are faced with a choice between making a few rather simple determinations of a large number of samples or complete analysis of a limited number of samples. Before undertaking an analysis, the results of which will represent the composition of a crop or a consignment of a food-grain, it is necessary to ensure that the sample taken is randomly selected so as to be truly representative of the original bulk, and is sufficient in amount.

3.2.1 Determination of 1000 grain weight

The mass was determined by randomly selecting 100 samples and weighing in an electronic balance of 0.001 g sensitivity. The weight was then converted into 1000 seed mass.

3.2.2 Determination of moisture

Moisture content of mustard sample was determined by conventional method i.e., drying in an oven at 100° C for overnight.

Procedure

Empty aluminum moisture dish was weighted (w_1) and 2.5 g sample was taken in a moisture dish and weighted (w_2). The sample was spread evenly and placed without lid in oven and dried samples overnight at 100° C. The dishes were transferred to desiccators to cool. Aluminum dish was weighed after cooling (w_3).

Calculation

$$\% \text{ Moisture} = \frac{(W_2 - W_3)}{(W_2 - W_1)} \times 100$$

3.2.3 Determination of ash

The sample is ignited at 600° C to burn off all organic material. The inorganic material which does not volatilize at that temperature is called ash. The procedure was described by Ranganna (1986).

Equipments

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

1. Balance
2. Muffle furnace
3. Desiccators.

Procedure

The temperature of the muffle furnace was fixed to 600°C and crucible was heated for 1h and transferred into a desiccators; cooled them to room temperature and weighted (W_1). About 2 g sample was put into the crucible weighted (W_2). The sample was burned in a muffle furnace at 600° C for about 2 h. The crucibles were transferred into the desiccators and cooled them to room temperature and weighted (W_3). It was done immediately to prevent moisture absorption. The incineration repeated until constant weight was obtained.

Calculation

Weight of the sample taken = $W_2 - W_1$

Weight of the ash obtained = $W_3 - W_1$

$$\% \text{ Ash} = \frac{(W_3 - W_1)}{(W_2 - W_1)} \times 100$$

3.3 Chemical Analyses

3.3.1 Estimation of oils/fats

The oil content was determined by the ether soluble extract method.

Reagents &Equipments

1. Anhydrous ethyl ether
2. Soxhlet, flask and condenser
3. Hot plate, metal heater

Procedure

Dried sample was weighed out into an extraction thimble. Weight of thimble and sample were recorded in laboratory book. The thimble was placed into the soxhlet. 50-100 ml ethyl ether was added to the soxhlet flask then it was connected to holder and condenser. Soxhlet flask was placed on hot plate and distilled at low temperature for 16-20 hours. After extraction it was turned off and allowed to cool. When distillation was ceased, the extraction thimble was removed and allowed to air dry for 30-40 minutes the thimble was weighed out. The loss of weight was cured fat.

% Crude fats/Oil (on a dry weight basis) =

$$\frac{\text{Wt. of thimble \& sample before extraction - Wt. of thimble \& sample after}}{\text{Weight of sample before extraction}} \times 100$$

The fat determined by the above procedure (Hughes, 1965) contains usual lipids including waxes pigments, certain gums and resins. A better name for these constituents would be "ether soluble extract."

3.3.2 Estimation of total protein content by Microkjeldhal method

The protein content of food stuff is obtained by estimating the nitrogen content of the material and multiplying the nitrogen value by 6.25 (according to the fact that nitrogen constitutes on average 16% of a protein molecule). This is referred to as crude protein content, since the non-protein nitrogen (NPN) present in the material is not taken in consideration. The estimation of nitrogen is done by Kjeldhal method (AOAC 2010) which depends upon the fact that organic nitrogen when digested with sulphuric acid in the presence of catalyst selenium oxide, mercury or copper sulfate is converted into ammonium sulphate. Ammonia liberated by making the solution alkaline is distilled into a known volume of a standard acid which is then back titrated.

The nitrogen present in the sample is converted to ammonium sulphate by digestion at (380 °C) with sulphate acid in presence of a catalyst, potassium sulphate and mercuric oxide. Ammonia liberated by distilling the digest with sodium hydroxide solution is absorbed by boric acid and is titrated for quantitative estimation.

Equipments

1. Balance
2. Microkjeldhal (Mkj) digestion set
3. Mkj distillation set.

Reagents

1. Digestion mixture: 100 g of potassium suphate (K_2SO_4) was thoroughly mixed with 20 g of copper sulfate ($CuSO_4.5H_2O$) and 2.5 g selenium dioxide (SeO_2) was added with it.
2. 60% Sodium hydroxide solution: 600 g sodium hydroxide and 50 g sodium thiosulphate were dissolved in distilled water, cooled and made the volume up to 1 liter.
3. Boric acid: 40 g of boric acid was dissolved in water and made up to 1 liter.

4. Double indicator: 200 mg each methyl red and bromocresol green was dissolved separately in 100 ml of 70% ethanol. One part of methyl red and five parts of bromocresol green were mixed before use.

5. Hydrochloric acid (0.02 N HCl): 8.5 ml concentrated hydrochloric acid was added to 5 liter of distilled water. Standardized to 0.02 N acids by titrating it against standard sodium carbonate (0.02 N) solution.

Procedure

A known quantity of the finely ground sample (100 mg) weighted out in an Mkj digestion flask. About 2 g digestion mixture was added with it 2 ml of concentrated sulphuric acid was dispensed into the flask. Then it was digested for about 2 hrs in Mkj digestion set and was cooled the clear digest. The digest was dissolved in minimum amount of distilled water and carefully transferred to an Mkj distillation set. 10 ml of sodium hydroxide solution was added and distilled it. The distillate was collected for 5 min into 5 ml boric acid containing 2 drops of mixed indicator in a 50 ml conical flask, till the color of solution was changed. The distillate was titrated against a standard hydrochloric acid and noted the titer value (TV).

Calculation

$$N\,\% = \frac{(14.007) \times (\text{normality of the acid, } 0.02) \times (TV) \times 100}{\text{Weight of sample (mg)}}$$

Where 14.007 is the equivalent weight of nitrogen.

Nitrogen % is converted into protein by multiplying with a factor 6.25 for cereals and pulses.

3.3.3 Chemical constant

3.3.3.1 Saponification value

Saponification value is the number of milligrams of KOH required to completely saponify 1 g of oil. The method is based upon the principle that fat, on treatment with excess of alcoholic KOH is used up. The excess of KOH left unused may then be found by titrating it against a standard acid.

Reagents

1. Hydrochloric acid (0.5N).
2. Alcoholic solution of Potassium hydroxide. Take 28 g potassium hydroxide and dissolve it in very little water. Make up to one liter by adding rectified spirit (C_2H_5OH) of specific gravity 0.81.

Procedure

1. Weight accurately 2 g of fat in 250 ml conical flask. Add 25 ml of 0.5 N alcoholic potash solutions and fit the flask with a cork and a long air condenser.
2. Refux the contents of the flask for about 30 minutes by heating on boiling water bath so that the contents just simmer. Cool the flask and add 1 ml of 1% solution of phenolphthalein and titrate the excess of the alkali against standard N/2 acid (a).

At the same time and under similar conditions carry out a blank expt (b) without fat (25 ml of the same alcoholic KOH heated in a similar way is titrated, against .05 N acid). 1 ml of 0.5 N HCL was equivalent to 0.02805g of KOH.

Calculation

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

3.3.3.2 Iodine value

Iodine value or Iodine absorption number is the percentage of iodine monochloride (ICI) in terms of iodine absorbed by the oil. Some oils and fats contain many unsaturated fatty acid constituents such as oleic and linoleic acids which take up halogen to form saturated compounds. The extent of this combination however, depends on the degree of unsaturation.

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

Regents required

1. 0.1N sodium thiosulphate.
2. Starch solution (indicator).
3. Wij's solution: The Wij's solution required for this process is prepared as dissolve 8.5 of iodine and 7.8 g of iodine trichloride in separate portions of about 450 ml of glacial acetic acid. Mix the solutions and make up to one liter.
4. Potassium iodide solution: Dissolve 104 g KI crystals in water and make up the volume to 1litre.

Procedure

1. Accurately weight the oil or fat into a glass stoppered bottle of 200 ml capacity.
2. Add 5 ml of carbon tetrachloride to dissolve the oil and then add 25 ml of Wij's solution.
3. Allow it to stand for at least 1 hour in a dark place. Also put a blank expt containing 5 lm of carbon tetrachloride and 25 ml of Wij's solution but no oil.
4. Now add 5 ml of 10% potassium iodide solution and 50 ml water to each bottle and titrate against 0.1N $Na_2S_2O_3$ using starch solution as the indicator, near the end when the colour of titre becomes pale yellow. Blue colour disappears which indicates the end point.

Calculations

Vol. of 0.1N $Na_2S_2O_3$ used in blank expt. = V_1 ml

Vol. of 0.1N $Na_2S_2O_3$ used in the case of oil = V_2 ml

Difference = (V_1-V_2) ml of 0.1 N sodium thiosulphate

$= (V_1-V_2)$ ml of 0.1N I_2 absorbed

$$= (V_1-V_2) \times \frac{127}{10} \times \frac{1}{1000} \text{ g of iodine}$$

$= (V_1-V_2) \times .0127$ g of iodine.

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

3.3.4 Estimation of fatty acid composition

Seed sample of rapeseed and mustard were received from ORC, BARI, Joydebpur, Gazipur. Fatty acid composition was determined by Gas-liquid chromatographic method (Uppstrom *et al.*1978).

Reagent

1. Ethylate reagent (Petroleum ether / 0.02M sodium hydroxide in ethanol (2/3).
2. A Salt solution (80 g NaCl and 3g Sodium hydrogen Sulphate in 1 litre water)

Procedure

1. About 12 mg of oil or equivalent amount of oil seeds was taken (seed was crushed in an oil paper and then transferred into a test tube).
2. The sample was extracted and transesterified at the same time with 5 ml ethylated reagent and Shaked.
3. The samples were kept for overnight at room temperature.

4. 10 ml salt solution was added and shaked. As soon as the two layers were separated, the benzene phase was transferred to small test tubes.
5. A Philips PU 4500 chromatograph instrument was used with flame ionization detector (FID).
6. A glass column (1.5m x 4mm) was packed with BDS. With this column the injection post, column and detector temperature was set at 220° C, 185° C and 240° C, respectively.
7. Nitrogen flow (used as career gas) rate was 22 ml/min, the injection volume was 2µl.
8. Peak areas were measured with an electronic digital integrator (ShinadzuC-R6A chromatopac).

3.3.4 Estimation of Carbohydrate

Total carbohydrate Estimation: The method was described by Raghuramulu *et al.* (2003). The content of the available carbohydrate was determined by the following equation:

Carbohydrate = 100- [(Moisture + Protein + Ash + Oil/Fats) g/100g]

3.3.6 Estimation of minerals

Mineral content was determined using Absorption Spectrophotometer.

Preparation of reagents

a. Reagents for P determination

Reagent A

1. Forty five gm antimony trioxide and 400 ml water were mixed in 1 liter volumetric flask and 150 ml conc. H_2SO_4 was added then it was allowed to cool.
2. Ammonium molybdate (7.5 gm) was dissolved in 300 ml water.
3. Cool antimony solution and molybdate solution was mixed by adding 1 liter of water.

Reagent B

1. One gm gelatin was dissolved in 100 ml hot water.
2. Reagent A (150 ml) dissolved to about 500 ml water and dissolved gelatins were mixed and finally, 1 gm of ascorbic acid was dissolved with it to make volume 1 liter.

b. Reagent for Ca and Mg determination

1. 1% Lanthanum solution:

Fifty nine gm of lanthanum oxide (La_2O_3) were added with about 50

ml of water. Slowly and cautiously, 250 ml conc. HCL was added

to dissolve the La_2O_3. It was made to 5 liters with water.

c. Reagents for S determination

Mixed acid seed solution

Sixty five ml of conc. HNO_3 and 250 ml glacial acetic acid ware added to about 500 ml of water. 3 ml of 1000 ppm S standard solution was added and made volume to liter with water.

d. Turbidimetric reagent

Ten gm of polyvinyl pyrolidone (PVP K30) was dissolved in about 100 ml of hot water. 150 gm of $BaCl_2$. 2 H_2O was dissolved in about 500 ml of water. The PVP and barium chloride solutions were mixed and were made to liter with water.

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

e. Preparation of standards

1. For convenience the Cu, Fe, Mn and Zn were prepared together in water. The high concentration for these elements was as follows: 2 μg Cu/ml, 10μg Fe/ml, 4μg Mn/ml, 2 μg Zn/ml.
2. The P, K and Na were prepared together in water with high concentrations as follows: 20μg P/ml, 100 μg K/ml, 40 μg Na/ml.
3. S was prepared in the same solution with high concentrations as follows. 20 μg S/ml.
4. Ca and Mg were prepared in the same solution with high concentrations as follows; 100 μg Ca/ml, 40 μg Mg/ml.

f. Digestion solution

1. Nitric-perchloric solution. Conc. Perchloric acid (100 ml) was added to 500 ml concentrated HNO_3 to prepare nitric-perchloric solution.

3.3.6.1 Digestion of oil seed cake for determination of P, K, Ca, Mg, S, Fe, Zn and B

a. Digestion procedure

Weighted 500 gm dry seed sample and put into a 50 ml boiling flask. 5 ml of nitric-perchloric solution was allowed on cool hot plate and turned temperature to 375° C. It was allowed to digest for 1 hour and 30 minutes. The flask was removed from digestion chamber and was cooled and 15 ml water was added. The flask was agitated and heated to dissolve the ash and filter.

b. Analytical procedure

By using a combination diluter-dispenser, 1 ml aliquot was taken from filtrate and 19 ml water (dilution 1) was added. The other dilutions were made in the following order. For S determination, 7 ml of aliquot from dilution 1, 9 ml of

acid seed solution and 4ml of turbidimetric solution were mixed together thoroughly. It was allowed to stand 20 minutes and not longer than one hour. The reading was taken in turbid meter or in colorimeter at 535 nm using a cuvette with 2 cm light path. For P, K and Na determination, 1 ml aliquot from dilution 1, 9 ml of water and 10 ml of color reagent were mixed together. It was allowed to stand about 20 minutes and reading was taken of spectrophotometer at 680 nm.

For Ca and Mg determination, 1 ml aliquot from dilution 1, 9 ml of water and 10 ml of 1% lanthanum solution were mixed together. It was analyzed by AA procedure.

For Fe, Mn and Zn determination, the original filtrate was used to analyze these elements by AA procedure.

3.3.6 Estimation of Energy:

The chemical energy content of food ingredients is usually expressed in terms of heat units (since all forms of energy are convertible into heat energy).The gross food energy was estimated by multiplying the crude protein, crude fat and total carbohydrate by at water factors 4, 9 and 4 respectively (Okwu, 2006; Osborne and Vooget, 1978).

3.4 Statistical Analysis

The recorded date for each character from the experiments was analyzed statistically to find out the variation resulting from experimental treatments using MSTAT package program. The mean for all the treatments were calculated and analysis of variance of characters under the study was performed by F variance test. The mean differences were evaluated by least significance difference test.

Chapter 4

RESULTS AND DISCUSSION

Sher-e-Bangla Agricultural University
Library
Sher-e-Bangla Nagar, Dhaka

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

Chapter IV

RESULTS AND DISCUSSION

Three varieties of mustard and three varieties of groundnut seed were collected taken for the determination of physical and chemical characteristics. The seeds were stored in the store house under a suitable storage condition. The proximate composition and some other nutrients compositions of mustard seeds are also reported.

Analytical studies of the whole seeds

The proximate composition of whole ground seeds of different varieties are presented in different tables. The data have also been estimated on moisture free basis in order to allow for better comparison of the different fraction. The data mentioned are the average of three replication and have been presented and discussed.

4.1 Physical characteristics of rapeseed and mustard varieties

4.1.1 Grain weight

Weight of thousand grain of different released varieties of mustard and groundnut have been compared in Table-1 and Table-2. It was found that seed weight varied with their size and shape. Groundnut seed size is higher than mustard and its grain weight is also higher as compared to mustard. Seed weights were determined at 13% moisture level. Among different mustard varieties highest thousand grain weight was found in BARI Sarisha-17 (4.24g). Statistically similar results were found in BARI Sarisha-16(3.620g), BARI Sarisha-15 (3.17g). Among different groundnut varieties highest thousand grain weight was found in BARI Chenabadam-7 (127.90 g), followed by BARI Chenabadam-6(117.6g), BARI Chenabadam-8(100.20g). The present values mustard seed weight are consistent with the results reported by Banga *et al.*,(2013), Siddiqui *et al.*, (2004), Chowdhury *et al.*, (2014), Kumar and Singh

(1994), Andarhennadi *et al.*, (1991), Biswas (1989), Chowdhury *et al.*, (1987) and Kaul *et al.*, (1986). Banga *et al.*, (2013) and Siddiqui *et al.*, (2004) found that the highest amount of 1000 seed weight were 5.15g and 3.95g respectively. The present values are higher than the reported value of Mondal and Wahhab (2001); who found that thousand seed weight varies from 2.50-2.65 g .Chowdhury *et al.* Observed the thousand seed weight of groundnut and found 128.30g to 66.76g among different Bangladeshi groundnut verities.

4.1.2 Moisture

Seed deterioration increased as moisture content is increased. Seeds have moisture content of above 18% gets heating, is attacked by molds and insects. Seed stores reasonable well for 6-8 months in temperate climate in open storage at a moisture content from 10%-13%. The moisture content of different released varieties of mustard and groundnut have been presented in Table-1. The moisture content of different released varieties of mustard was ranged from 4.10% to 4.52% and the groundnut varieties moisture content was ranged from 3.70% to 4.20%. The results of the moisture content were significantly lower than Sarker *et al.*, (2015), Al Mahmud *et al.*, (2012), Marnoch and Diosady (2006), BARI annual report (1987-88). According to Sarker *et al.* (2015) moisture content of mustard cakes were 9.20 ± 0.5% and 9.73 ± 0.6%; and the moisture content 8.3 ± 0.2% reported in literature by Al Mahmud *et al.* (2012); Marnoch and Diosady, (2006). Ingale *et al.*, (2011) reported groundnut seed contain 5.529% moisture .Chowdhury *et al.*, (2015) found thr range of moisture content of groundnut seed of 1.130 to 5.120 among different Bangladeshi groundnut varieties.

Table 1. Weight of 1000 seeds and Moisture of different varieties of mustard oilseed varieties

Name of the varieties (Treatments)	Weight of 1000 seeds (at 13% moisture level) (gm)	Moisture (%)
BARI Sarisha-15	3.17	4.52 a
BARI Sarisha-16	3.62	4.20 b
BARI Sarisha-17	4.24	4.10 b
LSD $_{(0.05)}$	2.627	0.3285
CV (%)	1.33 %	3.36 %

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

Table 2. Weight of 1000 seeds and Moisture of different varies of groundnut oilseed varieties

Name of the varieties (Treatments)	Weight of 1000 seeds (at 13% moisture level)(gm)	Moisture (%)
BARI Chenabadam-7	127.90 a	3.70 c
BARI Chenabadam-8	100.20 c	4.00 b
BARI Chenabadam-9	117.60 b	4.20 a
LSD $_{(0.05)}$	3.463	0.1897
CV (%)	1.33 %	2.18 %

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

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

4.1.3 Oil content

The oil content of the mustard and rape seeds depends on many factors like genetic factor; agro-ecological conditions include cultivation sites and crop management system etc. The oil content of different varieties of mustard and groundnut varied from 40.95% to 49.51% (Table 2). Groundnut varieties contain significantly higher amount of oil as compared to mustard varieties. Groundnut variety BARI Chenabadam-9 contained highest amount of 49.51% of oil followed by BARI Chenabadan-7 (49.35%), BARI Chenabadam-8(49.15%). Mustard variety BARI Sarisha-16 contained lowest amount of oil (40.95%), followed by BARI Sarisha-15(41.85%).The results clearly indicated that groundnut variety can be considered as better source of oil. The present values of oil content of groundnut seed were supported by the reported values of Chowdhury *et al.*,(2015) andAsibuo *et al.*, (2008) .Chowdhury *et al.*(2015) found that percentage of oil content range from 50.76% to 49.20% whereas Asibuo *et al.*, (2008) found 49.70%. Present values oil content of mustard seed are higher than the reported value of Gadei *et al.*, (2012) and B.R. Moser *et al.* (2009), who found that oil content ranges from 28–32%; whereas Arif *et al.* (2012), Bhowmik (2003), Novoselov *et al.*, (1994) reported that oil content of rapeseed ranges from 45.67- 43.87%,42-46%and45-46% respectively, which are slightly higher than present results. On the other hand, the present investigations were more or less similar the reported values of Vijay *et al.*, (1992), Rathore (1999-2000). Niraz *et al.*, (2001), BARI report (2001), Sengupta *et al.*, (2003), Mandal *et al.*, (2002). These variations might be due to biological factor, environmental factor, soil and crop management practices.

4.1.4 Oil cake

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-16 contained significantly highest amount of oil cake (59.05%), followed by BARI Sarisha-15 (58.15%) and

BARI Sarisha-17(58.02%). The lowest value was found in BARI Chenabadam-6 (50.49%). The present values mustard oil cake were supported by the reported values of Chowdhury *et al.*, (2014) and Appelqvist *et al.*, (1992).Chowdhury *et al.*,(2014) found that percentage of oil cake range from 58.14 to 59.95% and Appelqvist *et al.*, (1992), reported that typically rape seed oil (Kind of mustard seed) contain 58% cake.

4.1.6 Dry weight of cake

Dry 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 has been presented in Table 2. The highest value was obtained from BARI Sarisha-16 (54.85%), followed by BARI Sarisha-17 (53.92). The Lowest value obtained from BARI Chenabadam-8(46.85%), Chenabadam-7(46.95%).

Table 3. Proximate analysis of oil content, oil cake and Dry wt. of cake of the different Oilseed varieties

Name of the varieties (Treatments)	Oil content (%)	Oil cake (%)	Dry wt. of cake (%)
BARI Sarisha-15	41.85 c	58.15 b	53.63 c
BARI Sarisha-16	40.95 d	59.05 a	54.85 a
BARI Sarisha-17	41.98 c	58.02 b	53.92 b
BARI Chenabadam-7	49.35 a	50.65 d	46.95 d
BARI Chenabadam-8	49.15 b	50.85 c	46.85 d
BARI Chenabadam-9	49.51 a	50.49 d	46.29 e
$LSD_{(0.05)}$	0.1726	0.1726	0.1908
CV (%)	0.21%	0.17%	0.21%

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

1.2 Chemical characteristics of rapeseed and mustard varieties

4.2.1 Chemical constant of oil

Saponification value

Saponification value of oil/fats refers to the number of mg of KOH required to saponify one gram of fats /oil. It is inversely proportionate to the molecular weight or chain length of the fatty acids present in the fats/oil. The range of saponification values have been presented in Table-4 and Table-5. Saponification values of mustard oil is lower as compared to the groundnut oil. In case of groundnut varieties the highest saponification value was found in BARI Chenabadam-8 (183.40), statistically similar result was found in BARI Chenabadam-7(182.00) and the lowest saponification value was found in BARI Chenabadam-9(179.50). In case of mustard varieties, the saponification values are statistically similar BARI Sarisha-15 (157.60) ,BARI Sarisha-16 (157.90), BARI Sarisha-171(59.40). The present saponification values found in groundnut varieties 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. The present saponification values of groundnut varieties were more or less same as Nkafamiya *et al.*, (2010) who found the range of saponification values from 179.50 ± 0.36 to 184.30 ± 0.20 in case of refined oil. However these values are supported by Chowdhury *et al.*, (2014).

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 mustard and groundnut varieties have been presented in Figure-1.In case of mustard varieties, the all iodine values are statistically similar Sarisha-15(72.50), Sarisha-16(70.60), Sarisha-17(73.44). Groundnut varieties have significantly higher iodine value than mustard varieties. The highest amount of iodine value were observed in BARI Chenabadam-6 (106.40), followed by

BARI Chenabadam-7(104.10), whereas the lowest iodine value was found in BARI Chenabadam-8(101.30). 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.*, (1995), Chowdhury *et al.*, (2015).

Table 4. Chemical constant of oil of different mustard oilseed varieties

Name of the varieties (Treatment)	Saponification Value	Iodine Value
BARI Sarisha-15	157.60	72.50
BARI Sarisha-16	157.90	70.60
BARI Sarisha-17	159.40	73.44
LSD $_{(0.05)}$	2.35	3.28
CV (%)	0.66 %	2.00 %

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

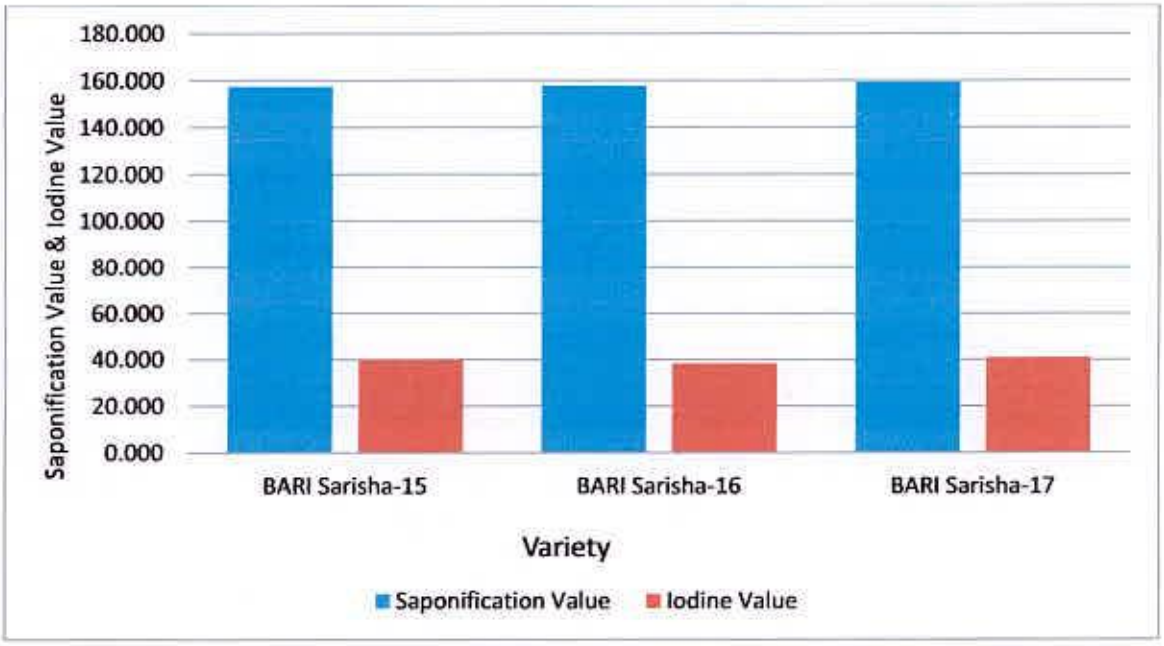

Figure 1. Saponification value and Iodine value of different mustard oilseed varieties

Table 5. Chemical constant of oil of different groundnut oilseed varieties

Name of the varieties (Treatment)	Saponification Value	Iodine value
BARI Chenabadam-7	182.00 a	104.10 ab
BARI Chenabadam-8	183.40 a	101.30 b
BARI Chenabadam-9	179.50 b	106.40 a
LSD $_{(0.05)}$	2.389	3.46
CV (%)	0.58 %	1.47 %

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

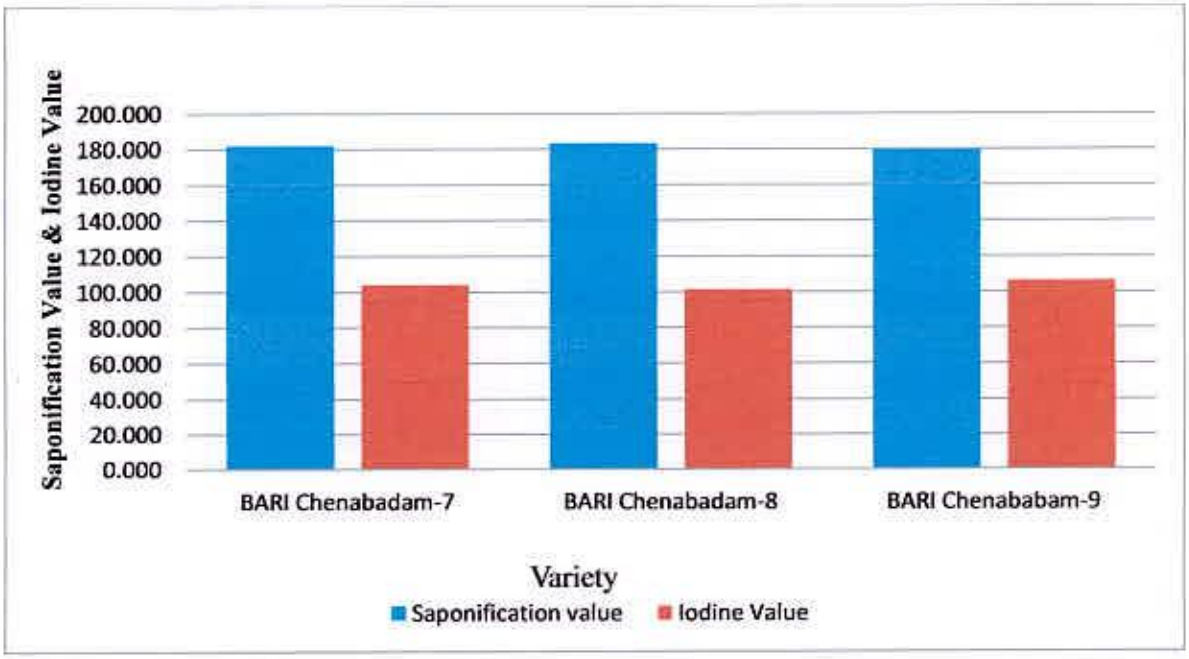

Figure 2. Saponification value and Iodine value of oil of the different groundnut oilseed varieties

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

4.2.2 Fatty acid composition

Comparison of Gas chromatography results are demonstrated in Table-3. According to results, there was a significant difference between the studied mustard and groundnut varieties in terms of their fatty acid composition. Significantly the highest amount of palmitic acid was observed in BARI Chenabadam-8 (13.98%); followed by BARI Chenabadam-7 (11.16%). Lowest amount of palmitic acid content was observed in BARI Sarisha-16 (2.090%); which was significantly similar to BARI Sarisha-15 (2.880%). Highest amount of stearic acid content found in BARI Chenabadam-7 (2.79%) and the lowest amount found in BARI sarisha-17 (1.19%). BARI Chenabadam-6 contained the highest amount (62.94%) of oleic acid followed by BARI Chenabadam-7 (60.76%),BARI Chenabadam-8 (45.07%).The lowest amount was found in BARI Sarisha-16 (14.72%) followed by BARI Sarisha-15(16.16%),BARI Sarisha-17(18.69%). The BARI Sarisha-15, BARI Sarisha-16, BARI Sarisha-17, contained 4.74%, 4.96%, 4.02% of arachidic acid; these three varieties contained statistically similar amount of arachidic acid; whereas lowest amount found in BARI Chenabadam-7 (0.42%). Highest amount of linoleic acid contained was found in BARI Chenabadam-8 (36.10%) which was significantly highest among all the varieties and lowest amount (13.49%) was found BARI Sarisha-17(14.38%). The linoleic acid content is important from the stand point of utilization of oil for food products. Differences were found between the varieties of mustard and groundnut in respect of linoleic acid and eurecic acid content. Mustard variety BARI Sarisha-17, BARI Sarisha-16, BARI Sarisha-15 contained significantly highest amount 51.35%, 50.67%, 50.67% of erucic acid, whereas groundnut varieties contained no eurecic acid. The concentration of linoleic acid varied from 0.240% to 7.10%. Analytical data indicated that the highest amount of total saturated fatty acid (TSFA) contained in BARI Chenabadam-8 (18.41%) and the lowest amount contained BARI Sarisha-16 (8.28%). Highest amount of total unsaturated fatty acid

(TUSFA) contained in BARI Chenabadam-9 (94.21%) lowest amount contained in BARI Sarisha-8 (83.43%). The highest amount of gross energy found from BARI Chenabadam-7 (595.70 kcal/g; while lowest amount of gross energy recorded from BARI Sarisha-16(531.20 kcal/g). From the present data, it might be suggested that the groundnut oil seeds are suitable for edible purpose as they contained higher amount of protein, oil and gross energy. 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.*, (2003) and Appelqvist (1980), Chowdhury *et.al.*(2015), Chowdhyry *et al.*, (2014). Mubashir, (2012) stated that mustard oil possess 42% erucic acid and 12% oleic acid, it has also 6% omega-3 alpha-Linolenic acid and 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) observed that, mustard oil has a special 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. Ingale *et al.*, (2011) reported that the major saturated fatty acid in groundnut seed oil was palmitic acid (6.20%); the main unsaturated fatty acids were oleic acid (16.28%) and linoleic acid (16.35%). According to Chowdhury *et al.*,(2015) the range of total saturated fatty acid (TSFA) and unsaturated fatty acid among different Bangladeshi groundnut varieties are 10.92% to 17.47% and 81.13% to 94.81%.

Table 6. Fatty acid composition of the different oilseed varieties

Name of the varieties (Treatments)	Percentage of fatty acids						
	Palmitic Acid ($C_{16:0}$)	Stearic Acid ($C_{18:0}$)	Arachidc Acid ($C_{20:0}$)	Oleic Acid ($C_{18:1}$)	Linolei c Acid ($C_{18:2}$)	Linole nic Acid ($C_{18:3}$)	Erucic Acid ($C_{22:1}$)
BARI Sarisha-15	2.88 e	1.40 d	4.74 a	16.16 e	15.11 c	7.14 a	50.6 b
BARI Sarisha-16	2.09 f	1.23 e	4.96 a	14.72 f	14.88cd	6.84 b	50.6 b
BARI Sarisha-17	3.22 d	1.19 e	4.02 a	18.69 d	14.38 d	5.84 c	51.35 a
BARI Chenabadam-7	11.16 b	2.79 a	0.42 b	60.76 b	29.90 b	0.24 f	0.00 c
BARI Chenabadam-8	13.98 a	2.52 b	1.91 b	45.07 c	36.10 a	2.27 d	0.00 c
BARI Chenabadam-9	8.71 c	2.41 c	0.62 b	62.94 a	30.17 b	1.10 e	0.00 c
LSD $_{(0.05)}$	0.1409	0.09965	1.987	1.005	0.6904	0.2573	0.5548
CV (%)	1.12%	2.99%	39.33%	1.52%	1.62%	3.59%	1.20%

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

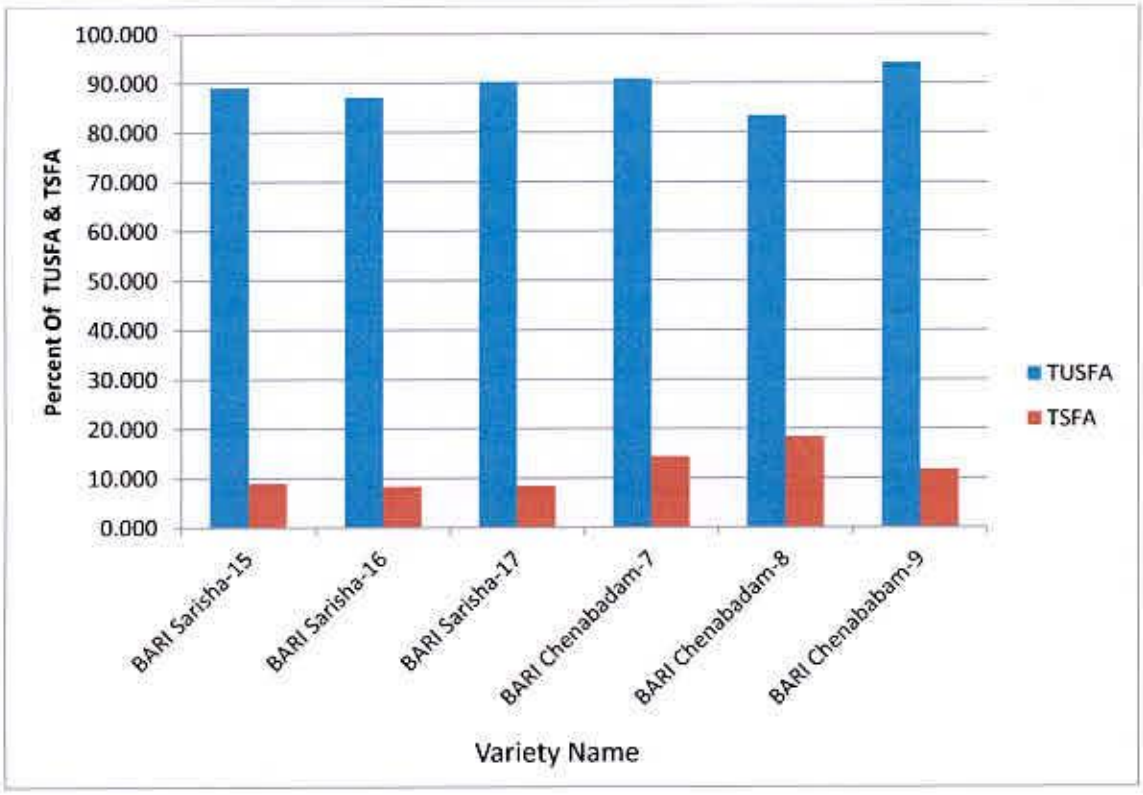

Figure 3. Percentage of total saturated and unsaturated fatty acid of oil of the different varieties of oilseed

4.3 Analysis of oil cake

After extraction of oil the seeds gave the defatted cakes of varying amounts. The proximate composition of the oil cakes was determined by standard procedure. The results of cake analysis were presented in Table 4.

4.3.1 Ash

Ash content of different released varieties of mustard and groundnut varieties were variable and ranged from 9.06% to 14.20% (Table 4). BARI Sarisha-16 contained the highest amount of ash (14.20%) followed by BARI Sarisha-17(12.50%),BARI Sarisha-15 (11.90%); whereas lowest amount of ash found in BARI Chenabadam-7(9.06%) followed by BARI Chenabadam-6 (9.60), BARI Chenabadam-

8(9.80%).The present values mustard varieties were significantly higher than the reported value of Sarker *et al.*, (2015), Abul-Fadl *et al.*, (2011), Nehrins *et al.*, (1990), Sosulski *et al.*, (1991) and Kaul *et al.* (1986). The current values groundnut verities were supported by the reported values of Chowdhury *et al.*, (2015) but significantly higher than the reported values of Abdulrazak *et al.*, (2014), Ayoola *et al.*, (2012).

4.3.2 Protein

Protein is the major nutrient components of different varieties of mustard and groundnut. Protein content is genetically controlled. It is also influenced by nitrogen fertilizer application and agronomies practices. The protein content was determined on moisture free basis. Protein content of different varieties of mustard and groundnut have been presented in Table 4. Significantly highest amount of protein was obtained from BARI Chenabadam-8 (34.50%),. the Lowest amount of protein content found in BARI Sarisha-17 (22.57%). The present values are more or less similar with the reported values of Sarker *et al.*, (2015), Chowdhury *et al.*, (2010), Nehrins *et al.*, (1990), Sosulki *et al.*, (1991), and Mirza *et al.*, (1998),Chowdhury *et al.*,(2015). These results are lower than those reported by many other authors. Marnoch and Diosady (2006); Prapakornwiriya and Diosady (2004) determined the protein 45.0% and 34.0% respectively and Sengupta *et al.* (2003)revealed that protein content of rapeseed were ranges from44.2-44.7%. However these result is higher than the reported value of Asibuo *et al.*,(2008), Ingale *et al.*, (2011), Ayoola *et al.*, (2012). This might be due to the nitrogen fertilizer application, ecology and agronomics practices.

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

Table 7. Proximate analysis of protein, ash and carbohydrate content of the Different Oilseed varieties (Dry weight basis)

Name of the varieties (Treatments)	Ash (%)	Protein (%)	Carbohydrate (%)
BARI Sarisha-15	11.90 c	28.00 c	13.73 b
BARI Sarisha-16	14.20 a	26.60 c	14.05 b
BARI Sarisha-17	12.50 b	22.57 d	18.85 a
BARI Chenabadam-7	9.06 e	30.15 b	7.74 c
BARI Chenabadam-8	9.80 d	34.15 a	2.55 d
BARI Chenabadam-9	9.60 d	29.85 b	6.84 c
$LSD_{(0.05)}$	0.2636	1.661	1.953
CV (%)	1.29%	3.10%	10.10%

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

4.3.3 Carbohydrate

Carbohydrate content of different released varieties of oil seed were determined moisture free basis. The data have been presented in Table 4.From this table it was observed that the groundnut varieties contain significantly lower amount of carbohydrates than the mustard varieties. The amount of carbohydrate contained found in BARI Sarisha-17,BARI Sarisha-16, BARI Sarisha-15 were 18.85%,14.05%,13.75% whereas BARI Chenabadam-8, BARI Chenabadam-9, BARI Chenabadam-7 contained 2.55%,6.85%,7.74%. Agronomics practices, environmental factors as well as variation among the species and varieties might be influenced the carbohydrate content. The present values are slightly lower than the reported values of Bachheti *et al.*, (2012) and Gopalan *et al.*, (1981), Ingale *et al.*, (2011) Ayoola *et al.*, (2012). Bachheti *et al.*, (2012) found that mustard seeds contain 23.8% carbohydrate and Gopalan *et al.*, (1981) stated that dry mustard

seeds contained 20-23% carbohydrate.Incase of groundnut these results are more or less same as reported by Chowdhury *et al.*, (2015).

4.3.4 Minerals

Different major and minor minerals were analyzed this work. The amounts of major minerals content of rapeseed have been illustrated in Table 5. It is well known that rape seed contained small amount of minerals.

Calcium (Ca)

In case of calcium content of different released varieties of mustard and groundnut was ranged from 2.58% to 1.00% (Table 5). Significantly highest amount of calcium (Ca) content was observed in BARI Chenabadam-9 (2.58%), followed by BARI Sarisha-16 (2.52%), BARI Chenabadam-8 (2.50%), BARI Chenabadam-7 (2.403%), and BARI Sarisha-14(2.15%); these varieties are statistically similar in respect to calcium content. The lowest amount of calcium content was obtained from BARI Sarisha-17 (1.10%). The present investigations were supported by reported value of Sarker *et al.*, (2015), Arif *et al.*, (2012), Bachheti *et al.*, (2012), Josefson (1988), Sengupta *et al.*, (2003) and Pathak *et al.*, (1973), Chowdhury *et al.*,(2015). Bachhetiet *al.*, (2012), Sengupta *et al.*, (2003) reported that mustard contained 492.1mg and 490mg respectively, while Josefson (1988) stated that mustard contain 0.7% Ca.

Magnesium (Mg)

Magnesium is the major minerals for human nutrition. Magnesium content of different released varieties of oil seed have been presented in Table 5. There is no significant variation in magnesium content among the varieties. Magnesium content of different varieties was ranged from 0.637% to 0.740%. The present investigations were supported by reported value of Sarker *et al.*, (2015), Arif *et al.*,(2012), Bachheti *et al.*,(2012), Josefson (1988), Sengupta *et al.* (2003) and Pathak *et al.* (1973),Chowdhury *et al.*, (2015).

Nitrogen (N)

Percentage of N is influenced by nitrogen fertilizer application and agronomies practices. Nitrogen content of different varieties of mustard and groundnut have been presented in Table-5. Significantly highest amount of content was obtained from BARI Chenabadam-8 (5.52%),. the Lowest amount of protein content found in BARI Sarisha-17 (3.67%). The present values are more or less similar with the reported values of Sarker *et al.*, (2015), Chowdhury *et al.*, (2010), Nehrins *et al.* (1990), Sosulki *et al.*, (1991), and Mirza *et al.* (1998), Chowdhury *et al.*, (2015). However these results are lower than those reported by many other authors. This might be due to the nitrogen fertilizer application, ecology and agronomics practices.

Table 8. Proximate analysis of minerals content of the different Oilseed varieties

Name of the varieties (Treatments)	Ca (%)	Mg (%)	N%
BARI Sarisha-15	2.15 c	0.74 a	4.48 c
BARI Sarisha-16	2.52 ab	0.74 a	4.26 c
BARI Sarisha-17	1.10 d	0.64 a	3.66 d
BARI Chenabadam-7	2.40 b	0.73 a	4.78 b
BARI Chenabadam-8	2.50 ab	0.72 a	4.82 a
BARI Chenabadam-9	2.58 a	0.73 a	5.52 b
$LSD_{(0.05)}$	0.1409	0.1286	1.661
CV (%)	3.54%	6.96%	3.10%

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

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

Copper (Cu)

Copper contained of different varieties of mustard and groundnut were ranged from 6.18-14.04 ppm (Table 6). Statistically similar amount of Cu content observed in BARI Chenabadam-9 (14.04 ppm), BARI Sarisha- 16 (13.40 ppm), BARI Sarisha-17. Lowest amount of Cu contained observed in BARI Sarisha-17 (6.18 ppm).The present investigations were supported by reported value of Sarker *et al*., (2015), Arif *et al*.,(2012), Bachheti *et al.*, (2012), Josefson (1988), Sengupta *et al*., (2003) and Pathak *et al.*, (1973).

Iron (Fe)

Iron contained of different varieties of mustard and groundnut were ranged from 75.70 ppm to 170.30 ppm (Table 6). Significantly highest amount of Fe contained was observed in BARI Sarisha-15 (170.30 ppm) which was followed by BARI Chenabadam-8 (172.3 ppm). These might be influenced the different levels of Fe in soil, Fertilizer and variation among the varieties. The present values were higher than the reported values of Bachheti *et al*., (2012) and Josefson (1988); who found that Fe content of mustard seed oil were 8.11(g/100g) and 18ppm respectively. However these values supported by the reported values of Chowdhury *et al.*, (2015).

Zinc (Zn)

The zinc content of different varieties of rapeseed and mustard were ranges from 47.94 to 66.90 ppm in (Table 6). Significantly highest amount of Zn contained was found in BARI Chenabadam-8 (66.90 ppm) which was followed by BARI Sarish-16 (66.80 ppm). The lowest amount was found in BARI Chenabadam-6 (47.94 ppm) which was followed by BARI Chenabadam-7 (51.48 ppm) and BARI Sarisha-17 (51.91 ppm). The present values were supported by the reported value of Bachheti *et al.*, (2012) and Josefson (1988), Chowdhury *et al*., (2015).

Table 9. Proximate analysis of minerals content of the different Oilseed varieties

Name of the varieties (Treatments)	Cu (ppm)	Fe (ppm)	Zn (ppm)
BARI Sarisha-15	13.40 a	170.30 a	51.45 b
BARI Sarisha-16	13.26 a	75.70 e	66.80 a
BARI Sarisha-17	6.18 c	100.70 d	51.91 b
BARI Chenabadam-7	14.04 b	99.80 d	51.48 c
BARI Chenabadam-8	11.10 b	131.00 c	66.90 b
BARI Chenabadam-9	10.51 a	147.50 b	47.94 a
LSD $_{(0.05)}$	1.226	6.084	0.7277
CV (%)	5.90%	2.77%	0.71%

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

4.4 Gross energy

Energy from Carbohydrate of mustard and groundnut varieties varied significantly due to different varieties (Table 7). Significantly the highest amount of energy from carbohydrate found in BARI Sarisha-17 (75.41 kca/g), followed by BARI Sarisha-16 (56.20 kca/g), BARI Sarisha-15 (54.92); while the lowest amount found in BARI Chenabadam-8(10.20 kca/g). The highest energy from protein observed from BARI Chenabadam-8(138.00kca/g); whereas the lowest amount of energy (90.27 kca/g) from protein observed from BARI Sarisha-16. The highest amount of energy from fat was observed in BARI Chenabadam-9 (445.60 kcal/g), significantly same amount of energy obtained from BARI Chenabadam-8(442.40 kcal/g). The study found that Gross energy of different varieties of mustard and groundnut ranged from 531.20 kcal/g to 595.70 kcal/g. The highest amount of gross energy found from BARI Chenabadam-8 (595.70 kcal/g); while lowest amount of gross energy recorded from BARI Sarisha-16 (531.20 kcal/g). The current value supported by the reported value of Chowdhury *et al.*, (2015), Hossain *et al.*, (2015).

Table 10. Proximate analysis of Gross energy from carbohydrates, Proteins and oils of the different varieties of oilseed

Name of the varieties (Treatments)	Energy from Carbohydrate (kcal/g)	Energy from Protein (kcal/g)	Energy from Oil (kcal/g)	Total Energy (kcal/g)
BARI Sarisha-15	54.92 b	112.00 c	376.60 c	543.6 d
BARI Sarisha-16	56.20 b	106.40 c	368.50 d	531.2 e
BARI Sarisha-17	75.41 a	90.27 d	377.80 c	543.5 d
BARI Chenabadam-7	30.96 c	120.60 b	444.10 b	595.7 a
BARI Chenabadam-8	10.20 d	138.00 a	442.40 a	590.5 c
BARI Chenabadam-9	27.3 c	119.40 b	445.60 a	592.3 b
LSD $_{(0.05)}$	7.811	6.445	1.554	1.549
CV (%)	10.10%	3.10%	0.21%	0.15

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

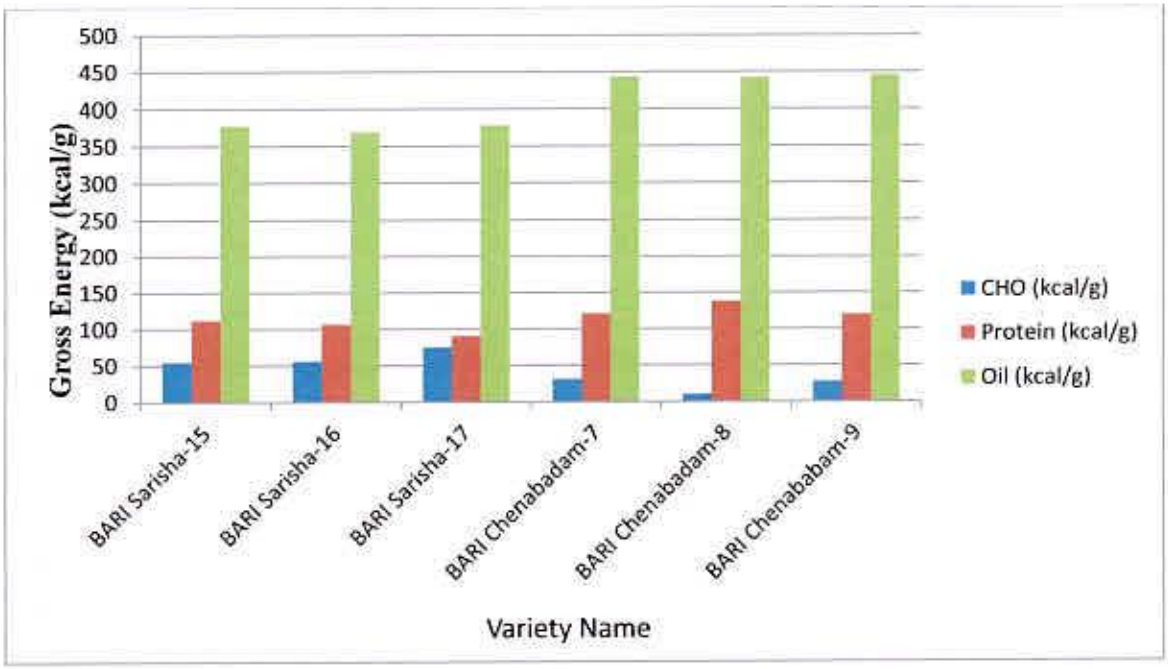

Figure 4. Gross Energy of the different oilseed varieties

Sher-e-Bangla Agricultural University
Library
Sher-e-Bangla Nagar, Dhaka

Chapter 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Chapter V

SUMMARY, CONCLUSIONAND RECOMMENDATIONS

The study was conducted at the Biochemistry laboratory, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from July to December 2013 to evaluate the physicochemical parameters of the mustard and groundnut. Three varieties of mustard and three varieties of groundnut were selected for the study. All the varieties were evolved by BARI and growing in large scale in Bangladesh. Mustard seeds are small in size and its grain weight is also lower as compared to groundnut seeds. The highest thousand grain weight was found in BARI Chenabadam-7 (127.90g) and the lowest thousand grain weight was found in BARI Sarisha-15 (3.173g).There are significant variation between mustard and groundnut varieties seed weight. The highest moisture content (4.52%) was observed from BARI Sarisha-15; whereas the lowest moisture content (3.70%) was found in BARI Chenabadam-7. Significantly highest amount of dry matter contained was recorded in BARI Sarisha-16 (96%); while the lowest amount of dry matter contained was found in BARI Sarisha-15 (94.8%).

The oil content of different varieties of mustard and groundnut varied from 40.95% to 49.51%.The variety BARI Sarisha-16 contained lowest amount of oil (40.95%), while the variety BARI Chenabadam-9 contained significantly highest amount of oil (49.51%). The BARI Sarisha-15 contained significantly highest amount of oil cake (59.05%), and the lowest amount was found in BARI Chenabadam-9 (50.49%). The highest dry weights of cake was obtained from BARI Sarisha-13 (56.65%).

The highest Saponification value was found in BARI Chenabadam-8 (183.40) the lowest saponification value was found in BARI Sarisha-15 (157.60). The highest of iodine value were observed in BARI Chenabadam-9 (106.40). The lowest amount of iodine value recorded in BARI Sarisha-16 (38.44).

Significantly the highest amount of palmitic acid was observed in BARI Chenabadam-8(13.98%) and the lowest amount of palmitic acid content was observed in BARI Sarisha-16 (2.090%).The concentration of stearic acid varied from 1.19% to 2.78%; whereas arachidic acid contents ranged from 0.423%to 4.96%. BARI Chenabadam-9 contained the highest amount (62.94%) of oleic acid and the lowest amount was found in BARI Sarisha-16 (14.72%) which was significantly lowest among all the varieties. The Highest amount of lenoleic acid contained was found in BARI Chenabadam-8 (36.10%),and lowest amount was found both in BARI Sarisha-17 (14.38%). The concentration of linolenic acid varied from 7.10% to 0.24%. Groundnut varieties contained noerucic acid whereas mustard variety contained significant amount of erucic acid. BARI Sarisha-17 contained the highest amount of erucic acid (51.35%).Highest amount of total saturated fatty acid (TSFA) contained in BARI Chenabadam-8(18.41%) and the lowest amount contained BARI Sarisha-16 (8.28%). Highest amount of total unsaturated fatty acid (TUSFA) contained in BARI Chenabadam-9 (94.21%) lowest amount contained in BARI Sarisha-8 (83.43%).

Ash content of different released varieties of mustard and rapeseed were variable and ranged from 9.60% to 14.20%. Significantly highest amount of protein was obtained from BARI Chenabadam-8 (34.50%), the lowest amount of protein obtained from BARI Sarisha-17 (22.57%). The amount of carbohydrate contained found in BARI Sarisha-17 (18.85%) was significantly highest than other varieties. The lowest amount of carbohydrate was obtained from BARI Chenabadam-8(2.55%).

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

Significantly highest amount of calcium (Ca) content was observed in BARI Chenabadam-9 (2.58%), while the lowest amount of calcium content was obtained from BARI Sarisha-17 (1.10%). There is no significant variation in magnesium content among the varieties. Highest amount of Cu contained observed in BARI Chenabadam-9 (14.04 ppm) and the lowest amount of Cu contained observed in BARI Sarisha-17 (6.18 ppm). Significantly highest amount of Fe contained was observed in BARI Sarisha-15 (170.30 ppm), the variety BARI Sarisha-16 showed lowest amount of Fe (75.70 ppm). Zinc content of varieties range from 47.94 ppm to 66.90 ppm. The highest amount of gross energy found from BARI Chenabadam-7 (595.70 kcal/g; while lowest amount of gross energy recorded from BARI Sarisha-16(531.20 kcal/g).

From the above discussion, it was observed that groundnut varieties performed better than mustard varieties by all nutrient parameters. BARI Chenabadam-8 contained the highest amount of protein, saturated fatty acid and also the highest saponification value. In case of oil content and unsaturated fatty acid composition BARI Chenabadam-9 performed good results. BARI Chenabadam-7 contained highest amount of gross energy. Among mustard varities BARI Sarisha-17 contained highest amount of oil and also highest saponification value. All mustard varieties contained good amount of erucic acid that is not present in groundnut varieties. Based on the information mentioned above, it is suggested that varieties of groundnut may be grown in large scale as they contained higher amount of different nutrient contents.

RECOMMENDATIONS

- Further analysis of different oilseed variety should be done to know their nutrient content.

- Nutritional analysis is also important for breeders to evolve more nutrients rich oilseed crops.

- Chemical composition and nutritional traits suggests the future strategy for the nutritionist, health advisors and dieticians as to how to make best use of the oilseed crops.

Sher-e-Bangla Agricultural University
Library
Sher-e-Bangla Nagar, Dhaka

REFERENCES

REFERENCES

Ayoola, P. B., Adeyeye, A. and Onawumi, O.O. (2012).Chemical evaluation of food value of groundnut (*Arachi hypogaea*) seeds. American Journal Of Food And Nutrition.36: 2157-1317.

Abdulrazak, S., Otie, D., and oniwapele, Y.A. proximate analysis and anti-nutritional factors of groundnut and melon husk. *Online Journal of Animal and Feed Research*. 4(2): 25-28.

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.

Ajala, A. S., &Adeleke, S. A. (2014). Effect of drying temperatures on physicochemical properties and oil yield of African star apple (*Chrysophyllumalibidum*) seeds. *G.J. E.D.T.*, 3(3):12-16

Amir, H.R., and Zandi,P.(2012). A comparison of fatty acid compounds in winter and spring rapeseed varieties. *Annals of Biological Research*. 3 (3):1408-1414.

Andrahennadi, C.P., Weerasena, L.A. and Aberyrantne, M.D.R.S.(1991). Evaluation of brown mustard germplasms in Srilanka. *Cruciferae Newsletter*. **14**(15): 62-63.

AOAC. (2010). Official methods of analysis. Association of official analytical chemists, Washington, DC.

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

Appelqvist, L.A. and Ohlson. (1992). Rapeseed, Elsevier Publishing co., London NY. P. 37.

Aremu, M. O., Ibrahim H. and T. O. Bamidele. (2015) Physicochemical Characteristics of the Oils Extracted from Some Nigerian Plant Foods – A Review. *Chemical and Process Engineering Research*. 32.

Aremu, M. O., Bamidele, T. O., &Amokaha, J. A. (2012). Compositional studies of rattle box (*Crotalaria retusa* L.) seeds found in Nasarawa State, Nigeria. *Pakistan Journal of Nutrition,* 11(10), 880 – 885.

Aremu, M. O., Olaofe, O., &Akintayo, E. T. (2006a). Chemical composition and physicochemical characteristics of two varieties of bambara groundnut (*Vigna subterrenea*) flours. *J. Applied Sciences,* 6

Arif, M., Nasiruddin, Masood,T. and Shah,S.S.(2012). Evaluation of oil seeds for their potential nutrients. *ARPN Journal of Agricultural and Biological Science.*7(9):730-734.

Asibuo, J. Y., Akromah, R., Safo, K.S., Dapaah, A., Kofi,H., Dapaah, O., Seth. andAgyeman, A. (2008). Chemical composition of groundnut, *Arachis hypogaea* (L) *landraces. African Journal of Biotechnology*. 7 (13), 2203-2208,

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

Atasie, V. N., Akinhanmi, T. F. &Ojiodu, C. C. (2009). Proximate analysis and physioco-chemical properties of groundnut *(Arachis hypogaea L.). Pakistan Journal Nutrition,* 8(2), 194 – 197.

Atasie, V.N., Akinhanmi, T.F. and Ojiodu, C.C., (2009). Proximate analysis and physico-chemical properties of groundnut *Arachis hypogaea L.* Pak. J. Nutri., 82: 194-197.

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

Bachheti, R.K., Rai, I., Joshi, A. and Rana, V.(2012). Physico-chemical study of seed oil of *Prunusarmeniaca*L. grown in Garhwal region (India) and its comparison with some conventional food oils. *International Food Research Journal*.**19**(2): 577-581.

Banga, R.S., Dhawan,K. and Singh,D. (2013). Quality and yield of Indian mustard genotypes as influenced by different fertility levels. Oilseeds Section, Department of Plant Breeding ,CCS Haryana Agricultural.University, Hisar (India).

BARI. (1986-87). Determination of oil content of some *Brassica campestris.* Annual report. Joydebpur, Gazipur-1701.

BARI. (1987-88). Biochemical report on oilseeds. Oilseed Research center, Joydebpur, Gazipur-1701.

BARI. (1992-93). Determination of oil content and Fatty acid composition of Brown seeded *B. compestris* genotypes. Annual report. Joydebpur, Gazipur-1701.

BARI. (2001). Biochemical report on oilseeds. Oilseed Research centre, Joydebpur, Gazipur-1701.

BARI. (2010). Status of oil crop production in Bangladesh. Oilseed Research centre. Joydebpur, Gazipur-1701.

Barrozo, M.A.S., Silva, A.A.M. and Oliveira,D.T. (2008). The use of curvature and bias measures to discriminate among equilibrium moisture equations for mustard seed. *Journal of Stored Products Research*.**44** (2008):65-70.

Bauer, B., V. Kostik, Gjorgeska B. (2015). Fatty acid composition of seed oil obtained from different canola varieties. *Farmaceutski glasnik*.71, 1/2015.

Bell, J. M., Rakow, G. and Downey, R. K. (1999). Mineral composition of oil free seeds of B. napus, B. rapa and B. Juncea as affected by location and year. *Can. J. Anim. Sci.* 79:405-408.

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

Besbes S., Blecker, C.,Deroanne,C., Drira, N. E. and Attia,H. (2003). Date seeds: Chemical composition and characteristics profiles of the lipid fraction. *J. Food. Chem.* 84: 577-584.

Bhowmik, T.P. (2003). Oilseed Brassicas (constrain and their management). Principle Scientist (Retd.), Division of Mycology and pathology .Indian Agricultural Research Institute, New delhi, India.

Biswas, K.P. (1989). Performance evaluation of 14th genotype of oleiferous Brassica. Proceeding of the 14th Annual Bangladesh Sci. Conf., pp. 70.

Campos- Mondragon MG, Calderon AM, DelaBarca A, Duran-Prado, Campos-Reyes LC, Oliart-Ros RM, Ortega-Garcia J, Medina-Juarez LA, Angulo O (2009). Nutritional composition of new peanut (*Arachis hypogaea*L.) cultivars, Grasos Y. Aceites, 60: 161-167.

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.

Chemical and Process Engineering Research www.iiste.org ISSN 2224-7467 (Paper) ISSN 2225-0913 (Online) Vol.32, 2015

Chowdhury,M.F.N., Ahmed, K.U, Nuruddin, M.M. and Hosen, M. (2010). Study on fatty acid composition, oil and protein of different varieties and advanced lines of ustard and rapeseeds. *Bangladesh Research Publication Journal* .**4**(1):7.

Chowdhury, L.B. and Prasad, B. (1987). Genetic variation and heritability of quantitative characters in Indian mustard. *Indian J. Agric. Sci.***38**(5): 820-825.

Chowdhury, M. F. N., Hossain, M. D., Hosen, M. and Rahman, M. S.(2015). Comparative Study on Chemical Composition of Five Varieties of Groundnut (*Arachis hypogaea*). *World Journal of Agricultural Sciences*. **11** (5): 247-254.

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

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.

Damian,C.(2014). Physical Properties of Mustard seeds (*sinapis alba* L.),*LucrăriȘtiințifice - Seria Zootehnie*.**61**:39-44.

Demba S. (1985). ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). Proceedings of the

Durrani, F.R., and Khalil, I.A.(1990). Chemical composition of Brassica oilseed meal. *Pakistan. J. Sci. Ind. Res.* 33: 39-41.

FAO (2006). http//apps.fao.org/page/collection?subset=agriculture Galvaro LCA, Lopez A, Williams HL (1976). Essential mineral elements in peanut and peanut butter. J. Food Sci. **41**: 1305-1307.

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

Feia, A. M., Isam, A. M. A., Suha, O. A. and Elfadil, E. B. *(2012)* Nutritional and functional characterization of defatted seed cake flour of two Sudanese groundnut (*Arachis hypogaea*) cultivars. *International Food Research Journal.19(2): 629-637.*

Gadei ,G.,Gaceu,L.,Gruia,R.(2012).Preliminary research regarding the impact of mustard flour addition in bread, proceeding of BIOATLAS Conference,Transylvania university of Brasov, Faculty of Food and Turism.

Gibbon, D. and Pain, A. (1985). Crops of the drier region of the tropics. longman group Ltd UK pp 146.

Gopalan, C., Rama Sastri, B.V. and Balasubraminian, S.C. (1981). Nutritive value of Indian foods. National institute of nutrition. ICMR, Hyderabad. India.

Hossain, S., Hazarika, G.N. and Barua, P.K. (1998). Genetic variability, heritability and genetic advance in Indian rapeseed (*Brassica campestris* L.) and mustard (*Brassica juncea*). *J. Assam Agril. Univ.* **11**(2): 260-261.

Hossein,A., Rad,S. and Zandi, P.(2012). A comparison of fatty acid compounds in winter and spring rapeseed varieties. *Annals of Biological Research.* **3**(3):1408-1414.

Huda, M.A. (2001). Why quality seed reality and vision. PhD (Agronomy), BAU; (seed technology). Published by evergreen printing and packaging 9/1, Bangladesh. Dhaka. pp.145.

Hughes, M. (1965). Determination of moisture and oil in the seed of winter rape (*B. napus*). Comparison of extraction methods or the estimation of oil. *J. Agric.***20**:745-747.

Hossain, M. D., Ahmed, K. U., Chowdhury, M. F. N., Roksana, K. M., Islam, S. Barman, A. (2015). Experimental study on Grain weight, Moisture, Ash, Carbohydrates, Protein, Oil, Total energy and minerals content of different varieties of Rapeseed and Mustard (*Brassica spp.*). *International Journal of Scientific and Research Publications*, pp. 394-400

Hussain,R., Hussain,A., Asadullah., Sattar, S., Zeb, M.,Hussain, A. and Nafees, M. (2015) Physico-chemical Properties and Assessment of Edible Oil Potential of Peanuts Grown in Kurram Agency, Parachinar. Pak. J. Anal. Environ. Chem.16(1): 45-51.

Idouraine, A., Kohlhepp, E. A., & Weber, C. W. (1996). Nutrient constituents from eight lines of naked seed squash (*Cucurbita pepo* L.). *Journal of Agriculture & Food Chemistry*, 44, 721 – 724.

Ingale, S. and S. K. Shrivastava, S. K. (2011). Nutritional study of new variety of groundnut (*Arachis hypogaea*L.) JL-24 seeds. *African Journal of Food Science*. **5** (8): 490 – 498.

Jasass,A. F.M. and Al-Jasser,M.S.(2012). Chemical Composition and Fatty Acid Content of Some Spices and Herbs under Saudi Arabia Conditions.*The Scientific World Journal*. 2012(2012): Article ID 859892.

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

Josefson, E. (1988). Chemistry of the oil Industry. *Indian J. Plant Physiology*. **2**(4): 250-251.

Karim, M.R., Ahmed, F. and Islam, R. (2000). Performance of some *Brassica juncea* varieties/lines under on farm condition at Pabna. *Bangladesh J. Agril. Sci.* **27**(1): 157-158.

Kaul, A.K. and Das, M.L. (1986). Oilseeds in Bangladesh. Winrock international. Bangladesh Agricultural Research council, Dhaka.

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.

Kudla, M. (1993). Comparative analysis of winter Swede rape genotypes. *Biuletyninstytutu Hodowli Roslin.* pp. 99-107.

Kumar, A. G., Panwar, V., Yadav, K.andSihag, S. (2002). Mustard cake as a source of dietary protein for growing lambs. *Small Rumin Res.* **44**(1):47–51.

Kumar, V. and Singh, D. (1994). Genetics of yield and its components in Indian mustard (*Brassica juncea* L. Czern and Coss). *Crop Research.* **7**(2): 243-246.

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.

Latif ,K., Alam, M., Sayeed ,M., Hussain, M.A., Sultana ,S.and Hossain, M. (2008). Comparative study on the effects of low cost oil seed cakes and fish meal as dietary protein sources for Labeorohita (Hamilton) fingerling. *University Journal of Zoology, Rajshahi University*.**27**:25–30.

Lebowitz, R.J. (1989). Image analysis measurements of repeatability estimates of siliqua morphological traits in *Brassica campestris*L. *Euphytica*. **43**(1-2): 113-116.

Mahmud, A., N., Hasan, M., Hossain, M. and Minar, M. (2012). Proximate composition of fish feed ingredients available in Lakshmipur region, Bangladesh. *American-Eurasian J Agric& Environ Sci*. **12**(5):556–560.

Mandal, S., Yadav, S., Singh,R., Begum, G., Suneja, P. and Singh ,M. (2002). Correlation studies on oil content and fatty acid profile of some Cruciferous species. *Genet Res Crop Evol*.**49**: 551-556.

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

Mazzoncini, M., Vannozzi, G.P., Megal, P., Secehiari, P., Pistoia, A. and Lazzeri, L. (1993). Characterization and Agronomic evaluation of Ethiopian mustard (*Brasscacarinata*). Institute of Agronomy. **123**(4): 330-338.

Mirza, M., Sirazul, H. Ullah, M.A. and Awwal, A. (1998). Variation of seed weight, oil and fatty acid composition in linseed oil. *Bangladesh J. Agril. Res.* **23**(2): 307-314.

Mondal, M.R.I. and Wahhab, M.A. (2001). Production technology of oilseeds.Oilseed Res. Laboratory, Bangladesh Agril. Res. Inst. Joydebpur, Gazipur. pp. 6-24.

Moser, B. R., Shah, S.N., Winkler,J. K.,Vaughn, S.F. and Evangelista, R.L. (2009). Composition and physical propertiesof cress (*Lepidium sativum* L.) and field pennycress (*Thlaspi arvense* 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 acidComposition of three varieties of mustard (*brassica compestris*)viz,basanti, kalasona, kaveri ak-47. *Int. j pharm bio sci*. **3**(4): (b) 421 – 428.

Nabipour, M. ,Meskarbashee, M. andYousefpour, H. (2007).The Effect of Water Deficit on Yield and Yield Components of Safflower (*Carthamustinctorius* L.).*Pak. J. Biol. Sci*.10:421-426.

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.

Nehrins, K., and Fettu (1990). In rapeseed Meal for livestock poultry. A review. The Canada Department of Food and Nutrition. Dhaka University.

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.

Nkafamiya, I. I., Maina, H. M. ,Osemeahon, S. A. and Modibbo, U. U. (2010). Percentage oil yield and physiochemical properties of different groundnut species (*Arachis hypogaea*).*African Journal of Food Science.***4** (7): 418-421.

Novoselov, M.A., Sahai, V.N., S.H. and Mondal, M. (1997). Oil content in different oilseed varieties of Bangladesh. *Indian J. Agric. Res.***22**: 7-10.

Okwu, D. E. (2006). The Potentials of *Ocimum gratissum, Pengluria exntensa, and Tetrapheurea* Onimawo, I.A., A.H. Momoh and A. Usman, 1998. Proximate composition and functional properties of four cultivars of bambara groundnut (*Voandzeia subterranea*). *Plant Foods Human Nutr.* **53**: 153-158.

Osborne, O. R. & Vooget P (1978). Calculation of Calorific Value in the Analysis of Nutrients in Roots, Academic Press New York, 239-244.

Pathak, R.K., Sharma, M.K. and Tripathi, R.D. (1973). Quality Studies in some cruciferous oilseeds. *Indian J. Agric. Res.* **7**(2): 99-103.

Pospišil,M., Škevin, D. ,Mustapić, Z. , Nakić, S.N. , Butorac, J. , and D. Matijevic,(2007). Fatty Acid Composition in Oil of Recent Rapeseed Hybrids and 00-Cultivars . *Agric. conspec.sci.***72**(3): 187-193.

Sher-e-Bangla Agricultural University Library Sher-e-Bangla Nagar, Dhaka

Prapakornwiriya, N. and Diosady, L.L. (2004). Isolation of yellow mustard proteins by a microfiltration-based process. *Int J ApplSci Eng.* **2**(2):127–135.

Raghuramula, N., Madhavan, N.K. and Kalyanasundaram, S. (2003). A Manual of laboratory Techniques. National Institute of Nutrition. Indian council of Medical Research, Hyderabad-500007, India. pp: 56-58.

Ramachandran,S., Singh, S.K., Larroche, C., Soccol,C.R. and Pandey,A.(2007). Oil cakes and their biotechnological applications–A review. *Bioresour Technol.* **98**(10):2000–2009.

Ranganna, S. (1986). Handbook of analysis and quality control for fruit and vegetable production (second end.), chapter 1. The McGraw Hill publishing company limited, New Delhi.

Rathore, P.S. (1999-2000). Techniques and Management of field crop production. Rajasthan Agricultural University. Published by Agro bios India. Chopasani Road. Jodhpur- 342003.

Razzaque M, Karim M. (2007). Effect of varing concentrations of certain salts on germination and seedling vigor of two rape (*Bassica napus* L.) varoties.). Mesopotamia Journal of Agriculture.**14**(2):25-40.

Regional Groundnut Workshop for Southern Africa, 26-29 March 1984, Lilongwe, Malawi. Patancheru, A.P. 502 324, India: ICRISAT, pp 4-6.

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.

Rollet, W., and Raquet. C. (1995). Nutritive value of Indian foods. M/N. ICMR.

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.

Sanches, G.L. and Raquot, C. (1990). Oil content and fatty acid composition in different oilseed varieties of Bangladesh. *Indian J. Agric. Res.*22: 5-11.

Sarker,A.K., Saha,D, Hasina Begum, H., Zaman, A. and Rahman, M.M. (2015).Comparison of cake compositions, pepsin digestibility and amino acids concentration of proteins isolated from black mustard and yellow mustard cakes. *AMB Express.* 2015(5):22.

Sarwar, M., Ahmad, N., Khan, G. Z., &Tofique, M. (2009). Varietals resistance and susceptibility in mustard (*Brassica campestris* L.) genotypes against aphid *Myzus persicae* (Sulzer) (Homoptera: Aphididae). *The Nucleus*, 46(4), 507 – 512.

Sarwar, M., Ahmad, N., Siddiqui, Q. H., Ali, A., &Tofique M (2004b). Genotypic response in canola (*Brassica species*) against aphid (Aphidae: Homoptera) attack. *The Nucleus*, 41(1–4): 87 – 82.

Savage GP, Keenan JI (1994). The composition and nutritive value of groundnut kernels. In: Smart J. (ed). The Groundnut Crop: Scientific basis for improvement, London: Chapman and Hall, pp. 173-213.

Savage, G.P., and Keenan, J.I. (1994). The composition and nutritive value of groundnut kernels. In: Smart J. (ed). The Groundnut Crop: Scientific basis for improvement, London: Chapman and Hall. 173-213.

Sengupta, K. and Das, P.K. (2003). Cultivated annual oilseeds crops of India. Department of Agriculture. Govt of west Bengal. Published by ParthasankarBasu. 206 Bidhansarani, Kolkata 700006, India.

Siavash, B. ,Karaptian, J. andZare. S. (2005).Studying on lipid content and fatty acids in some varieties of colza (*Brassica napus*).*J. Pajuhesh & Sazandegi.* 67:95-101.

Siddiqui, M.H. and Fizor, M. (2004). Physiomorphological analysis of rapeseed mustard cultivars, *Indian J. of plant physiology*. **9**(3): 283-284.

Sood S.K., Sharma, D., Kumar, S. andLakhanpal, T.N. (2010).Healing Herbs: Traditional Medications for Wounds, Sores and Bones.Pointer Publishers, Jaipur,India.

Sosulski, F.W., and Bakal. (1991). Quality studies in some cruciferous oil seeds. *Indian J. AgricRes.* **7**(2): 99-703.

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.

Stuchlik, M., Zác,S.(2002). Vegetable lipids as components of functional foods.*Biomed. Pap. Med. Fac. Univ. Palacky Olomouc Czech Repub.***146**(2): 3-10.

Tyagi, A.K. and singhal, K.K. (2001). Proximate composition of various Indian mustard/rapeseed (*Brasica* sp). Division of cattle Nutrition, National Dairy Research Institute. **21**(1): 37-39.

Ullah, M.A., Akber, M.A., Mirza, S.H. and Ahmed, K.U. (1997). Oil content and fatty acid composition in different oilseed varieties of Bangladesh. *Bangladesh J. Agric. Res..***22**: 5-11.

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.

Vijay, K., Yadav and Neel, A.M. (1992). Oil and glucosinolate contents in Indian Rapeseed and mustard varieties. *Indian J. Agric.***21** (2): 15-20.

Wahhab, M.A. and Caesar, K. (1980). Selection of mustard plants (*Brassica juncea* L.) with low content of erucic acid.

Sher-e-Bangla Agricultural University
Library
Sher-e-Bangla Nagar, Dhaka

APPENDIX

Sher-e-Bangla Agricultural University Library
Accession No. ..... Date : .....
Sign. .....

APPENDIX

Appendix 1. Chemical composition of some Oilseed varieties

Variety	Seed					Fatty acid composition		Minerals (ppm)				Total Energy (kcal/g)
	Moisture	Oil	Protein	Ash	CHO	TSFA %	TUSFA %	Fe	Ca	Mg	Zn	
BARISarisha-15	4.52	41.85	28.00	11.90	13.73	9.02	89.04	170.3	2.15	0.74	51.45	543.6
BARI Sarisha-16	4.20	40.95	26.60	14.20	14.05	8.28	87.11	75.7	2.52	0.74	66.80	531.2
BARI Sarisha-17	4.10	41.98	22.57	12.50	18.85	8.43	90.26	100.7	1.10	0.64	51.91	543.5
BARI Chenabadam-7	3.70	49.35	30.15	9.06	7.74	14.37	90.90	99.80	2.40	0.73	51.48	595.7
BARI Chenabadam-8	4.00	49.15	34.15	9.80	2.55	18.41	83.43	131.0	2.50	0.72	66.90	590.5
BARI Chenabadam-9	4.20	49.51	29.85	9.60	6.84	11.73	94.21	147.5	2.58	0.73	47.94	592.3