POSTHARVEST QUALITY ASSESSMENT OF LOCAL POTATO AS AFFECTED BY NATURAL STORAGE

NISHAT SHARMIN

DEPARTMENT OF AGRONOMY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

DHAKA-1207

JUNE, 2015

POSTHARVEST QUALITY ASSESSMENT OF LOCAL POTATO AS AFFECTED BY NATURAL STORAGE

By

NISHAT SHARMIN

REGISTRATION NO. 09-03609

A Thesis
Submitted to the Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka,
in partial fulfilment of the requirements
for the degree of

MASTER OF SCIENCE

IN

AGRONOMY

SEMESTER: JANUARY-JUNE, 2015

Approved by:

(Prof. Dr. A.K.M. Ruhul Amin)	**(Prof. Dr. Tuhin Suvra Roy)**
Supervisor	**Co-supervisor**

(Prof. Dr. Md. Fazlul Karim)
Chairman
Examination Committee

DEPARTMENT OF AGRONOMY
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207
PABX: 9110351 & 9144270-79

CERTIFICATE

This is to certify that the thesis entitled ***"POSTHARVEST QUALITY ASSESSMENT OF LOCAL POTATO AS AFFECTED BY NATURAL STORAGE"*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of* ***MASTER OF SCIENCE (M.S.)*** *in* ***AGRONOMY,*** *embodies the results of a piece of bona fide research work carried out by* ***NISHAT SHARMIN,*** *Registration. No.* ***09-03609*** *under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information as has been availed of during the course of this investigation has duly been acknowledged.

Dated:
Dhaka, Bangladesh

(Prof. Dr. A.K.M. Ruhul Amin)
Supervisor

DEDICATED TO

MY

BELOVED PARENTS

ACKNOWLEDGEMENTS

All praises are due to the Almighty Allah, the great, the gracious, merciful and supreme ruler of the universe to complete the research work and thesis successfully for the degree of Master of Science (MS) in Agronomy.

The author expresses the deepest sense of gratitude, sincere appreciation and heartfelt indebtedness to her reverend research supervisor ***Dr. A.K.M. Ruhul Amin****, Professor, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka for his scholastic guidance, innovative suggestion, constant supervision and inspiration, valuable advice and helpful criticism in carrying out the research work and preparation of this manuscript.*

The author deems it a proud privilege to acknowledge her gratefulness, boundless gratitude and best regards to her respectable co-supervisor ***Dr. Tuhin Suvra Roy****, Professor, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka for his valuable advice, constructive criticism and factual comments in upgrading the research work and this documents.*

The author would like to express her deepest respect and boundless gratitude to all the respected teachers of the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, for their valuable teaching, sympathetic co-operation, and inspirations throughout the course of this study and research work.

The author wishes to extend her special thanks to Kaniz Fatema, Tanjina Arfin, Tasmin Jannat, Md. Nazmul Haque, Md. Mahfuzur Rahman, Rajesh Chakraborty, Kamal Uddin for their help during experimentation. Special thanks to all other friends for their support and encouragement to complete this study.

The author is deeply indebted to her father and grateful to her respectful mother, brother and other relative's for their moral support, encouragement and love with cordial understanding.

Finally the author appreciate the assistance rendered by the staffs of the Department of Agronomy and Agronomy Laboratory, Sher-e-Bangla Agricultural University, Dhaka, who have helped her during the period of study.

The Author

POSTHARVEST QUALITY ASSESSMENT OF LOCAL POTATO AS AFFECTED BY NATURAL STORAGE

ABSTRACT

The experiment was conducted at the Agronomy Laboratory, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka from March to June, 2014, to study the quality assessment of some local potato varieties in natural storage condition. Eight potato varieties *viz.*, 'Lal pakri', 'Sada shapla', 'Bhuta', 'Jam alu', 'Deshi sotti', 'Berma', 'Tel pakri' and 'Lady rosetta' were used as planting materials. Postharvest quality parameters of tuber *viz.*, tuber shape, eye depth, color of skin and flesh, general appearance of tuber and specific gravity, tuber dry matter, total soluble solids (TSS), firmness, crispness, color of chips, weight loss (%) were determined the processing quality. Skin color among the varieties the highest L* in 'Sada shapla' (60.47) 0 DAS, a* and b* in 'Lady rosetta' (14.83) 60 DAS and (32.12) 60 DAS. Flesh color of the varieties the highest L* in 'Lady rosetta' (76.00) 0 DAS, a* in 'Jam alu'(5.98) 60 DAS and b* in 'Lady rosetta' (34.67) 60 DAS. Chips color of the varieties the highest L* in 'Tel pakri' (73.75) 0 DAS, a* in 'Jam alu'(12.92) 60 DAS and b* in 'Lady rosetta' (36.78) 60 DAS. 'Lady rosetta' executed the minimum weight loss (0.46%, 0.17%, o.23% and 0.17% respectively) at 15, 30, 45 and 60 DAS compared to other varieties at different DAS. Weight loss (%) gradually increased in 'Lal pakri' (4.71%), 'Sada shapla' (5.71%) and 'Bhuta' (4.18%). 'Lady rosetta' found maximum specific gravity (1.101%, 1.103% and 1.110% respectively) at 0, 15 and 30 DAS, 'Berma' found maximum (1.134%) at 60 DAS. Dry mater (%) of different varieties 'Lady rosetta' executed the highest (24.60%) 0 DAS, (25.40%) 15 DAS, (26.35%) 30 DAS, (27.20%) 45 DAS, (27.90%) 60 DAS and 'Sada shapla' executed the lowest (17.39%) 0 DAS, (17.98%) 15 DAS, (18.60%) 30 DAS, (19.50%) 45 DAS, (20.30%) 60 DAS. Among the varieties, more than 20% dry matter present in 'Lady rosetta'(27.90%), 'Lal pakri'(25.78%), 'Jam alu'(26.98%), 'Bhuta'(24.48%) and 'Berma'(25.40%). The highest TSS was recorded in 'Jam alu'(7.30%) at 60 DAS and the lowest in 'Lady rosetta'(3.00%) at 0 DAS. Among the varieties the highest firmness in 'Jam alu' (33.78) 0 DAS, the lowest in 'Bhuta' (13.45) 60 DAS and the highest crispness in 'Jam alu' (3.320) 0 DAS, the lowest in 'Bhuta' (0.337) 60 DAS. 'Lady rosetta', 'Bhuta' and 'Berma' showed better performance compared to those of other varieties. The information obtained in this study will inform Bangladeshi potato farmers and processors regarding the suitable potato varieties at different DAS in natural storage condition for processing industries.

CONTENTS

CONTENTS (Cont'd)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Cont'd)

LIST OF APPENDICES

LIST OF APPENDICES (Cont'd)

LIST OF PLATES

LIST OF ACCRONYMS AND ABBREVIATIONS

%	Percentage
^{0}C	Degree Celsius (Centigrade)
AEZ	Agro-Ecological Zone
Agric.	Agriculture
Agril.	Agricultural
ANOVA	Analysis of variance
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
CIP	International Potato Centre
Cm	Centi-meter
cm^2	Square centi-meter
CRD	Completely Randomized Design
CV	Coefficient of Variance
DAS	Days After Storage
Dev.	Devlopment
DMC	Dry Matter Content
DPOD	Total Potato Defects
*e.*g	for example
Environ.	Environmental
et al.	And others
Expt.	Experimental
FAO	Food and Agriculture Organization
g	Gram (s)
i.e.	*id est* (L), that is
j.	Journal
kg	Kilogram (s)
LSD	Least Significant Difference
M.S	Master of Science
m^2	Meter squares
MF	Maximum Force
mg	Milligram
ns	Non Significant
PRC	Potato Resarch Centre
Res.	Research
RH	Relative humidity
SAU	Sher-e-Bangla Agricultural University
Sci.	Science
TCRC	Tuber Crop Research Centre
TSS	Total Soluble Solids
UNDP	United Nations Development Programme
viz	Namely
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

Potato (*Solanum tuberosum* L.), one of the major food crops of the world is popularly known as 'The King of vegetables'. It is a tuber crop belongs to the family Solanaceae. It originated in the Peru Bolivian region in the Andean area of South America (Grewal *et al.*, 1992). It is the 4th world crop after wheat, rice and maize. Bangladesh is the 8th potato producing country in the world. In Bangladesh, it ranks 2nd after rice in production (FAO, 2013). It contributes not only energy but also substantial amount of high quality protein and essential vitamins, minerals and trace elements to the diet (Horton, 1987).

The total area under potato crop, per acre yield and total production in Bangladesh are 4,62,032 hectares, 10.370 metric t ha^{-1} and 89,50,024 metric tons, respectively (BBS, 2013). It is considered as a vegetable crop and contributes as much 55% of the total vegetable production in Bangladesh (BBS, 2013). The yield is very low in comparison to that of the other leading potato growing countries of the world, 40.16 t ha^{-1} in USA, 42.1t ha^{-1} in Denmark and 40.0 t ha^{-1} in UK (FAO, 2013).

In Bangladesh, potato is grown during the winter season. Nutritionally, the tuber is rich in carbohydrates or starch and is a good source of protein, vitamin C and B, potassium, phosphorus and iron. Potato is one of the most important vegetable crops and having a balanced food containing about 75 to 80% water, 16 to 20 % carbohydrates, 2.5 to 3.2% crude protein, 1.2 to 2.2% true protein, 0.8 to 1.2% mineral water, 0.1 to 0.2% crude fats, 0.6% crude fiber and some vitamins (Schoenemenn, 1977). It is a staple diet in European countries and its utilization both in processed and fresh food form is increasing considerably in Asian countries (Brown, 2005). Being a carbohydrate rich crop, potato can partially substitute rice, which is our main food item. It is grown in almost all countries of the world. In main countries including those Europe, America and Canada, potato is a staple food. In the last 2-3 decades, production of potato in

Bangladesh has increased with the cultivation of high yielding varieties. In Bangladesh, potato is mainly used as vegetable and available in the market throughout the year with reasonable price as compared to other vegetables.

The total production is increasing day by day as such consumption also rapidly increasing in Bangladesh (BBS, 2013). Number of processing industries and potato products are increasing with the demand of specific varieties. Besides culinary consumption, the use of potato has progressively increased as a raw material by the processing industry (Iritani, 1981). French fries and potato chips is the most consumed industrially processed potato products in Bangladesh, especially in the major urban centers. Processors have, however, complained of inadequate supply and low quality of potatoes currently supplied in the market. So quality attributes should take into account to fulfill the customers and industry demand. Potato must meet a number of requirements including high dry matter, high starch high crispness, high firmness, high specific gravity content and good color to fulfill the requirement of processing (Brook *et al*., 1995). Now a day, the most important features of potato production is tuber quality (Brown, 2005). Chip quality may be defined by various parameters, however, the most common index is color. Consumer preference is predominately for an attractive light brown chip (Smith, 1955). Therefore, to meet the preference of the consumer and to produce a superior product, factors affecting chip quality are important to both the grower and the processor and must be well understood by both to maintain acceptable chip color throughout the chipping season.

The yield and processing characteristics of available potato varieties are largely unidentified. Keeping in view the consumers requirement, it is important to identify varieties that posses traits to meet the domestic demand and provide growers the opportunity to meet the challenges of frequently changing market, production circumstances and improving their economic condition by selling their export quality potato at good price to the processing industry both in Bangladesh and abroad (Connor *et al*., 2001). Potatoes of local varieties can

store long time then any other varieties in natural storage condition. Quality attributes are satisfied in local varieties. The proposed study will be undertaken the potato varieties have higher longivity in natural storage condition and can be used in processing purposes in case of local varieties.

Potato being a vegetable with 80% of moisture in its fresh form is also subjected to price fluctuation and causes a lot of economical loss to the farmers during glut seasons. Further increased cost of cold storage and appreciable loss in storage is making the growers to go for potato processing. Among the processed products chips are the most popular ready-to-eat snacks in Bangladesh. Potato consumption in different processed products needs to be enhanced to sustain the increase in production and to ensure remunerative prices to the farmers. Processing of the bulky perishable potatoes into various processed products is variable option which can help to extend the shelf life, solve the problem of storage, cater to customer preferences belonging to different age group and social levels, serve as means to maximize the supply in off-seasons thereby maximizing potato utilization. With specifications for morphological and biochemical traits, screening of potato cultivar suitable for either direct composition or process is a prerequisite for processors, industrialists and customer in the food chain. Employing the common and feasible methods of processing, the present study on screening of potato cultivars for chemical composition and processing was formulated with the following objectives:

1. To study the physical characteristics of different local potato varieties.

2. To study the storage performance of different potato varieties and

3. To study the selected potato varieties for processing aspects, for growers food industries and potato products consumers in Bangladesh.

CHAPTER 2

REVIEW OF LITERATURE

Potato is one of the most important vegetable crops in Bangladesh. Potatoes currently have the highest rate of production growth in most developing countries and the main stay in the diet of people in many parts of the world. On an average, about 28% of total potato produced throughout the world is processed. Storage facilities are a serious problem in Bangladesh due to lack of appropriate storage facilities and transport. Some of the important and informative works conducted at home and abroad. The related literature pertaining to the study has been reviewed under the following subtitles:

2.1 Physico-chemical characteristics of potato varieties

Ganga and Kulkarni (2014) carried out an experiment where chemical analysis of ten potato cultivars were done. They reported that the dry matter content ranged from 15.30 (J/99-242) to 20.93% (Kufri Khayti). Starch was minimum in J/99-242 (52.55%) and maximum in Kufri Khayti (85.67%). The highest reducing sugars were found in Kufri Pushkar (210.33 mg 100 $^{g-1}$). Lowest level of total sugars was found in J/99-242 (216.10 mg 100 g^{-1}) and Kufri Khayti (216.67 mg 100 g^{-1}) the two being at par with each other and highest in Kufri Jyoti (816.67 mg 100 g^{-1}). Minimum non reducing sugars (104.43 mg 100 g^{-1}) were also found in J/99-242 and maximum (575.00 mg 100 g^{-1}) in Kufri hipsona-2. They also reported that dry matter was positively correlated with flavor and taste of baked potatoes which could be due to highest amount of starch that forms stable complex with flavor compounds during cooking.

Ten varieties of potato tubers and revealed that tubers mean length varied significantly between the varieties ranging from 5.9 cm - 7.6 cm in kufri Ashoka. Mean breadth of tubers ranged between 4.4 cm - 5.6 cm with shortest in Kufri Pushkar and longest in Kufri Ashoka. Kufri Ashoka showed significantly large mass (113 g), highest volume (106.9cc) and longest diameter (5.8 cm) while Kufri Pushkar had significantly smallest mass, lowest volume whereas Kufri Surya recorded significantly shortest diameter.

Majority of the cultivars were oval shaped with brown colored skin and cream flesh, number of eyes were less in most of the cultivars with shallow eye depth, without sears and green tint. Highest numbers of natural depression were found in kufri Chipsona-2, Kufri Khayti produced highest slices (84.00%) as well as chips (22.83%) and thus ranked first. Specific gravity increased yield of slices as well as yield of chips which was significant at 0.05 level Ganga *et al*. (2013).

Abbas *et al.* (2012) carried out an experiment using 32 potato genotypes for processing and yield quality traits were evaluated for screening found significant differences in all the quality parameters and various characteristics , while the genotypes 394021-120, 9625, kiran, NARC 2002-1, NARC 1-2006/1 and VR 90-217 gave the highest yield but low quality characters. The tuber sizes and weight was also significantly different among genotypes in tuber characteristics such as skin color, tuber shape, eye depth, flesh color and general appearance.

Schwarz and Geisel (2012) reported that storage problems most often occur because of conditions in the field and not conditions in storage. Adverse weather, disease or improper harvesting and handling of tubers can cause problems in storage. Tubers that are rotting, frozen, chilled or diseased must be managed differently than mature, sound tubers. Good storage management will help to salvage problem tuber lots, but storage will never improve a poor quality variety.

Elfinesh *et al.* (2011) conducted to investigate the influence of growing environment and blanching on chips quality of five improved potato cultivars (Chiro, Zemen, Bedassa, Gabissa and Harchassa). They reported that the highest tuber dry matter content (27.33%) and specific gravity (1.110 gcm^{-3}) were produced by cultivar Harchassa while the lowest dry matter content (20.33%) and specific gravity (1.078 gcm^{-3}) were by cultivar Zemen both grown at Haramaya condition. All the cultivars at all locations produced tubers with a dry matter content greater than 20.0% and a specific gravity of 1.070 gcm^{-3} which are within the acceptable range for chip processing. The cultivars produced tubers with low reducing sugar content that ranged from 0.036 to 0.051g $100g^{-1}$ fresh weight (FW). For chips making, peeled potatoes were sliced to 2.0 mm thickness, washed and surface-dried.

Ghulam *et al.* (2011) conducted an experiment in thirty two genotypes including eight commercial varieties of potato to evaluate the yield processing quality traits. They reported that significant differences in all the quality parameters were observed among the genotypes. The highest dry matter was found in NARC 1-2006/1 (25.65%) while NARC 1-2006/2 had the lowest dry matter (14.86%). Reducing sugars ranged from 0.57% in 396243-24 to 0.01% in NARC1-2006/1. Maximum starch was observed in NARC 1-2006/1 (20.01%) while it was minimum in Cardinal (9.00%). Protein value was found to be the highest (3.40%) in 9721 whereas the minimum value for protein was recorded in NARC 1-2006/2 variety (0.72%). They also reported that dry matter content of genotypes was positively correlated to starch (r = 0.9048), specific gravity (r = 0.5966) and negatively related to reducing sugars (r = -0.5515). The quality traits/characteristics represented by specific gravity, dry matter, sugars, starch, protein and ash are influenced by genotype.

Liu *et al.* (2007) conducted an experiment to estimate Physic-chemical properties of dry matter and starch from potatoes in Canada. They stated that percent total starch, dietary fiber, protein, free sugar and apparent amylase content of AC Stampede Russet, Russet Burbank and Karnico potato dry matter ranged between 70.5 to 72.4%, 5, to 5.6%, 7.1 to 9.7%, 3.3 to 6% and 29.7 to 33.3% respectively.

Composition and characterization of starch extracted from various potato cultivars in Golestan province of Iran. The diameter of potato starch granular were shown to range from 34.2 to 42.1μm with a mean of 38.7+3.3μm, indicating that the granular size had no significant differences among potato varieties. The yield of potato starch varied from 9 to 12.6% on fresh weight basis. The highest and lowest yield of starch was observed in concord and Draga respectively. The starch yield was directly correlated to the dry matter content of the tubers, which ranged between 17.2 and 22%. Among the six potato cultivars, the average value of the amylase content was lowest in Sante (24.4%) and highest in Graga (27.1%) Yaghbani *et al.* (2006).

Kumar and Ezckiel (2004) conducted an experiment in Himachal Pradesh to study on distribution of dry matter and sugars of potato cultivars namely, Kufri Chipsona-1, Kufri Chipsona-2, kufri jyoti, Kufri Lauvkar and Atlantic. They reported that the highest values

of dry matter were obtained in stem end cortical tissue of kufri Chipsona-2 (27.5%) and lowest in pith region of Kufri Lauvkar (14.8%).

Effect of location, season and cultivar on the processing quality of potatoes was investigated in Uttar Pradesh investigated by Kumar *et al.* (2003). An average chip color score of less than 4 was observed from the potatoes procured from Deesa, Dhali, Jorhat and Kota. Potatoes from Jorhat gave most consistent results.

Tabatabaeefar (2002) studied physical properties of different potato cultivars in Iran. Among the four varieties studied, Draga and Agira had longer diameter and larger masses than other two varieties. All the varieties exhibited ellipsoidal shape. The per cent spherecity for Draga, Ajacks and vital varieties was 81%. With minimum sphericity (71%) and highest length to width ratio (1:5), Agria variety was less spherical. As the diameter of tuber increased volume of potato increased linearly.

A study carried out the effect of chemical composition of potato on chips by Kita (2002) in Poland. The contents of dry matter, starch and protein nitrogen ranged from 19.92 to 23.28%, 15.2 to 18.4% and 0.136 to 0.0180% respectively.

Uppal and Khurana (2001) carried out a study on potato varieties grown at different locations for chipping was done in Punjab. The chip quality and contents of dry matter and free sugars varied among locations. Potatoes grown at Bhubeneswar, Chhindwara, Deesa, Kota and Panta had low concentration of reducing sugars ranging from 0.13% to 0.245 on fresh weight basis. The amount of reducing sugars was much more than the permissible limits (0.29% to .04%) for processing at Faizabad, Muzaffarbad, Hisar, Jalandhar and Udham Singh Nagar. There researched on chipping performance of potato varieties grown at different locations in Punjab. Potatoes grown at Bhubeneswar, Chhindwara, Deesa, Kota and Panta produced acceptable chips of golden yellow color with color score 4.7, 4.0, 4.2, 3.6 and 4.3 respectively. The tubers grown at Faizabad, Muzaffarbad, Hisar, Jalandhar and UdhamSinghth Nagar were unfit for making chips and produced chips of darker color ranging from 6.3 to 9.7 color score.

In Bangladesh, potatoes are generally harvested in February to March, when both temperature and humidity begin to rise sharply. Under such conditions, the tubers

terminate dormancy and begin to sprout, which results in decrease of their quality due to changes such as shrinkage, weight loss and rot under ambient conditions in Bangladesh, 20 to 80% of the tubers have been lost (Devendra *et al*., 1995).

Misra and Chand (1990) conducted an experiment to see the relationship between size of tuber and chemical composition of potato in Meerut. They reported that a negative linear relationship was observed between tuber size and total phenolic content (44.0 mg $100g^{-1}$ for 1.5 cm and 4.8 mg $100g^{-1}$ for 8.0 cm) as well as reducing sugar (150 mg 100 g^{-1} for 105 cm and 0.3 mg 100 g^{-1} for 8.0 cm). The tuber size did not affect dry matter, sucrose and ascorbic acid content of the two varieties. Thus biggest the tuber, better the processing characteristics so far as reducing sugars and phenolic content are concerned.

Dayal and Sharma (1987) reported that stored potatoes deteriorate in quality due to a number of reasons. These are weight loss, sprouting and formation of little tuber and internal sprouts. Such deterioration is pronounced under relatively high temperature. Storage methods of overcoming these problems and prolonging the store life of potatoes have been reported. Sprout suppression are used for prolonging the storage. Successive de-sprouting of storage potatoes can be employed for harvesting sprouts for use in rapid multiplication techniques.

A field trial was conducted Kleinkopf *et al.* (1987) to observe the variability in specific gravity of Russet Burbank potatoes. Maximum variation was 40 units among individual tubers within hills (one unit equals one part in 1000th of specific gravity measurement) and 15 units among hills. Field site variability of 10-15 units was common between sampled grid lines in the field, but bulked samples (truckloads) reduced the sampled variability to 8-10 units. When the samples were taken from bulked lots as opposed to single hill samples the variability decreased. Grower lots, which were pooled samples from several truckloads, showed specific gravity differences of 2-7 units even though all lots were from the same field. These variations among specific gravity samples should be taken into account when considering total solids content in any lot of potatoes. Degree of resetting of the skin and hollow heart also influenced specific gravity measurements. Measured differences between peeled and unpeeled lots of 10 units in specific gravity corresponded to 2% difference in total solids content. Statistically, the variance of the

peeled lot was one half that of the unpeeled lot, therefore, to minimize the measured differences due to skin type, peeled potatoes could be used for the specific gravity measurements.

Khan *et al*. (1984) reported 40.6% tuber weight loss in natural storage. Roy and Hossain (1981) also reported that storage of potatoes under non-refrigerated condition was very much promising.

In Bangladesh, farmers need to store their potatoes from March to September. Tuber weight loss due to dehydration and rottage under natural storage was reported up to 80.0% by Hashem (1979) and 40.6% by Khan *et al*. (1981).

Miller *et al*. (1975) reported that the content of the major sugars found in potatoes, glucose, fructose and sucrose varied among good and poor chipping varieties.

2.2 Processing of potato variety

Affleck *et al.* (2012) conducted that processing quality of potatoes for French fries is partially ascertained by reducing sugar content of the tuber. Much of the potato crop is processed after a storage period when sugar content can change and affect processing quality. In this study, the stability of sugar levels in 8 potato genotypes was studied over four environments (i.e., two locations over two yr). The GGE bi-plot analysis was used to measure the stability, and the association between, quality traits and sugar content. Quality and sugar content were measured 105 and 120 d after planting and 60 and 120 d after storage. The bi-plots indicated a change in French fry color scores and stability between the 105 and 120 d after planting harvest dates. Genotypic differences were noted for French fry color scores and glucose content. Genotypes were identified that were stable for French fry color during the two storage periods indicating low genotype by environment interaction. The GGE bi-plot identified mega-environments that encompassed a group of environments with similar attributes. Based on this finding potatoes from only one environment within the mega environment would need to be stored for quality evaluations.

A study was undertaken to determine the cooking quality characteristics of advanced clones and potato cultivars by Hassanpanah *et al.* (2011) in Iran under *in vitro* conditions. There were significant differences between cultivars and clones for tuber dry matter, starch percent, specific gravity, chips color, quality and amount of reducing sugars. Dry matter (22.52%), specific gravity (1.91) and starch (16.62%) content were highest in Salvalan variety among the three cultivars whereas 396156-6 clones had the highest dry matter (24.4%). Specific gravity (1.100) and starch (17.69%) were highest in 396156-6 among the clones.

George *et al.* (2010) conducted an experiment in Kenya to evaluate the newly developed potato cultivars for processing into quality crisps. Twenty four potato cultivars including eighteen varieties and six clones were evaluated for some physico-chemical properties and crisps processing potential. Most cultivars with the exception of six of them including Roslin Tana, Desiree, Roslin Eburu, Nyayo, Tigoni Long and Kihoro had acceptable physical characteristics for processing. The specific gravity of the cultivars varied from 1.074 to 1.098 and dry matter contents from 19.50% to 24.20%. Reducing sugar levels significantly ($P \leq 0.05$) varied among the cultivars and ranged between 0.07% and 0.4%. In addition to Dutch Robyjn which is currently used for processing potato crisps in Kenya, the varieties Tigoni and Kenya Baraka, and the clones 393371.58, 392657.8, 391691.96 and 393385.39 were also similarly suitable for processing into potato crisps. They had desired physical characteristics with low levels of reducing sugars and were highly rated by sensory panelists. Promoting these cultivars will increase the number of processing varieties for the rapidly expanding processing industry and thus safeguard availability and quality.

Evalution of potato cultivars for processing into crisps was carried out by Abong *et al.* (2010) in Kenya. Majority of the cultivars with exception of RoslinTana, Desire, Rodlin Ebura, Nyayo, Tigonilong and Kihora had acceptable physical characteristics suitable for processing. Tuber diameter varied significantly ($p<0.05$) among the cultivars ranging from 43 mm in tigoni long to 56 mm in Kenya Sifa and Clone 392617054. The specific gravity of the cultivars varied from 1.074 to 1.098 and dry matter contents from 19.50 to

24.20%. Majority of the cultivars were round in shape. Reducing sugar levels varied significantly ($p<0.05$) among the cultivars and ranged between 0.07% and 0.4%.

Abong *et al.* (2009) conducted an experiment on Kenyan cultivars to observe the influence of potato cultivars and stage of maturity on chips and French fries. They reported that the dry matter content ranged from 19.50 to 24.07% and 20.56 to 24.66% in clone 393385.39 and variety Dutch Roby for tubers harvested 90 and 120 days after planting respectively.

Study on suitability of potato varieties grown in North-eastern Indian plains for processing was undertaken by Singh *et al.* (2009) in West Bengal. The dry matter content of popular variety Kufri Jyoti, from different districts of West Bengal, ranged from 17 to 19.6%. Processing varieties 'Lady Rosetta', kufri Chipsona-3, Kufri Chipsona-1 and Atlantic showed a dry matter content of 23.3, 22.8, 19.5 and 20.1% respectively, while all the other varieties, except Kufri Chandramukhi (19.2%), had dry matter content of 18.1%. The reducing sugars content of processing varieties, Atlantic and kufri Chipsona-1 was very low (45.0-57.7 mg 100 g^{-1} fresh wt), while all other varieties contained higher levels of reducing sugars (96.3-240.7mg 100g^{-1} fresh wt). Kufri Jyoti contained higher levels of total phenols (74.6-110.4 mg g^{-1} fresh wt); while processing varieties, Atlantic and Kufri Chipsona-1 had lower levels (43.3-58.9 mg 100 g^{-1} fresh wt), 'Lady Rosetta' contained lowest total phenols (23.6 mg 100 g^{-1} fresh wt), whereas, Kufri Jyoti contained very high levels of phenols (55.1-92.4 mg 100g^{-1} fresh wt).

Investigation on impact and future priorities of potato processing varieties was carried out by Pandey *et al.* (2009) in Himachal Pradesh. They reported that processing varieties Kufri Chipsona-1, Kufri Chipsona-2, Kufri Chipaona-3 produced dry matter content of 21 to 24% and reducing sugars of <0.1%.

A comparative study of physical and sensory properties of pre-treated potato slices during vacuum and atmospheric frying was conducted by Troncoso *et al*. (2009) in Chile. Vacuum frying increased significantly ($p<0.05$) oil content and decreased instrumental color and textural parameters. Potato slices fried under vacuum had better color reading significantly higher compare to the slices fried under atmospheric conditions. Sensory

attributes, flavor quality and overall quality, were significantly improvement using vacuum frying. The higher frying temperature (140° C) increased color, breaking force, hardness and crispness. A great improvement on color parameters was obtained using sulphited potato slices instead of the other pre-treatments. Although, the better flavor was obtained for control potato chips, no significant differences were found for overall quality between control and sulphited potato chips.

Marwaha *et al.* (2009) conducted an experiment in India on exotic potato processing varieties for storage behaviour and changes in nutritional compounds under different condition. They reported that Indian and American processing varieties having high dry matter content viz. Kufri Chipsona-2, Atlantic and Frito Lay produced high chip yield 30.4 to 32.1% with low oil content (<35%). Both Indian and American processing varieties contained (>22%) dry matter, while Kufri Jyoti showed lowest dry matter content before 17.2% and after storage 19.6% and 18.4% under both storage condition.

Raj and lal (2008) studied the effect of cultivars, cold storage and frying media on yields and processing qualities of potatoes in Solan. Cultivars with high dry matter and low moisture produced chips with low moisture levels. The color and texture of the chips of Kufri Chipsona-1 and Kufri Chipsona-2 were the best. He studied the effect of cultivars, cold storage and frying media on yields and processing qualities of potatoes in Solan. Cultivars with high dry matter and low moisture produced chips with low moisture levels. The color and texture of the chips of Kufri Chipsona-1 and Kufri Chipsona-2 were the best.

With an effort to develop a processing potato variety suitable for growing in high lands, a study was conducted in Himachal Pradesh by Pandey *et al.* (2008a). The round oval tubers had high dry matter (22.4%), low reducing sugar (<100 mg $100g^{-1}$ fresh weight basis) with less than 250 mg 100 g^{-1} of sucrose on fresh weight basis.

With an effort to develop a processing potato variety suitable for growing in highlands, a study was conducted in Himachal Pradesh by Pandey *et al.* (2008b). The variety Kufri Himsona produced high yield and good processing grade tubers. The color of the chips

produced from Kufri Himsona was light and acceptable (<3.0), none of the varieties produced acceptable color chips.

Marwaha *et al.* (2008) conducted an experiment on potato the effect of blanching of slices of potato varieties on chipping quality in Punjab. They found that dry matter content ranged from kufri Pukhaj (15%) to kufriChipsona-2 (23.4%). Kufri Chipsona-1 and Kufri Chipsona-2 contained high tuber dry matter i.e.>21%, while Kufri Pukhaj contained minimum dry matter (15%).

Changes in reducing sugars content and chip color of tubers during storages at different temperature was observed by Singh and Ezekiel (2008) in Jalandhar. Dry matter content varied with the cultivar and growing location. Processing cultivars kurif Chipsona-1 and kurif Chipsona-2 had higher dry matter content (24.4 and 25.8% respectively) as compared to other cultivars. Least dry matter content was observed in kufri Pukhraj (15.6%). Reconditioning was effective in improving the chip color.

Ezekiel and Rani (2006) investigated the shelf life of potato chips during storage. The dry matter content of tubers of thirty three potato genotypes varied from 16.3 to 26.2%. Oil content showed a highly significant negative relationship with tuber dry matter content and starch content.

A study was undertaken by Singh *et al.*, (2005) on MP/97-644: A promising hybrid for making potato chips and dehydrated products in Uttar Pradesh. They reported that the hybrid MP/97-644 gave significant higher dry matter, low reducing sugars and showed round shape with shallow eyes making it suitable for chips preparation.

Ezckiel and Dahiya (2004) assessed the storage losses of potatoes stored in heaps and pits in the (Madhya Pradesh) and found that at harvest, tuber had relatively higher dry matter content of 22.3% and lower reducing sugar content of 25.1 mg $100g^{-1}$ fresh weight basis. The chip color score was 3.3, which was good. After storage in heaps and pits, the dry matter content improved by 2-3% due to weight loss with higher inn heap storage method (25.2%) and the reducing sugar content remained within the acceptable limit (36.7 mg $100g^{-1}$) on fresh weight basis.

Study on effect of pre-drying on texture and oil uptake of potato chips was undertaken in Chile by Pedreschi and Moyano (2004). Texture analysis revealed that final maximum force was significantly higher (P>0.05) for blanched and dried potato chips than for only blanched potato chips. Both frying temperature and pre-drying temperature had a significant effect (p>0.5) over the final texture and oil content of the fried potato chips. When fried at 120° C, potato chips containing moisture < 10g $100g^{-1}$ were crispier and contained more oil than potato chips fried at 180° C. Pre-drying dramatically decreased the oil absorption and significantly increased (p>0.05) the crispness of the blanched potato slices after frying.

With an aim to develop a reference color chart for potato chips from fresh and stored potatoes, a study was conducted by Ezekiel *et al.* (2003) in Himachal Pradesh. Increasing color scores showed a significant positive correlation (r=0.77**) with reducing sugar content of tubers. Tubers with reducing sugar content ranging from 30 to 54 mg 100 g-1 fresh weight produced chips of color score 1, whereas tubers with reducing sugar content of 44 to 239 mg 100 g-1 fresh weight produced chips of color score 5.

Starch content, yield and quality of dehydrated chips were investigated in Patna. Varieties Kufri Chipsona-2 had higher dry matter content of 21.2% and 22.0% respectively. There was no significant difference in the moisture content of dehydrated chips. The peeling loss was also low in both Kufri Chipsona-1 (11.3%) and Kufri Chipsona-2 (11.9%), respectively Das *et al.*, (2001).

A study conducted on low and high sugar potato cultivars for processing quality as influenced by storage temperature by Marwaha (2000) in Punjab. The dry matter content of exotic cultivars was higher than the Indian cultivars and free amino acids and total phenols were significantly lower in the exotic cultivars than the Indian cultivars at the time of storage. The reducing sugar content of the exotic cultivars was very low 964 to 80 mg $100g^{-1}$ fresh wt basis) as compared to the Indian cultivars (158 to 285 mg $100g^{-1}$ fresh wt basis).

Peschin (2000) studied the influence of storage temperature and reconditioning on the biochemical composition of potato tubers in Himachal. There was no significant varietal

difference among genotypes in their biochemical constituents at the time of storage and during. Among these Kufri Kuber, Kufri Chandramukhi and Kufri Lauvkar contained low reducing sugars of 1.8, 5.8 and 5.0 mg/100 g fresh weight basis respectively. On storage at 5-7°C, all the cultivars showed accumulation of phenols, which was more predominant after 90 days of storage. Post harvest reconditioning of tubers for 10 days at ambient temperature (20 ±2°C) caused decline in reducing sugar in all the cultivars. However, it was ineffective as a means of lowering free amino acids content and there was no significant improvement in chip color.

Research on chip and processing parameters of potatoes grown during spring and autumn in north-western plains was conducted by Uppal (2000) in Punjab. Chips made from tubers of spring crops were of light yellow color (2 to 3 scores), superior in taste and highly acceptable, whereas autumn crop potatoes produced unacceptable chips having dark brown color (6 to 7 scores). He documented chip color and processing parameters of potatoes grown during spring and autumn in north-western plains in Punjab. The reducing sugar content of both Kufri Chandramukhi and Kufri Jyoti varieties were much low, 67 to 89 mg $100g^{-1}$ fresh weight basis in spring as against 289 to 304 mg $100g^{-1}$ in autumn. But Chandramukhi contained amount of reducing sugars and total sugar, in both the seasons.

Uppal (1999) studied the effect of storage environments on chip color and sugar levels in tubers of potato cultivars were studied in Punjab. The contents of reducing sugars ranged between 188 mg and 325 mg $100g^{-1}$ fresh weight basis at the initial stage with lowest in 'kufri Sherpa' with 312 mg 100 g^{-1} fresh weight basis and maximum in 'Kufri Chandramukhi' (198 mg 100 g^{-1}) fresh weight basis. Maximum reduction (44%) in reducing sugars was found in tubers of 'kufri Jawahar' and minimum (6%) in 'Kufri Lauvkar' when stored at evaporative cool storage.

Ramaswamy *et al.* (1999) investigated the effects of various preparation technologies on the proximate composition and energy content of potato products in Mauritius. Various preparation technologies viz., boiling, baking, frying of chips and frying of battered cakes have a significant effect ($P<0.01$) on the proximate composition and energy content of potato products. A general decrease in moisture, fiber, carbohydrate and protein was

noted for most of the preparation technologies. The ash content of processed products increased @ 5, 4, 7, 9.5 g 100g $^{-1}$ dry weight basis for boiled potato, baked potato and chips respectively compared to raw potato (4.4 g 100 g^{-1} dry weight basis) with the exception of battered cakes. In frying chips and battered cakes, the fat as well as energy contents were significantly higher ($P<0.01$) compared to boiling and baking. Compared to raw potato, drastic increased in fat contents of 9795% and 9321% were observed during frying of chips and battered cakes respectively.

Marwaha (1999) carried out an experiment on chipping quality and related processing characteristics of Indian potato varieties grown under short day conditions in Punjab. Fresh fried chips prepared from two varieties *viz.,* Kufri Sherpa, Kufri Lauvkar were light in color with score 2 and 3 respectively and were acceptable, whereas other eight varieties gave a unacceptable color score ranging from 6 to 8. However, when physical characters such as tuber size and shape were taken into consideration, only Kufri Lauvkar was found most suitable for chipping.

Gaur *et al.* (1998) conducted an experiment in Kufri Chipsona-1, Kufri Jyoti variety for processing. Kufri Jyoti had 2 to 4% lower tuber dry matter than Kufri Chipsona-1. Kufri Chipsona-1 also produced acceptable light color chips of grade 1-3. In contrast, Kufri Jyoti produced unacceptable brown color chips of grade 5-6. But chip yield were 331.7% and 306.0% from Kufri Chipsona-1 and Kufri Jyoti respectively.

Singh *et al*. (1976) conducted an experiment on storage temperature of potato varieties that respond differently. They reported some varieties are stored at the most favorable temperatures may accumulate enough reducing sugars (glucose and fructose) within two weeks of storage to caused dark colored chips. Other varieties are capable of withstanding storage at low temperatures and can e reconditioned at higher temperatures to produce an acceptable chip color. Monona and Kenneec varieties have been shown to respond favorably to reconditioning.

Sucrose and reducing sugar content vary under different storage conditions. Samotus *et al.* (1974a) reported that the predominant in tubers following short term storage at low temperature was sucrose. However, upon prolonged storage they found the reducing

sugar content increased and sucrose content decreased. They attributed this shift in the sucrose to reducing sugar ratio to peak concentration of invertase after three weeks of storage, converting the sucrose to glucose and fructose.

Pressey (1969) reported that newly harvested mature Kennebec potatoes contained low levels of reducing sugars and a low concentration of the enzyme, invertase. However, upon exposure of the tubers to temperatures of 4.4^0 c (40^0 F), he discovered a rapid increase in reducing sugars along with increased invertase concentration and rate of activity. His data indicated that at low temperatures invertase was one of the enzymes involved in the formation of reducing sugars from sucrose.

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted during the period from 01 March to 31 May, 2014. The materials and methods describes a short description of the experimental site, climate condition of the storage room, experimental materials, experimental treatments and design, method of the study, data collection procedure and procedure of data analysis. The detailed materials and methods that are used to conduct the study are presented below under the following headings:

3.1 Location of the experimental site

The experiment was conducted at the Agronomy Laboratory, Department of Agronomy, Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh. It was located in $23^0 41'$ N Latitude and $90^0 22'$ E Longitudes.

3.2 Condition of storage room

The temperature and relative humidity of the storage room were recorded daily basis during the study period with a digital thermo hygrometer (TERMO, TFA, Germany). The minimum and maximum temperature during the study period of the storage room was 26.2°C to 33.4°C, respectively. The minimum and maximum relative humidity was 56% and 84% respectively.

3.3 Experimental materials

The eight varieties of potato tubers namely- ‘Lal pakri’, ‘Sada shapla’, ‘Bhuta’, ‘Jam alu’, ‘Deshi sotti’, ‘Berma’, ‘Tel pakri’, and ‘Lady rosetta’ were collected from the farmers fields, the local area of Natore District. The collected tubers were free from any visible defects, disease symptoms and insect infestations and transported to the Laboratory of the Department of Agronomy, SAU, Dhaka with careful handling to avoid disease and injury.

3.4 Experimental treatments and design

Tubers were randomly selected and placed on the floor of the Laboratory at natural condition to find out the better variety/genotypes under quality observation.

Treatment: Potato variety (8 varieties) as

1. Lal pakri
2. Sada shapla
3. Bhuta
4. Jam alu
5. Deshi sotti
6. Berma
7. Tel Pakri
8. Lady rosetta

The experiment was laid out in a Completely Randomized Design (CRD) with 5 replications.

3.5 Physico-chemical composition of potato tubers

3.5.1 Physical characteristics of potatoes

Physical characteristics of the agricultural produce are the most important parameters in the design of grading, handling, processing and packaging system. Physical characteristics mainly weight, volume, specific gravity, diameter, shape, color, visual observation of skin and flesh color of ten potatoes of each varieties were recorded.

3.5.1.1 Tuber Shape

The tuber simply was scored for shape according to the following key (Wooster and Farooq, 1995).

1 = Round	2 = Round to short oval	3 = Short oval
4 = Short oval to oval	5 = Oval	6 = Oval to long oval
7 = Long oval	8 = Long oval to very long oval	9 = Very long oval

3.5.1.2 Eye depth

The cultivation of the simple, pertaining to tuber eye depth was made as mentioned Wooster and Farooq (1995).

1 = Very deep	2 = Very deep to deep	3 = Deep
4 = Deep to medium	5 = Medium	6 = Medium to shallow
7 = Shallow	8 = Shallow to very shallow	9 = Very shallow

3.5.1.3 Color of screen and flesh

Tuber skin color i.e., white or red were noted by visual observation immediately after harvesting. For flesh color 10 tubers from each treatment were cut into two halves and the assessment of the simple for flesh color was done as describe by Wooster and Farooq (1995).

1 = White	2 = Cream	3 = Yellow

3.5.1.4 Total potato defects (TPOD)

Total potato defects were examined externally in terms of presence of green tint, scars, natural depression, skin texture and number of eyes in internally TPOD of cut potatoes was visualized for presence of hollow hearts and black spots (Singh *et al*., 2005).

3.5.1.5 Color measurement

Color was measured with a color spectrophotometer NF 333 (Nippon Denshoku, Japan) using the CIE Lab L*, a* and b* color scale. The 'L*' value is the lightness parameter indicating degree of lightness of the simple; if varies from 0 = black (dark) to 100 = white (light). The 'a*' which is the chromatic redness parameters whose value means trending to red color when positive (+) and green color when negative (-). The 'b*' is yellowness chromatic parameters corresponding to yellow color when it is positive (+) and blue color when it is negative (-). Each sample consisted of 10 slices, each of which was measured thrice. Hue angle = arctg and chroma = were calculated. Higher number of chromaticity indicate a more vivid color, whereas lower numbers correspond to dull colors. Color management was done just after cutting tubers.

3.5.1.6 Weight loss (%)

Potato was stored as per treatment and their initial weight was taken. Weight loss percentage was recorded at 15, 30, 45 and 60 days after storage (DAS) from the stored potato. Weight loss was calculated using the following formula:

$$\text{Percent weight loss (\%), WL} = \frac{\text{IW-FW}}{\text{IW}} \times 100$$

Where, WL = Percent total weight loss; IW = Initial weight of tubers (g)

FW = Final weight of tubers (g)

3.5.1.7 Specific gravity

Weight of each potato sample in the air and weight of water displaced by the same potato was recorded. Specific gravity was calculated using the formula and mean value was expressed (Tabatabaeefar, 2002).

$$\text{Specific gravity} = \frac{\text{Weight in air } (g^1)}{\text{Weight of water displaced } (g^2)}$$

3.5.1.8 Determination of dry matter content (DMC)

For determination of dry matter, five whole tubers were randomly selected from each treatment and cut into small slices (1-2 mm) and mixed thoroughly. Dry weight of samples was then determined by drying at 70°C for 72 hours in forced air oven. From which the dry matter percentage was calculated with the following formula (Elfinesh *et al.,* 2011).

$$\text{DM (\%)} = \frac{\text{Dry weight}}{\text{Fresh weight}} \times 100$$

3.5.1.9 Firmness and Crispness

Fries and crisp texture measurements were performed at room temperature by a puncture test performed in a Texture Analyzer (Sun Scientific Co. Ltd, Japan) equipped with a wedge probe imitating front teeth. Maximum Force (MF) was defined as the force at which the wedge penetrates the outer layer of the surface of the fried potato fries and crisps slices (Segnini *et al.*, 1999). Higher firmness and lower crispness are suitable for potato product. For this result, determination of firmness and crispness are essential for processing quality potato.

3.6 Chemical composition of potatoes

3.6.1 Total soluble solids (TSS)

TSS of potato tubers was determined in a drop of potato juice by using portable hand refractometer (ERMA, Tokyo, Japan) Range: 0 to 32% according to (AOAC, 1990) and expressed as °BRIX value.

3.7 Preparation of chips

Chips from the refresh tubers were prepared as per standard procedure given by CPRI, Shimla (Marwaha *et al.*, 2008). Well cured uniform size tubers of weight 100 g to 150 g from each variety were selected to chips preparation. Preliminary trials were conducted for optimization of chips preparation using slicer with adjustable blade for slice width. As standard, the slice thickness 2.0 mm and frying time of potato slices 3 min and frying temperature 190°C to yield potato chips of optimum quality.

3.8 Statistical Analysis

The data obtained for different characters were statistically analyzed following the analysis of variance techniques by using MSTAT-C computer package programme (MSTAT, 1991). The significant differences among the treatment means were compared by Least Significant Difference (LSD) at 1% level of probability (Gomez and Gomez, 1984).

CHAPTER 4

RESULTS AND DISCUSSION

Potato is a tuber- a short, thick, underground stem is one of the most important food crops in developed as well as in developing countries. Potato production has increased in Bangladesh with the cultivation of high yielding varieties. Bangladesh is amongst the ten major potato producing countries in the world. Many potato varieties have been released in Bangladesh, however the demand for processed potato products has led the manufacturer to select the most suitable and round year available potato variety, so that there will be continuous supply of products in the market. The results of investigation on different potato cultivars assessed for physical, chemical and processing has been presented.

4.1 Physico-chemical composition of potato

4.1.1 Physical characteristics of potatoes

4.1.1.1 Salient features of tuber

4.1.1.1.1Tuber shape

The shape of tubers is also controlled by the genetic factors and environment may also affect it to some extent. Shape of the tested tuber have been presented in (Table 1). In the present study five varieties *viz.,* 'Lal pakri', 'Bhuta', 'Jam alu', 'Deshi sotti' and 'Tel pakri' had oval shaped tubers, while other three varieties namely 'Sada shapla', 'Berma' and 'Lady rosetta' had round shaped tubers. Majority of the cultivars were oval shaped in the present study. Potatoes are generally small and round shape in case of wild variety (Bradshaw, 1994). The tubers of early domesticated landrace cultivars are larger and have great variability in shape (Haan, 2009). Potato tubers that are round and oval in shape are found to be suitable for making chips by most processors because they easily make the required crisp diameters (Kulkarni and Govinden, 1994; Kabira and Lamega, 2006; Pandey *et al.,* 2009).

4.1.1.1.2 Eye depth

Tuber eye depth of potato is an important trait for the processing quality and appearance of potatoes. In the present trial 'Deshi sotti' and 'Tel pakri' had deep eyes, 'Jam alu' had

deep to medium eyes, ‘Bhuta’ , and ‘Lady Rosetta’ had medium eyes, ‘Lal pakri’ and ‘Sada shapla’ had shallow to medium eyes and ‘Berma’ had shallow eyes (Table 1). The characteristic of eye depth is controlled by particular gene and less affected by environment. During evaluation most of the varieties had shallow eye depths, which are suitable to reduce to losses during trimming and peeling (Kabira and Lamega, 2006).

4.1.1.1.3 Color of skin and flesh

In the present study skin color of three varieties like ‘Sada shapla’, and ‘Berma’ had white color; ‘Deshi sotti’ had reddish white in color and other five varieties like ‘Lady rosetta’, ‘Lal pakri’, ‘Bhuta’, ‘Jam alu’ and ‘Tel pakri’ had red in color (Table 1). Many Kenyan consumers have attributed white or red skin colored tubers to be of good quality for processing (Kabira, 2000).

The flesh color of four varieties viz., ‘Lady Rosetta’, ‘Lal pakri’, ‘Bhuta’ and ‘Berma’ had cream in color; ‘Jam alu’ had cream to red in color and another three varieties viz., ‘Sada shapla’, ‘Deshi sotti’ and ‘Tel pakri’ had yellow in color (Table 1). Similarly color of skin and flesh is controlled by genetic factors. Depth of eyes and tuber shape may be affected both by genetic and environmental factors while skin and flesh color is controlled purely by genetic factor (Anwar, 1982). In Bangladesh, Bhutan, Nepal, Pakistan and Philippines red skin potatoes are traditionally preferred. Thus characters such as tuber appearance, size, shape, color, skin flesh etc, which influence consumer choice, are considered as quality attributes in potato (Pandey *et al.*, 2000).

4.1.1.1.4 General appearance

Tuber characteristics include tuber skin color, tuber shape, eye depth, flesh color and general appearance is scored by giving number 9 for excellent to 1 for disliking. Out of eight varieties, ‘Bhuta’, ‘Berma’ and ‘Lady rosetta’ varieties got maximum score of 7; ‘Lal pakri’ ‘Jam alu’ and ‘Deshi sotti’ varieties got moderate score of 6 and other two varieties ; ‘Sada shapla’ and ‘Tel pakri’, got minimum score of 5 (Table 1).

Table 1: Salient tuber characteristics of eight potato varieties

Variety	Tuber shape	Eye depth	Color of skin	Color of flesh	General appearance
Lal pakri	Oval	Shallow to medium	Red	Cream	6
Sada shapla	Round	Shallow to medium	White	Yellow	5
Bhuta	Oval	Medium	Red	Cream	7
Jam alu	Long oval	Deep to medium	Red	Cream to red	6
Deshi sotti	Oval	Deep	Reddish White	Yellow	6
Berma	Round	Shallow	White	Cream	7
Tel pakri	Oval	Deep	Red	Yellow	5
Lady rosetta	Round	Medium	Red	Cream	7

Mean of 10 randomly selected potatoes of each variety.

4.1.1.2 Total potato defects (TPOD) of potato varieties

Results of the total potato defects of potato cultivars are presented in Table 2. External observation revealed absence of scars in most of the cultivars except for 'Bhuta', 'Sada shapla' and 'Deshi sotti'. Green tint was absent in all the varieties. Skin for most of the cultivars was smooth except in 'Lady Rosetta', 'Deshi sotti' and 'Tel pakri' which had rough skin. The mean number of eye ranged from 2.7 to 7.3 with least in 'Berma' and highest in 'Deshi sotti'. Natural depression was found in 'Jam alu' and 'Tel pakri'. The visualized total potato defects on potato skin were found to be negligible. The internal flesh of all the evaluated potato varieties was devoid of hollow hearts and black spots. Besides the desirable morphological and biochemical characters, the tubers of processing varieties should not have green tint more than 3% and the total tuber defects such as growth cracks, hollow heart, internal brown spots and secondary growth etc. also should not exceed 15% (Pandey *et al.*, 2009). Number of eyes was less in most of the cultivars with shallow eye depth, without scars and green tint. Deep eye depths lead to heavy losses during peeling, trimming and thus lowers overall yield of crisps (Smith *et al.*, 1985; Kabira and Lamega, 2006) which was absent in the tubers of present investigation. Thus the tubers investigated in the present study were suitable for processing due to low total potato defects (TPOD).

Table 2: Total potato defects (TPOD) of different potato varieties

Variety	External (skin)			Number of eyes	Internal (flesh)		
	Scars	Green tint	Type of skin		Natural depression	Hollow heart	Black spot
Lal pakri	Absent	Absent	Smooth	4.9	Absent	Absent	Absent
Sada shapla	Preset	Absent	Smooth	4.8	Absent	Absent	Absent
Bhuta	Preset	Absent	Smooth	5.7	Absent	Absent	Absent
Jam alu	Absent	Absent	Smooth	4.3	Preset	Absent	Absent
Deshi sotti	Preset	Absent	Rough	7.3	Absent	Absent	Absent
Berma	Absent	Absent	Smooth	2.7	Absent	Absent	Absent
Tel pakri	Absent	Absent	Rough	5.7	Preset	Absent	Absent
Lady rosetta	Absent	Absent	Rough	4.1	Absent	Absent	Absent

Mean of 10 randomly selected potatoes of each variety.

4.1.1.3 Color of skin at different days after storage

4.1.1.3.1 Color of skin at 0 days after storage

The statistical analysis showed that there were significant differences ($p<0.05$) on different varieties for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato skin at 0 days after storage (Table 3). The highest L* value was recorded within variety 'Sada shapla' (60.47) which was significantly different from all other varieties. The lowest L* value was noted for the 'Tel pakri' (47.87). 'Jam alu' (59.47) recorded an intermediate L* value.

The values of a* varied from 2.50 to 12.54 the lowest being recorded for 'Sada shapla', 'Tel pakri' had the highest a* value which was significantly different from others. Among the eight varieties, 'Tel pakri' demonstrated maximum b* values (27.92) and lowest was observed in 'Sada shapla (16.84).

Again chroma and hue angle were significantly affected by varieties. Among the varieties, the chroma of 'Tel pakri' (30.61) was the highest and the lowest was exhibited in 'Sada shapla' (17.03). It was observed that 'Sada shapla' had the highest hue angle (1.42), while the minimum value (1.15) for hue angle was noted for 'Tel pakri' (Table 3).

Table 3: Skin color (L*, a*, b*, chroma and hue angle) of different potato varieties at 0 DAS

Treatment	Skin color at 0 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	54.52 f	7.66 b	25.84 b	26.96 b	1.28 cd
Sada shapla	60.47 a	2.50 f	16.84 g	17.03 h	1.42 a
Bhuta	57.50 c	5.82 d	23.62 c	24.33 c	1.33 bc
Jam alu	59.47 b	5.51 d	20.31 e	21.05 e	1.30 c
Deshi sotti	55.34 e	4.08 e	21.92 d	22.29 d	1.39 ab
Berma	56.43 d	3.70 e	17.84 f	18.22 g	1.37 ab
Tel pakri	47.87 g	12.54 a	27.92 a	30.61 a	1.15 e
Lady rosetta	57.25 c	6.52 c	18.33 f	19.49 f	1.23 d
$LSD_{(0.01)}$	**0.63**	**0.53**	**0.91**	**0.39**	**0.06**
CV (%)	**1.65**	**3.07**	**2.43**	**1.01**	**2.74**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.1.3.2 Color of skin at 15 days after storage

Varieties of potato showed significant differences ($p<0.05$) for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato skin at 15 days after storage (Table 4). The skin of 'Sada shapla' had the highest L* value (56.39) which was statistically similar with 'Jam alu' (55.49). The lowest value (45.35) was observed in 'Lady rosetta'.

The values of 'a' were significant for different varieties. The skin of 'Lady rosetta' was characterized by the highest a* value (13.67), while the lowest value (3.45) was noted in 'Sada shapla' (Table 4). Among the eight varieties, 'Lady rosetta' showed the maximum b* values (29.45) and the lowest value was observed in 'Sada shapla (17.38).

Chroma and hue angle were also significantly affected by varieties. The chroma of 'Lady rosetta' (32.47) was the highest and lowest was exhibited in 'Sada shapla' (17.73). The highest hue angle was observed in 'Sada shapla' (1.37) which was statistically similar with

'Deshi sotti' (1.37) and 'Tel pakri' (1.34). The minimum value (1.13) for hue angle was noted for 'Lady rosetta' (Table 4).

Table 4: Skin color (L*, a*, b*, chroma and hue angle) of different potato varieties at 15 DAS

Treatment	Skin color at 15 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	52.34 de	8.45 b	26.45 b	27.77 b	1.26 c
Sada shapla	56.39 a	3.45 f	17.38 f	17.73 f	1.37 a
Bhuta	53.58 bc	6.13 d	23.78 c	24.55 c	1.31 b
Jam alu	55.49 a	6.47 cd	21.20 d	22.16 d	1.27 c
Deshi sotti	51.37 e	4.58 e	23.45 c	23.89 c	1.37 a
Berma	53.25 cd	4.23 ef	18.25 ef	18.73 f	1.34 ab
Tel pakri	54.36 b	7.23 c	19.24 e	20.55 e	1.21 d
Lady rosetta	45.35 f	13.67 a	29.45 a	32.47 a	1.13 e
$LSD_{(0.01)}$	**1.06**	**1.06**	**1.37**	**1.42**	**0.04**
CV (%)	**1.16**	**9.04**	**3.53**	**3.48**	**1.87**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.1.3.3 Color of skin at 30 days after storage

Among the eight potato variety showed significant differences ($p<0.05$) for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato skin at 30 days after storage (Table 5). The skin of 'Sada shapla' had the highest L* value (53.31) that was statistically similar with 'Tel pakri' (52.39), 'Bhuta" (52.38) and 'Jam alu" (51.30)compared whereas the lowest value (43.32) was observed in 'Lady rosetta'.

The values of 'a' were significant for different varieties. The skin of 'Lady rosetta' was characterized by the highest a* value (14.11), while the lowest value (4.70) was exhibited in 'Sada shapla' (Table 5). 'Lady rosetta' demonstrated maximum b* values (30.47) and lowest was observed in 'Sada shapla (17.81).

Chroma and hue angle were also significantly affected by varieties. Among the varieties, the chroma of 'Lady rosetta' (33.61) was the highest and the lowest was exhibited in 'Sada shapla' (18.47). It was observed that 'Deshi sotti' had the highest hue angle (1.35) similar with 'Sada shapla' (1.31), 'Berma' (1.31), 'Bhuta' (1.26) and 'Jam alu' (1.23) while the minimum value (1.13) for hue angle was noted for 'Lady rosetta'.

Table 5: Skin color (L*, a*, b*, chroma and hue angle) of different potato varieties at 30 DAS

Treatment	Skin color at 30 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	48.42 c	9.02 b	26.91 b	28.41 b	1.24 a-c
Sada shapla	53.31 a	4.70 d	17.81 e	18.47 f	1.31 ab
Bhuta	52.38 ab	7.70 b	24.15 c	25.38 c	1.26 ab
Jam alu	51.30 ab	7.50 bc	21.59 d	22.90 d	1.23 a-c
Deshi sotti	48.43 c	5.36 cd	24.59 c	25.20 c	1.35 a
Berma	50.42 bc	4.92 d	18.80 e	19.48 f	1.31 ab
Tel pakri	52.39 ab	7.60 bc	19.69 de	21.16 e	1.20 bc
Lady rosetta	43.32 d	14.11 a	30.47 a	33.61 a	1.13 c
$LSD_{(0.01)}$	**2.04**	**2.28**	**2.13**	**1.33**	**0.12**
CV (%)	**2.35**	**17.30**	**5.35**	**3.15**	**5.57**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.1.3.4 Color of skin at 45 days after storage

Varieties of potato showed significant differences ($p<0.05$) for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato skin at 45 days after storage (Table 6). The highest value of L* was observed in 'Sada shapla' (50.36) which was statistically identical with 'Tel pakri' (49.26), 'Jam alu' (48.45) and 'Bhuta' (48.27). The lowest value of L* was noted for 'Lady rosetta' (41.09) and it was statistically different from other varieties.

The skin of 'Lady rosetta' was characterized by the highest a* value (14.38), while the lowest value (5.39) was exhibited in 'Berma' (Table 6). Among the eight varieties, 'Lady

rosetta' demonstrated maximum b* values (30.88) and lowest was observed in 'Sada shapla (18.79).

Variation in chroma and hue angle among the potato varieties were also statistically different. Among the varieties, the chroma of 'Lady rosetta' (34.08) was the highest and the lowest was exhibited in 'Sada shapla' (19.93). It was observed that 'Deshi sotti' had the highest hue angle (1.34), while the minimum value (1.13) for hue angle was noted for 'Lady roseta'.

Table 6: Skin color (L*, a*, b*, chroma and hue angle) of different potato varieties at 45 DAS

Treatment	Skin color at 45 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	46.26 bc	9.45 b	27.34 b	28.94 b	1.23 bc
Sada shapla	50.36 a	6.57 cde	18.79 e	19.93 f	1.23 bc
Bhuta	48.27 ab	9.10 bc	24.78 c	26.41 bc	1.22 c
Jam alu	48.45 ab	9.37 b	21.79 d	23.73 de	1.16 cd
Deshi sotti	45.27 c	5.79 de	24.79 c	25.47 cd	1.34 a
Berma	45.27 c	5.39 e	19.46 e	20.22 f	1.30 ab
Tel pakri	49.26 a	8.38 b-d	19.94 e	21.65 ef	1.17 cd
Lady rosetta	41.09 d	14.38 a	30.88 a	34.08 a	1.13 d
$LSD_{(0.01)}$	**2.40**	**2.70**	**1.75**	**2.554**	**0.08**
CV (%)	**2.97**	**18.22**	**4.31**	**5.888**	**3.88**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.1.3.5 Color of skin at 60 days after storage

Different varieties of potato showed significant differences ($p<0.05$) for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato skin at 60 days after storage (Table 7). The highest L* value was observed in 'Tel pakri' (47.37) which was statistically identical with 'Sada shapla' (46.30) whereas the lowest value (38.27) was observed in 'Lady rosetta'.

The values of ‘a’ were significant for different varieties. The skin of ‘Lady roseta’ was characterized by the highest a* value (14.83), while the lowest value (5.61) was exhibited in ‘Berma’ (Table 7). Among the eight varieties, ‘Lady rosetta’ demonstrated maximum b* values (32.12) and lowest was observed in ‘Sada shapla’ (19.34).

Chroma and hue angle were also significantly affected by varieties. The chroma of ‘Lady rosetta’ (35.39) was the highest and the lowest was exhibited in ‘Sada shapla’ (20.67). It was observed that ‘Deshi sotti’ had the highest hue angle (1.32) which was similar with ‘Berma’ (1.30), while the minimum value (1.14) for hue angle was noted for ‘Lady rosetta’, and ‘Tel pakri’ (Table 7).

Table 7: Skin color (L*, a*, b*, chroma and hue angle) of different potato varieties at 60 DAS

Treatment	Skin color at 60 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	43.28 bc	10.05 bc	27.67 b	29.45 b	1.22 b
Sada shapla	46.30 a	7.27 d	19.34 e	20.67 e	1.21 b
Bhuta	44.38 b	10.38 b	25.03 c	27.11 c	1.18 bc
Jam alu	43.28 bc	10.28 b	22.35 d	24.61 d	1.15 c
Deshi sotti	43.27 bc	6.30 e	25.13 c	25.91 cd	1.32 a
Berma	42.12 c	5.61 e	20.35 de	21.10 e	1.30 a
Tel pakri	47.37 a	9.30 c	20.33 de	22.37 e	1.14 c
Lady rosetta	38.27 d	14.83 a	32.12 a	35.39 a	1.14 c
$LSD_{(0.01)}$	**1.73**	**0.77**	**2.12**	**1.71**	**0.06**
CV (%)	**2.30**	**4.78**	**5.09**	**3.83**	**2.82**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.1.4 Color of flesh at different days after storage

4.1.1.4.1 Color of flesh at 0 days after storage

The statistical analysis showed that there were significant differences ($p<0.05$) on different varieties for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato flesh at 0 days after storage (Table 8). Among eight

varieties, in case of flesh 'Lady Rosetta' had the highest L* value (76.00) compared to those of others whereas the lowest value (66.20) was observed in 'Jam alu'.

The values of 'a' were significantly influenced by varieties. The flesh of 'Jam alu' was characterized by the highest a* value (4.40), while the lowest value (0.23) was exhibited in 'Lady Rosetta' (Table 8). Among the eight varieties, 'Tel pakri' demonstrated the highest b* value (31.92) and the lowest was observed in 'Deshi sotti' (15.40).

Chroma was significantly affected by varieties (Table 8). Among the varieties the chroma of 'Tel pakri' (31.92) was the highest and lowest was exhibited in 'Deshi sotti' (15.40). Hue angle was not significantly influenced by different varieties of potato at 0 DAS.

Table 8: Flesh color (L*, a*, b*, chroma and hue angle) of different potato varieties at 0 DAS

Treatment	Flesh color at 0 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	70.47 c	1.03 e	28.80 b	28.82 b	1.51
Sada shapla	70.76 c	3.27 c	24.12 g	24.34 f	1.44
Bhuta	70.47 c	0.70 f	27.12 d	27.13 d	1.52
Jam alu	66.20 d	4.40 a	26.51 e	26.89 d	1.41
Deshi sotti	73.39 b	4.00 b	15.07 h	15.40 g	1.57
Berma	71.27 c	2.80 d	25.03 f	25.19 e	1.46
Tel pakri	74.07 b	1.17 e	31.90 a	31.92 a	1.51
Lady rosetta	76.00 a	0.23 g	28.01 c	28.01 c	1.52
$LSD_{(0.01)}$	**1.79**	**0.18**	**0.33**	**0.40**	**NS**
CV (%)	**1.44**	**4.60**	**1.73**	**1.90**	**2.76**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

NS= Non Significant

4.1.1.4.2 Color of flesh at 15 days after storage

Varieties of potato showed significant differences ($p<0.05$) for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato flesh at 15 days after storage (Table 9). Among eight varieties, the flesh of 'Tel pakri' had the

highest L* value (74.67) compared to those of others whereas the lowest value (62.40) was observed in 'Jam alu'.

The values of 'a' were significant for different varieties. The flesh of 'Jam alu' was characterized by the highest a* value (4.85) and it was statistically similar with 'Deshi sotti' (4.30). The lowest value (0.52) was exhibited in 'Lady rosetta' (Table 9). Among the eight varieties, 'Lady rosetta' demonstrated maximum b* values (32.57) which was statistically different from other varieties. The lowest value of a* was observed in 'Deshi sotti' (15.61).

Chroma and hue angle were significantly affected by different varieties. Among the varieties, the chroma of 'Lady rosetta' (32.58) was the highest and the lowest was exhibited in 'Deshi sotti' (16.19). It was observed that 'Lady rosetta' had the highest hue angle (1.55), while the lowest value (1.30) for hue angle was noted for 'Deshi sotti'(Table 9).

Table 9: Flesh color (L*, a*, b*, chroma and hue angle) of different potato varieties at 15 DAS

Treatment	Flesh color at 15 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	68.45 d	1.17 de	29.57 b	29.59 b	1.53 b
Sada shapla	67.57 e	3.54 b	24.79 d	25.04 d	1.42 d
Bhuta	66.58 f	1.37 cd	27.69 c	27.73 c	1.52 b
Jam alu	62.40 g	4.85 a	28.69 b	29.10 b	1.40 e
Deshi sotti	72.43 c	4.30 a	15.61 e	16.19 e	1.30 f
Berma	68.49 d	3.31 b	25.70 d	25.91 d	1.44 d
Tel pakri	74.67 a	1.96 c	27.13 c	27.20 c	1.49 c
Lady rosetta	73.40 b	0.52 e	32.57 a	32.58 a	1.55 a
$LSD_{(0.01)}$	**0.39**	**0.700**	**0.95**	**1.02**	**0.022**
CV (%)	**0.32**	**15.40**	**2.07**	**2.21**	**0.89**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.1.4.3 Color of flesh at 30 days after storage (DAS)

Variation of potato varieties showed significant differences ($p<0.05$) for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of

potato flesh at 30 days after storage (Table 10). Among eight varieties, the flesh of 'Tel pakri' had the highest L* value (73.29) compared to those of others whereas the lowest value (59.67) was observed in 'Jam alu'.

The values of 'a' were significant for different varieties. The flesh of 'Jam alu' was characterized by the highest a* value (5.34), while the lowest value (0.91) was exhibited in 'Lady rosetta' (Table 10). Among the eight varieties, 'Lady rosetta' demonstrated the highest b* value (34.23) and the lowest was observed in 'Deshi sotti' (16.46).

Chroma and hue angle were significantly affected by different varieties. Among the varieties, the chroma of 'Lady rosetta' (34.25) was the highest and the lowest was exhibited in 'Deshi sotti' (17.04). It was observed that 'Lady rosetta' had the highest hue angle (1.54), while the lowest value (1.31) for hue angle was noted for 'Deshi sotti'.

Table 10: Flesh color (L*, a*, b*, chroma and hue angle) of different potato varieties at 30 DAS

Treatment	Flesh color at 30 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	66.53 c	1.34 c	30.96 b	31.00 b	1.52 ab
Sada shapla	66.60 c	3.78 b	25.68 f	25.97 e	1.42 c
Bhuta	63.57 d	1.55 c	29.47 c	29.51 c	1.51 ab
Jam alu	59.67 e	5.34 a	30.35 bc	30.82 b	1.39 c
Deshi sotti	69.37 b	4.37 ab	16.46 g	17.04 f	1.31 d
Berma	66.45 c	3.88 b	27.25 e	27.53 d	1.42 c
Tel pakri	73.29 a	2.34 c	28.34 d	28.46 cd	1.48 b
Lady rosetta	72.47 a	0.91 c	34.23 a	34.25 a	1.54 a
$LSD_{(0.01)}$	**2.12**	**1.43**	**1.05**	**1.08**	**0.054**
CV (%)	**1.82**	**27.99**	**2.17**	**2.22**	**2.137**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.1.4.4 Color of flesh at 45 days after storage (DAS)

The statistical analysis showed that there were significant differences ($p<0.05$) on different varieties for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato flesh at 45 days after storage (Table 11). Among the eight

varieties, ‘Tel pakri’ had the highest L* value (71.26) compared to those of others whereas the lowest value (56.31) was observed in ‘Jam alu’.

The values of ‘a’ were significant for different varieties. The flesh of ‘Jam alu’ was characterized by the highest a* value (5.67), while the lowest value (0.89) was exhibited in ‘Lady Rosetta’ (Table 11). Among the eight varieties, ‘Lady Rosetta’ demonstrated the highest b* value (34.10) and the lowest was observed in ‘Deshi sotti’ (16.56).

Chroma and hue angle were significantly affected by different varieties. Among the varieties, the chroma of ‘Lady rosetta’ (34.11) was the highest and the lowest was exhibited in ‘Deshi sotti’ (17.24). It was observed that ‘Lady rosetta’ had the highest hue angle (1.54), while the lowest value (1.29) for hue angle was noted for ‘Deshi sotti’(Table11).

Table 11: Flesh color (L*, a*, b*, chroma and hue angle) of different potato varieties at 45 DAS

Treatment	Flesh color at 45 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	64.49 e	1.56 e	30.90 b	30.93 b	1.52 b
Sada shapla	63.33 f	4.12 c	25.89 e	26.21 d	1.41 e
Bhuta	62.39 g	1.89 e	29.79 bc	29.85 b	1.51 c
Jam alu	56.31 h	5.67 a	30.38 bc	30.90 b	1.39 f
Deshi sotti	67.33 c	4.79 b	16.56 f	17.24 e	1.29 g
Berma	65.42 d	4.38 bc	27.11 de	27.46 cd	1.41 e
Tel pakri	71.26 a	2.78 d	28.57 cd	28.70 bc	1.47 d
Lady rosetta	70.39 b	0.89 f	34.10 a	34.11 a	1.54 a
$LSD_{(0.01)}$	**0.80**	**0.63**	**2.19**	**2.24**	**0.013**
CV (%)	**0.71**	**11.15**	**4.53**	**4.60**	**0.52**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.1.4.5 Color of flesh at 60 days after storage(DAS)

Varieties of potato showed significant differences ($p<0.05$) for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato flesh at 60 days after storage (Table 12). Among eight varieties, the flesh of ‘Tel pakri’ had the

highest L* value (70.89) compared to those of others whereas the lowest value (52.34) was observed in 'Jam alu'.

The values of 'a' were significant for different varieties. The flesh of 'Jam alu' was characterized by the highest a* value (5.98) followed by 'Deshi sotti' (4.94), 'Berma' (4.79) and 'Sada shapla' (4.57). The lowest value of a* (1.02) was exhibited in 'Lady rosetta' (Table 12). Among the eight varieties, 'Lady rosetta' demonstrated the highest b* value (34.67) and the lowest was observed in 'Deshi sotti' (16.97).

Chroma and hue angle were significantly affected by varieties. Among the varieties, the chroma of 'Lady rosetta' (34.69) was the highest and the lowest was exhibited in 'Deshi sotti' (17.71). It was observed that 'Lady rosetta' had the highest hue angle (1.54) followed by 'Lal pakri' (1.50), 'Bhuta' (1.49) and 'Tel pakri' (1.46). The lowest value (1.28) for hue angle was noted for 'Deshi sotti'.

Table 12: Flesh color (L*, a*, b*, chroma and hue angle) of different potato varieties at 60 DAS

Treatment	Flesh color at 60 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	62.34 d	1.89 cd	31.37 b	31.43 b	1.50 a
Sada shapla	60.62 e	4.57 ab	26.46 d	26.87 d	1.39 bc
Bhuta	59.39 f	2.14 cd	30.25 bc	30.33 bc	1.49 a
Jam alu	52.34 g	5.98 a	31.55 b	32.13 b	1.38 c
Deshi sotti	64.39 c	4.94 a	16.97 e	17.71 e	1.28 d
Berma	61.28 e	4.79 a	27.45 d	27.88 d	1.39 bc
Tel pakri	70.89 a	3.04 bc	28.78 cd	28.95 cd	1.46 ab
Lady rosetta	67.48 b	1.02 d	34.67 a	34.69 a	1.54 a
$LSD_{(0.01)}$	**0.96**	**1.70**	**2.56**	**2.31**	**0.08**
CV (%)	**0.89**	**27.75**	**5.21**	**4.64**	**3.16**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.1.5 Weight loss (%) at different days after storage

Different varieties of potato showed significant influence on weight loss (%) at different days after storage (Figure 1). The highest percentage of water loss at 15 DAS was recorded from 'Lal pakri' (3.05 %) which was statistically similar with 'Bhuta' (3.05 %).

The highest weight loss at 30 DAS (4.33 %), 45 DAS (5.37 %) and 60 DAS (5.71 %) was reported from 'Sada shapla'. In comparison, the lowest amount of weight loss at 15 DAS (0.46 %), 30 DAS (0.17 %), 45 DAS (0.23 %) and 60 DAS (0.17 %) was observed in 'Lady rosetta'.

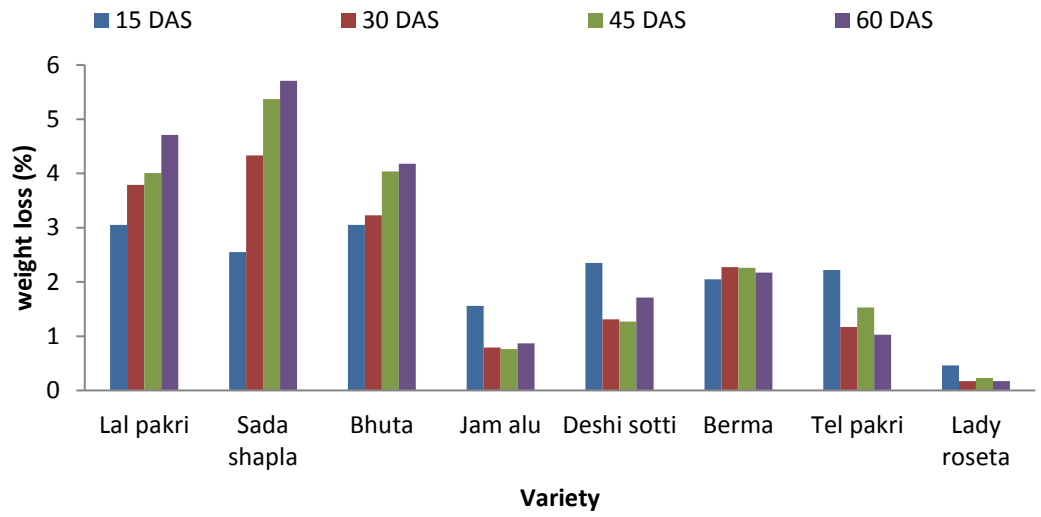


Figure 1. Weight loss (%) of different potato varieties at different days after storage (LSD value = 0.25, 0.14, 0.31 and 0.29 at 15, 30, 45 and 60 DAS, respectively)

4.1.1.6 Specific gravity (%) at different days after storage

Potato varieties had significantly different specific gravity at different days after storage (Figure 2). The highest specific gravity at 0 DAS (1.101), 15 DAS (1.103) and 30 DAS (1.110) was recorded from 'Lady rosetta'; while at 60 DAS the highest value was recorded from 'Berma' (1.136).On the contrary, the lowest specific gravity at 0 DAS (1.011) and 15 DAS (1.021) was recorded from 'Sada shapla'; while at 30 DAS (1.064) 'Bhuta' had the lowest specific gravity. At 60 DAS, the lowest specific gravity was noted for 'Tel pakri' (1.091). There was no significant difference in terms of specific gravity among the potato varieties at 45 DAS. Genotypes varied with respect to specific gravity, which ranged from 1.0343 to 1.1443 (Abbas *et al.*, 2011). Abong *et al*. (2010) also reported similar result with significant difference in specific gravity among the cultivars. Specific gravity illustrated a positive relationship with dry matter (Feltran *et al.*, 2004). In general, tubers with high specific gravity are preferred for processing (Adams, 2004). In this experiment 'Lady rosetta' and 'Berma' were outstanding for this character.

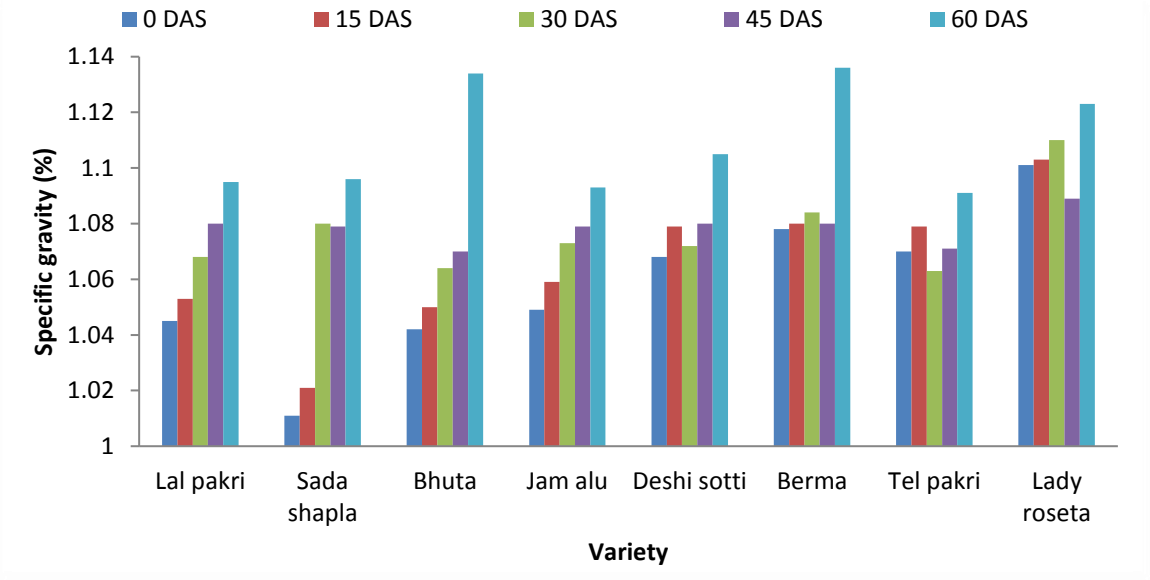


Figure 2. Specific gravity of different potato varieties at different days after storage (LSD value = 0.003, 0.031, 0.015, NS and 0.035 at 0, 15, 30, 45 and 60 DAS, respectively)

4.1.1.7 Tuber dry matter (%) at different days after storage

Tuber dry matter (%) was significantly influenced by different varieties of potato (Figure 3). The highest tuber dry matter at 0 DAS (24.60 %), 15 DAS (25.40 %), 30 DAS (26.35 %), 45 DAS (27.20 %) and 60 DAS (27.90 %) was recorded from 'Lady rosetta'. On the other hand, the lowest tuber dry matter at 0 DAS (13.52 %), 15 DAS (14.35 %), 30 DAS (14.98 %), 45 DAS (16.00 %) and 60 DAS (17.45 %) was observed in 'Tel pakri'. Uppal (1999) has reported that it ranged between 15% in Kufri Ashoka and 20.1% in Kufri Jawahar. Another study showed the highest values for dry matter content (24 – 26) % in La Molina (Amoros *et al.*, 2000). For processing varieties dry matter should be more than 20% as described by the other workers. For chips, French fries and dehydrated products tuber dry matter needs to be more than 20% (Ezekiel *et al.*, 1999). Tuber dry matter content differs considerably between cultivars and is a strongly genetic based character (Toolangi, 1995). The present works revealed that the genotypes 'Lal pakri', 'Lady rosetta' 'Jam alu' and 'Berma' had higher dry matter over 20% and hence is suitable for processing. High dry matter had been reported to be positively correlated with a lower sugar concentration during storage (Watada and Kunkel, 1955; Iritani and Weller, 1976). A significant relationship between dry matter and specific gravity was found in earlier reports (Rastovski *et al.*, 1981). Dry matter is one of the most important characters determining the end use of potato for processing and production efficiency. High dry

matter results in higher yield of processed products, mealiness, crispness and reduced oil consumption in fried products (Grewal and Uppal, 1989).

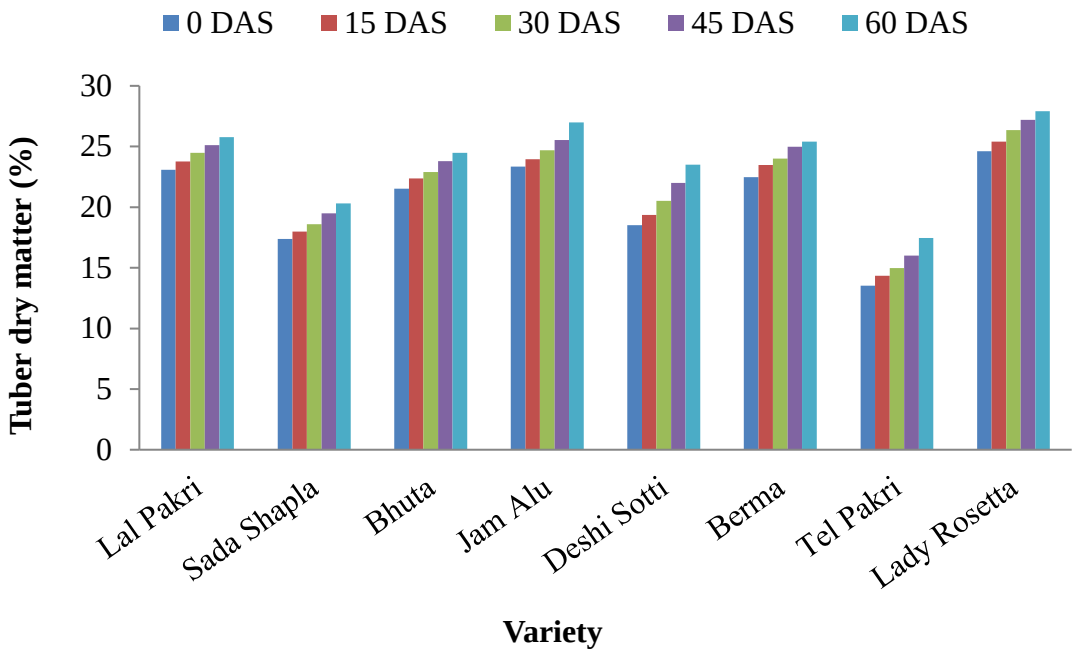


Figure 3. Tuber dry matter (%) of different potato varieties at different days after storage (LSD value = 0.65, 0.40, 0.48, 0.45 and 0.53 at 0, 15, 30, 45 and 60 DAS, respectively)

4.1.1.8 Firmness at different days after storage

Firmness was significantly influenced by different varieties of potato (Figure 4). The maximum value for firmness at 0 DAS (38.78), 15 DAS (36.68), 30 DAS (34.31), 45 DAS (30.11) and 60 DAS (27.13) was recorded from 'Jam alu'. On the other hand, the minimum value for firmness at 0 DAS (27.05), 15 DAS (24.95), 30 DAS (22.57), 45 DAS (18.36) and 60 DAS (13.45) was observed in 'Bhuta'.

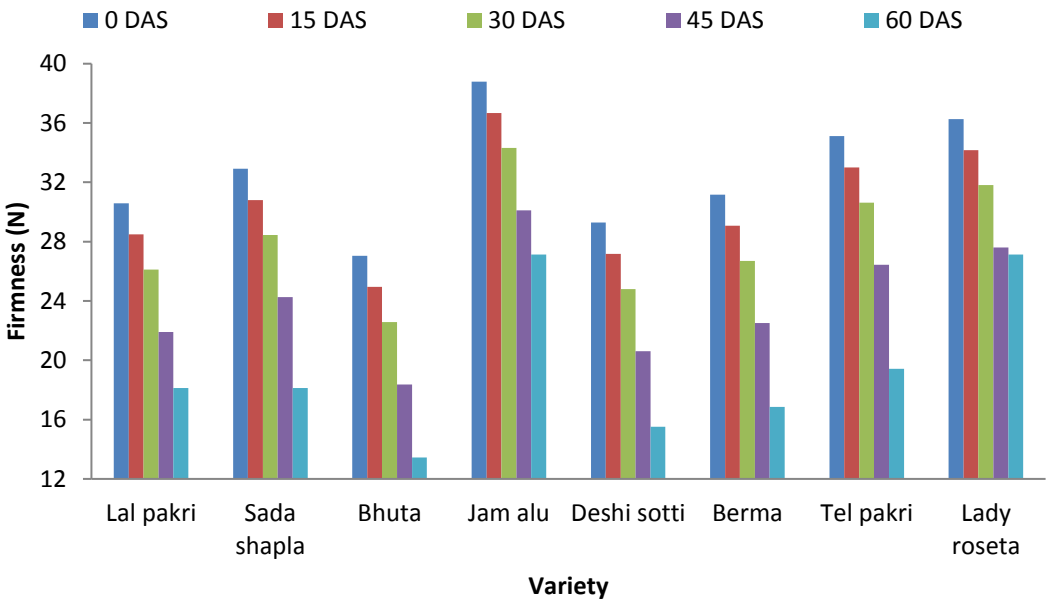


Figure 4. Firmness of different potato varieties at different days after storage (LSD value = 0.019, 0.019, 0.019, 0.019 and 0.019 at 0, 15, 30, 45 and 60 DAS, respectively)

4.1.2 Chemical composition of potatoes

4.1.2.1 Total soluble solids (% BRIX) at different days after storage

Total soluble solid (% BRIX) was significantly influenced by different varieties of potato (Figure 5).The maximum percentage of total soluble solid at 0 DAS (5.70 %), 15 DAS (6.10 %), 30 DAS (6.40 %), 45 DAS (6.70 %) and 60 DAS (7.30 %) was recorded from 'Jam alu'. On the other hand, the minimum percentage of total soluble solid at 0 DAS (3.00 %), 15 DAS (3.30 %), 30 DAS (3.70 %), 45 DAS (4.10 %) and 60 DAS (4.80 %) was observed in 'Lady rosetta'.

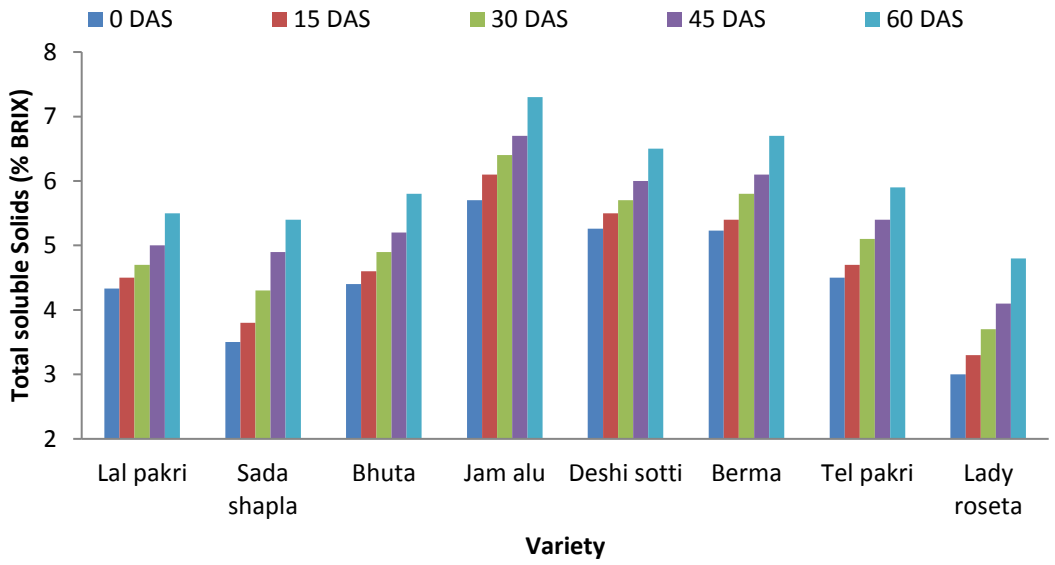


Figure 5. Total soluble solid (TSS) of different potato varieties at different days after storage

(LSD value = 0.38, 0.36, 0.23, 0.16 and 0.43 at 0, 15, 30, 45 and 60 DAS, respectively)

4.1.3 Optimization of processing of potato products

4.1.3.1 Color of chips at different days after storage

4.1.3.1.1 Color of chips at 0 days after storage

The statistical analysis showed that there were significant differences ($p<0.05$) on different varieties for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato chips at 0 days after storage (Table 13). Among the eight varieties, the chips of 'Tel pakri' had the highest L* value (73.75) compared to those of others whereas the lowest value (59.64) was observed in 'Jam alu'.

The values of 'a' were significant for different varieties of potato. The chips of 'Jam alu' was characterized by the highest a* value (11.13), while the lowest and negative value (−0.80) was exhibited in 'Tel pakri' (Table 13). Among the eight varieties, 'Lady rosetta' demonstrated maximum b* values (34.92) and the lowest was observed in 'Lal pakri' (21.35).

Chroma and hue angle were significantly affected by potato varieties. Among the varieties, the chroma of 'Lady rosetta' (34.99) was the highest and the lowest value was exhibited in 'Lal pakri' (21.37). It was observed that 'Deshi sotti' had the highest hue angle (1.55) followed by 'Lal pakri' (1.53), 'Lady rosetta' (1.51), 'Berma' (1.50), 'Bhuta'

(1.50) and ‘Sada shapla’ (1.24). The minimum and negative value (−1.54) for hue angle was noted for ‘Tel pakri’.

All the varieties produced light colored chips (L*> 50) which indicates that there was no excessive darkening. This can be attributed to low reducing sugars level exhibited by the varieties. The varieties who tended towards the negative values of redness parameter (a*) of chips color indicating that there was less or no excess browning of the products during frying. Lack of excess browning can be attributed to low or acceptable levels of sugars, major causes of browning during frying of potato products. Also all the potato varieties tended towards yellow as indicated by positive values of yellowness (b*) parameter (Table 13).

Table 13: Chips color (L*, a*, b*, chroma and hue angle) of different potato varieties at 0 DAS

Treatment	Chips color at 0 DAS				
	L*	**a***	**b***	**Chroma**	**Hue angle**
Lal pakri	70.79 b	0.97 f	21.35 h	21.37 f	1.53 a
Sada shapla	63.33 d	8.98 b	25.82 d	27.35 c	1.24 ab
Bhuta	68.93 c	1.90 e	24.5 e	24.52 de	1.49 a
Jam alu	59.64 e	11.13 a	22.48 g	25.04 d	1.11 b
Deshi sotti	67.49 c	0.66 g	28.00 c	28.01 c	1.55 a
Berma	72.50 a	1.96 d	29.14 b	29.21 b	1.50 a
Tel pakri	73.75 a	-0.80 h	23.90 f	23.91 e	-1.54 c
Lady rosetta	68.65 c	2.20 c	34.92 a	34.99 a	1.51 a
$LSD_{(0.01)}$	**1.70**	**0.17**	**0.52**	**0.76**	**0.35**
CV (%)	**1.44**	**2.90**	**1.14**	**1.65**	**1.21**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.3.1.2 Color of chips at 15 days after storage

Different varieties of potato showed significant differences ($p<0.05$) for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato chips at 15 days after storage (Table 14). Among the eight varieties, the chips of ‘Tel pakri’ had the highest L* value (72.79) followed by ‘Jam alu’ (70.68) compared to those of others whereas the lowest value (56.67) was observed in ‘Berma’.

The values of 'a' were significant for different varieties of potato. The chips of 'Jam alu' was characterized by the highest a* value (11.64), while the lowest value (0.61) was exhibited in 'Deshi sotti' (Table 14). Among the eight varieties, 'Lady rosetta' demonstrated the highest b* value (35.69) and the lowest value was observed in 'Lal pakri' (21.88).

Chroma and hue angle were significantly affected by potato varieties. Among the varieties, the chroma of 'Lady rosetta' (35.78) was the highest and it was significantly different from other varieties. The lowest value of chroma was exhibited in 'Lal pakri' (21.82). Variety 'Deshi sotti' had the highest hue angle (1.55) followed by 'Tel pakri' (1.53) however these two varieties showed statistically identical hue angle. The minimum (1.09) for hue angle was noted for 'Jam alu'.

All the varieties produced light colored chips (L*> 50) which indicates that there was no excessive darkening. This can be attributed to low reducing sugars level exhibited by the varieties. All the potato varieties tended towards yellow as indicated by positive values of yellowness (b*) parameter (Table 14).

Table 14: Chips color (L*, a*, b*, chroma and hue angle) of different potato varieties at 15 DAS

Treatment	Chips color at 15 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	68.89 bc	1.06 e	21.88 f	21.82 e	1.52 b
Sada shapla	62.79 e	9.28 b	26.24 cd	27.83 bc	1.23 d
Bhuta	67.57 cd	2.06 d	24.80 de	24.88 d	1.49 c
Jam alu	70.68 ab	11.64 a	22.98 ef	25.80 cd	1.09 e
Deshi sotti	65.76 d	0.61 f	28.35 bc	28.35 b	1.55 a
Berma	56.67 f	2.28 cd	29.81 b	29.89 b	1.49 c
Tel pakri	72.79 a	0.93 e	24.39 de	24.40 d	1.53 ab
Lady rosetta	67.68 cd	2.51 c	35.69 a	35.78 a	1.50 c
$LSD_{(0.01)}$	**2.11**	**0.28**	**2.18**	**2.09**	**0.021**
CV (%)	**1.83**	**4.33**	**4.70**	**4.42**	**0.836**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.3.1.3 Color of chips at 30 days after storage

Different varieties of potato showed significant differences ($p<0.05$) for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of

potato chips at 30 days after storage (Table 15). Among the eight varieties, the chips of 'Tel pakri' had the highest L* value (71.67) compared to those of others whereas the lowest value (54.79) was observed in 'Berma'.

The values of 'a' were significant for different varieties of potato. The chips of 'Jam alu' was characterized by the highest a* value (12.82), while the lowest value (0.97) was exhibited in 'Deshi sotti' (Table 15). Among the eight varieties, 'Lady rosetta' demonstrated the highest b* value (36.09) and the lowest value was observed in 'Lal pakri' (22.33).

Chroma and hue angle were significantly affected by potato varieties. Among the varieties, the chroma of 'Lady rosetta' (36.22) was the highest and the lowest value was exhibited in 'Lal pakri' (22.40). It was observed that 'Deshi sotti' had the highest hue angle (1.54) followed by 'Tel pakri' (1.52), while the minimum value (1.08) of hue angle was noted for 'Jam alu'.

All the varieties produced light colored chips (L*> 50) which indicates that there was no excessive darkening. This can be attributed to low reducing sugars level exhibited by the varieties. All the potato varieties tended towards yellow as indicated by positive values of yellowness (b*) parameter (Table 15).

Table 15: Chips color (L*, a*, b*, chroma and hue angle) of different potato varieties at 30 DAS

Treatment	Chips color at 30 DAS				
	L*	**a***	**b***	**Chroma**	**Hue angle**
Lal pakri	67.50 b	1.93 e	22.33 e	22.40 e	1.50 bc
Sada shapla	62.12 e	10.82 b	26.67 cd	28.69 bc	1.19 e
Bhuta	64.67 cd	3.04 cd	25.03 cd	25.19 d	1.46 d
Jam alu	68.56 b	12.82 a	23.35 d	26.52 cd	1.08 f
Deshi sotti	64.34 d	0.97 g	28.59 bc	28.61 bc	1.54 a
Berma	54.79 f	2.94 d	30.45 b	30.57 b	1.48 cd
Tel pakri	71.67 a	1.49 f	24.79 cd	24.82 d	1.52 ab
Lady rosetta	66.56 bc	3.25 c	36.09 a	36.22 a	1.49 c
$LSD_{(0.01)}$	**2.18**	**0.25**	**2.15**	**2.20**	**0.019**
CV (%)	**1.94**	**3.15**	**4.57**	**4.57**	**0.79**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.3.1.4 Color of chips at 45 days after storage

Varieties of potato showed significant differences ($p<0.05$) for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato chips at 45 days after storage (Table 16). Among the eight varieties, the chips of 'Tel pakri' had the highest L* value (70.27) compared to those of others whereas the lowest value (53.24) was observed in 'Berma'.

The values of 'a' were significant for different varieties of potato. The chips of 'Jam alu' was characterized by the highest a* value (12.88), while the lowest value (1.15) was exhibited in 'Deshi sotti' followed by 'Tel pakri' (Table 16). Among the eight varieties, 'Lady rosetta' demonstrated the highest b* value (36.69) and the lowest value was observed in 'Lal pakri' (23.10).

Chroma and hue angle were significantly affected by potato varieties. The chroma of 'Lady rosetta' (36.67) was the highest and the lowest value was exhibited in 'Lal pakri' (23.02). It was observed that 'Deshi sotti' had the highest hue angle (1.53) followed by 'Tel pakri' (1.50), while the minimum (1.07) for hue angle was noted for 'Jam alu'.

All the varieties produced light colored chips (L*> 50) which indicates that there was no excessive darkening. This can be attributed to low reducing sugars level exhibited by the varieties. All the potato varieties tended towards yellow as indicated by positive values of yellowness (b*) parameter (Table 16).

Table 16: Chips color (L*, a*, b*, chroma and hue angle) of different potato varieties at 45 DAS

Treatment	Chips color at 45 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	65.04 c	2.55 de	23.10 f	23.02 d	1.46 bc
Sada shapla	61.16 e	11.10 b	27.20 cd	29.17 b	1.18 d
Bhuta	62.87 d	3.55 cd	25.69 de	25.71 c	1.43 c
Jam alu	67.17 b	12.88 a	23.92 ef	26.97 c	1.07 e
Deshi sotti	62.27 de	1.15 f	29.17 bc	28.97 b	1.53 a
Berma	53.24 f	3.67 cd	30.91 b	30.90 b	1.45 c
Tel pakri	70.27 a	1.88 ef	25.32 d-f	25.17 c	1.50 ab
Lady rosetta	64.16 c	3.89 c	36.69 a	36.67 a	1.46 bc
$LSD_{(0.01)}$	**1.25**	**1.13**	**2.26**	**1.98**	**0.04**
CV (%)	**1.14**	**12.78**	**4.70**	**4.03**	**1.60**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

4.1.3.1.5 Color of chips at 60 days after storage

The statistical analysis showed that there were significant differences ($p<0.05$) on different varieties for lightness (L*), green-red chromatically (a*), blue-yellow chromatically (b*), chroma and hue angle of potato chips at 60 days after storage (Table 17). Among the eight varieties, the chips of 'Tel pakri' had the highest L* value (69.79) compared to those of others whereas the lowest value (52.68) was observed in 'Berma'.

The values of 'a' were significant for different varieties of potato. The chips of 'Jam alu' was characterized by the highest a* value (12.92), while the lowest value (1.44) was exhibited in 'Deshi sotti' (Table 17). Among the eight varieties, 'Lady rosetta' demonstrated the highest b* value (36.78) and the lowest value was observed in 'Lal pakri' (23.09).

Chroma and hue angle were significantly affected by potato varieties. Among the varieties, the chroma of 'Lady rosetta' (37.01) was the highest and the lowest value was exhibited in 'Lal pakri' (23.26). Variety 'Deshi sotti' had the maximum hue angle (1.52), while the minimum (1.07) hue angle was noted from 'Jam alu'.

All the varieties produced light colored chips (L*> 50) which indicates that there was no excessive darkening. This can be attributed to low reducing sugars level exhibited by the varieties. All the potato varieties tended towards yellow as indicated by positive values of yellowness (b*) parameter (Table 17).

Table 17: Chips color (L*, a*, b*, chroma and hue angle) of different potato varieties at 60 DAS

Treatment	Chips color at 60 DAS				
	L*	a*	b*	Chroma	Hue angle
Lal pakri	62.68 c	2.78 d	23.09 f	23.26 e	1.45 cd
Sada shapla	60.46 d	11.33 b	27.31 cd	29.57 b	1.17 f
Bhuta	62.47 cd	3.88 c	25.78 de	26.07 d	1.42 e
Jam alu	66.64 b	12.92 a	23.95 ef	27.22 cd	1.07 g
Deshi sotti	60.65 cd	1.44 f	29.36 bc	29.07 bc	1.52 a
Berma	52.68 e	3.97 c	30.95 b	31.20 b	1.44 d
Tel pakri	69.79 a	1.93 e	25.44 de	25.51 d	1.50 b
Lady rosetta	62.78 c	4.12 c	36.78 a	37.01 a	1.46 c
$LSD_{(0.01)}$	**2.20**	**0.42**	**2.29**	**2.17**	**0.012**
CV (%)	**2.04**	**4.53**	**4.75**	**4.38**	**0.50**

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.01 levels of probability

In an experiment, we found significant varietal differences in color and textural properties of chips with the product and variety. This might be attributed due to genetically, environmental or cultural factors. This color parameter could be used as an objective color index for preparing chips.

4.1.3.2 Crispness of chips at different days after storage

Crispness was significantly influenced by different varieties of potato (Figure 6). The maximum value for crispness at 0 DAS (3.320), 15 DAS (3.303), 30 DAS (3.283), 45 DAS (3.143) and 60 DAS (3.013) was recorded from 'Jam alu' chips. On the contrary, the minimum value for crispness at 0 DAS (0.530), 15 DAS (0.526), 30 DAS (0.457), 45 DAS (0.430) and 60 DAS (0.337) was observed in chips from 'Bhuta'.

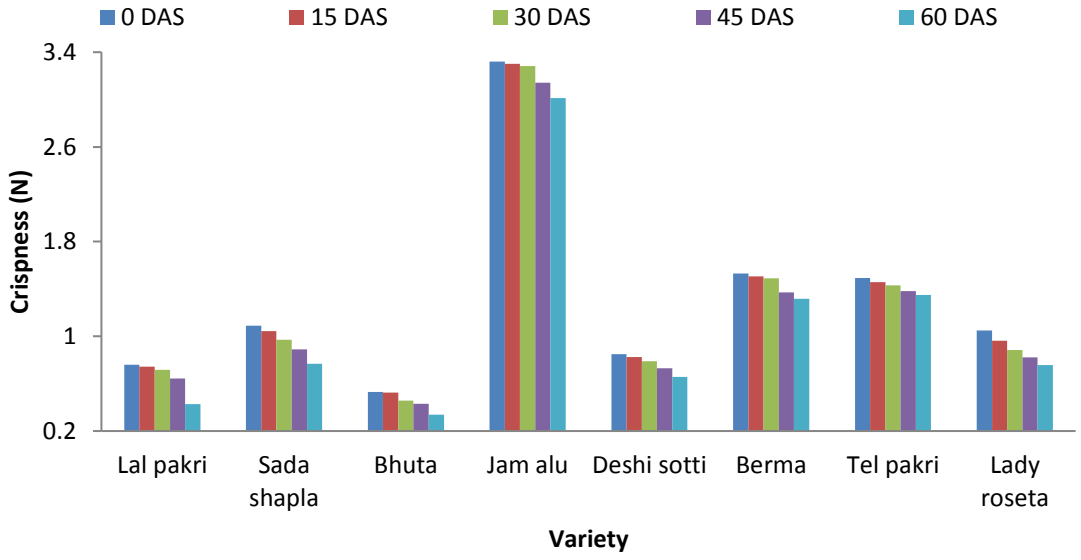


Figure 6. Crispness of different potato varieties at different days after storage (LSD value = 0.162, 0.016, 0.011, 0.014 and 0.033 at 0, 15, 30, 45 and 60 DAS, respectively)

CHAPTER 5

SUMMARY AND CONCLUSION

The study was conducted at the Agronomy Laboratory, Sher-e-Bangla Agricultural University, Dhaka during the period from 01 March to 31 June, 2014, to study the quality assessment of some local potato varieties in natural storage condition. Eight potato varieties viz., 'Lal pakri', 'Sada shapla', 'Bhuta', 'Jam alu', 'Deshi sotti', 'Berma', 'Tel pakri' and 'Lady rosetta' were used as experimental materials and analyzed for different physico-chemical attributes and processing quality. The experiment was laid out in a Completely Randomized Design (CRD) with 5 replications. The significant differences among the treatment means were compared by Least Significant Difference (LSD) at 1% level of probability.

Skin color at 0 DAS 'Sada shapla' had the highest L* value (60.47) whereas the lowest value (47.87) was observed in 'Tel pakri'. 'Tel pakri' was characterized by the highest a* value (12.54), while the lowest value (2.50) was exhibited in 'Sada shapla'. 'Tel pakri' demonstrated maximum b* values (27.92) and the lowest was observed in 'Sada shapla' (16.84). The chroma of 'Tel pakri' (30.61) was the highest and the lowest was exhibited in 'Sada shapla' (17.03). 'Sada shapla' had the highest hue angle (1.42), while the minimum value (1.15) for hue angle was noted for 'Tel pakri'. At 15 DAS, 'Sada shapla' had the highest L* value (56.39) whereas the lowest value (45.35) was observed in 'Lady rosetta'. The highest a* value was observed in 'Lady rosetta' (13.67), while the lowest value was noted for 'Sada shapla'(3.45). 'Lady roseta' demonstrated maximum b* values (29.45) and lowest was observed in 'Sada shapla' (17.38). The chroma of 'Lady roseta' (32.47) was the highest and lowest was exhibited in 'Sada shapla' (17.73). It was observed that 'Sada shapla' had the highest hue angle (1.37), while the minimum value (1.13) for hue angle was noted for 'Lady roseta'. At 30 DAS, 'Sada shapla' had the highest L* value (53.31) whereas the lowest value (43.32) was observed in 'Lady roseta. The highest a* value was observed in 'Lady roseta' (14.11), while

the lowest value (4.70) was exhibited in ‘Sada shapla’. ‘Lady roseta’ demonstrated maximum b* values (30.47) and lowest was observed in ‘Sada shapla’ (17.81). The chroma of ‘Lady roseta’ (33.61) was the highest and the lowest was exhibited in ‘Sada shapla’ (18.47). It was observed that ‘Deshi sotti’ had the highest hue angle (1.35), while the minimum value (1.13) for hue angle was noted for ‘Lady roseta’. At 45 DAS, ‘Sada shapla’ had the highest L* value (50.36) and the lowest value (41.09) was observed in ‘Lady roseta’. The highest a* value was noted for ‘Lady roseta’ (14.38), while the lowest value (5.39) was exhibited in ‘Berma’. ‘Lady roseta’ demonstrated maximum b* values (30.88) and lowest was observed in ‘Sada shapla’ (18.79). The chroma of ‘Lady roseta’ (34.08) was the highest and the lowest was exhibited in ‘Sada shapla’ (19.93). It was observed that ‘Deshi sotti’ had the highest hue angle (1.34), while the minimum value (1.13) for hue angle was noted for ‘Lady roseta’. At 60 DAS, the skin of ‘Tel pakri’ had the highest L* value (47.37) while the lowest value (38.27) was observed in ‘Lady roseta’.The highest a* value was noted for ‘Lady roseta’ (14.83), while the lowest value (5.61) was exhibited in ‘Berma’. ‘Lady roseta’ demonstrated maximum b* values (32.12) and lowest was observed in ‘Sada shapla’ (19.34). The chroma of ‘Lady roseta (35.39) was the highest and the lowest was exhibited in ‘Sada shapla’ (20.67). It was observed that ‘Deshi sotti’ had the highest hue angle (1.32), while the minimum value (1.14) for hue angle was noted for ‘Lady roseta’ and ‘Tel pakri’.

Flesh color at 0 DAS ‘Lady Rosetta’ had the highest L* value (76.00) and the lowest value (66.20) was observed in ‘Jam alu’. ‘Jam alu’ was characterized by the highest a* value (4.40), while the lowest value (0.23) was exhibited in ‘Lady rosetta’. ‘Tel pakri’ demonstrated the highest b* value (31.92) while the lowest value was observed in ‘Deshi sotti’ (15.40). The chroma of ‘Tel pakri’ (31.92) was the highest and lowest was exhibited in ‘Deshi sotti’ (15.40). Hue angle was not significantly influenced by different varieties of potato at 0 DAS. At 15 DAS, the flesh of ‘Tel pakri had the highest L* value (74.67) and the lowest value was observed in ‘Jam alu’ (62.40). The highest a* value ‘Jam alu’ (4.85), while the lowest value (0.52) was exhibited in ‘Lady roseta’. ‘Lady rosetta’ demonstrated

maximum b* values (32.57) and lowest was observed in ‘Deshi sotti’ (15.61). The chroma of ‘Lady rosetta’ (32.58) was the highest and the lowest was exhibited in ‘Deshi sotti’ (16.19). It was observed that ‘Lady rosetta’ had the highest hue angle (1.55), while the lowest value (1.30) for hue angle was noted for ‘Deshi sotti’. At 30 DAS, the flesh of ‘Tel pakri’ had the highest L* value (73.29) whereas the lowest value (59.67) was observed in ‘Jam alu’. The flesh of ‘Jam alu’ was characterized by the highest a* value (5.34), while the lowest value (0.91) was exhibited in ‘Lady roseta’. ‘Lady roseta’ demonstrated the highest b* value (34.23) and the lowest was observed in ‘Deshi sotti’ (16.46). The chroma of ‘Lady roseta’ (34.25) was the highest and the lowest was exhibited in ‘Deshi sotti’ (17.04). It was observed that ‘Lady roseta’ had the highest hue angle (1.54), while the lowest value (1.31) for hue angle was noted for ‘Deshi sotti’. At 45 DAS, ‘Tel pakri’ had the highest L* value (71.26) and the lowest value (56.31) was observed in ‘Jam alu’. The flesh of ‘Jam alu’ was characterized by the highest a* value (5.67), while the lowest value (0.89) was exhibited in ‘Lady rosetta’. ‘Lady Rosetta’ demonstrated the highest b* value (34.10) while the lowest was observed in ‘Deshi sotti’ (16.56). The chroma of ‘Lady rosetta (34.11) was the highest and the lowest was exhibited in ‘Deshi sotti’ (17.24). It was observed that ‘Lady rosetta’ had the highest hue angle (1.54), while the lowest value (1.29) for hue angle was noted for ‘Deshi sotti’. At 60 DAS, the flesh of ‘Tel pakri’ had the highest L* value (70.89) compared to those of others whereas the lowest value (52.34) was observed in ‘Jam alu’. The flesh of ‘Jam alu’ was characterized by the highest a* value (5.98), while the lowest value (1.02) was exhibited in ‘Lady rosetta’. ‘Lady rosetta’ demonstrated the highest b* value (34.67) and the lowest was observed in ‘Deshi sotti’ (16.97). The chroma of ‘Lady rosetta’ (34.69) was the highest and the lowest was exhibited in ‘Deshi sotti’ (17.71). It was observed that ‘Lady rosetta’ had the highest hue angle (1.54), while the lowest value (1.28) for hue angle was noted for ‘Deshi sotti’.

The highest percentage of weight loss at 15 DAS was recorded from ‘Lal pakri’ (3.05 %) which was statistically identical with ‘Bhuta’ (3.05 %). The highest water loss at 30 DAS (4.33 %), 45 DAS (5.37 %) and 60 DAS (5.71 %) was

reported from ‘Sada shapla’. In comparison, the lowest amount of water loss at 15 DAS (0.46 %), 30 DAS (0.17 %), 45 DAS (0.23 %) and 60 DAS (0.17 %) was observed in ‘Lady rosetta’.

The highest specific gravity at 0 DAS (1.101), 15 DAS (1.103) and 30 DAS (1.110) was recorded from ‘Lady roseta’, while at 60 DAS the highest value was recorded from ‘Berma’ (1.136). On the other hand, the lowest specific gravity at 0 DAS (1.011) and 15 DAS (1.021) was recorded from ‘Sada shapla’, while at 30 DAS (1.064) ‘Bhuta’ had the lowest specific gravity. At 60 DAS, the lowest specific gravity was reported from ‘Tel pakri’ (1.091). There was no significant difference in terms of specific gravity among the potato varieties at 45 DAS.

The highest tuber dry matter at 0 DAS (24.60 %), 15 DAS (25.40 %), 30 DAS (26.35 %), 45 DAS (27.20 %) and 60 DAS (27.90 %) was recorded from ‘Lady rosetta’. On the other hand, the lowest tuber dry matter at 0 DAS (13.52 %), 15 DAS (14.35 %), 30 DAS (14.98 %), 45 DAS (16.00 %) and 60 DAS (17.45 %) was observed in ‘Tel pakri’. From the above study more than 20% dry matter present in ‘Lady rosetta’, ‘Lal pakri’, ‘Jam alu’, ‘Bhuta’ and ‘Berma’.

Firmness was significantly influenced by different varieties of potato. The maximum value for firmness at 0 DAS (38.78), 15 DAS (36.68), 30 DAS (34.31), 45 DAS (30.11) and 60 DAS (27.13) was recorded from ‘Jam alu’. On the other hand, the minimum value for firmness at 0 DAS (27.05), 15 DAS (24.95), 30 DAS (22.57), 45 DAS (18.36) and 60 DAS (13.45) was observed in ‘Bhuta’.

The maximum percentage of total soluble solids at 0 DAS (5.70 %), 15 DAS (6.10 %), 30 DAS (6.40 %), 45 DAS (6.70 %) and 60 DAS (7.30 %) was recorded from ‘Jam alu’. On the other hand, the minimum percentage of total soluble solids at 0 DAS (3.00 %), 15 DAS (3.30 %), 30 DAS (3.70 %), 45 DAS (4.10 %) and 60 DAS (4.80 %) was observed in ‘Lady rosetta’.

Among the eight varieties at 0 DAS, the chips of ‘Tel pakri’ had the highest L* value (73.75) whereas the lowest value (59.64) was observed in ‘Jam alu’. The chips of ‘Jam alu’ was characterized by the highest a* value (11.13), while the

lowest and negative value (−0.80) was exhibited in ‘Tel pakri’. ‘Lady rosetta’ demonstrated maximum b* values (34.92) and the lowest was observed in ‘Lal pakri’ (21.35). The chroma of ‘Lady rosetta’ (34.99) was the highest and the lowest value was exhibited in ‘Lal pakri’ (21.37). It was observed that ‘Deshi sotti’ had the highest hue angle (1.55), while the minimum and negative value (−1.54) for hue angle was noted for ‘Tel pakri’. At 15 DAS, the chips of ‘Tel pakri’ had the highest L* value (72.79) and the lowest value (56.67) was observed in ‘Berma’. The chips of ‘Jam alu’ was characterized by the highest a* value (11.64), while the lowest value (0.61) was exhibited in ‘Deshi sotti’. ‘Lady rosetta’ demonstrated the highest b* value (35.69) and the lowest value was observed in ‘Lal pakri’ (21.88). The chroma of ‘Lady rosetta’ (35.78) was the highest and the lowest value was exhibited in ‘Lal pakri’ (21.82). It was observed that ‘Deshi sotti’ had the highest hue angle (1.55), while the minimum (1.09) for hue angle was noted for ‘Jam alu’. At 30 DAS, the chips of ‘Tel pakri’ had the highest L* value (71.67) whereas the lowest value (54.79) was observed in ‘Berma’. The chips of ‘Jam alu’ was characterized by the highest a* value (12.82), while the lowest value (0.97) was exhibited in ‘Deshi sotti’. ‘Lady rosetta’ demonstrated the highest b* value (36.09) and the lowest value was observed in ‘Lal pakri’ (22.33). The chroma of ‘Lady rosetta’ (36.22) was the highest and the lowest value was exhibited in ‘Lal pakri’ (22.40). It was observed that ‘Deshi sotti’ had the highest hue angle (1.54), while the minimum (1.08) for hue angle was noted for ‘Jam alu’. At 45 DAS, the chips of ‘Tel pakri’ had the highest L* value (70.27) compared to those of others whereas the lowest value (53.24) was observed in ‘Berma’. The chips of ‘Jam alu’ was characterized by the highest a* value (12.88), while the lowest value (1.15) was exhibited in ‘Deshi sotti’. ‘Lady rosetta’ demonstrated the highest b* value (36.69) and the lowest value was observed in ‘Lal pakri’ (23.10). The chroma of ‘Lady rosetta’ (36.67) was the highest and the lowest value was exhibited in ‘Lal pakri’ (23.02). It was observed that ‘Deshi sotti’ had the highest hue angle (1.53), while the minimum (1.07) for hue angle was noted for ‘Jam alu’. At 60 DAS, the chips of ‘Tel pakri’ had the highest L* value (69.79) compared to those of others whereas the lowest

value (52.68) was observed in ‘Berma’. The chips of ‘Jam alu’ was characterized by the highest a* value (12.92), while the lowest value (1.44) was exhibited in ‘Deshi sotti’. ‘Lady rosetta’ demonstrated the highest b* value (36.78) and the lowest value was observed in ‘Lal pakri’ (23.09). The chroma of ‘Lady rosetta’ (37.01) was the highest and the lowest value was exhibited in ‘Lal pakri’ (23.26). It was observed that ‘Deshi sotti’ had the maximum hue angle (1.52), while the minimum (1.07) for hue angle was noted from ‘Jam alu’.

Crispness was significantly influenced by different varieties of potato at different DAS. The maximum value for crispness at 0 DAS (3.320), 15 DAS (3.303), 30 DAS (3.283), 45 DAS (3.143) and 60 DAS (3.013) was recorded from ‘Jam alu’ chips. On the other hand, the minimum value for crispness at 0 DAS (0.530), 15 DAS (0.526), 30 DAS (0.457), 45 DAS (0.430) and 60 DAS (0.337) was observed in chips from ‘Bhuta’.

On the basis of some processing parameters viz., weight loss, specific gravity, tuber dry matter, firmness, crispness, color of flesh and color of chips it may concluded that variety ‘Lady rosetta’, ‘Berma’, ‘ Bhuta’ may be regarded as good quality raw materials suitable for processing industry. Considering the above observations of the present study further investigation in different agro-ecological zones (AEZ) of Bangladesh in the following areas may be suggested for regional adaptability.

REFERENCES

Abbas, G., Frooq. K., Hafiz, I.A., Hussain, A., Abbasi, N.A. and Shabbir, G. (2011). Assessment of processing and nutritional quality of potato genotypes in Pakistan. *Pakistan J. Agri. Sci.* **48**(3):169-175.

Abbas, G., Hafiz, I.A., Abbasi, N.A. and Hussain, A. (2012). Determination of processing and nutritional quality attributes of potato genotypes in Pakistan. *Pakistan J. Bot.* **44**(1): 201-208.

Abong, G.O., Okoth, M.W., Imungi, J.K. and Kabira, J.N. (2010). Evaluation of selected Kenya potato cultivars for processing into potato crisps. *Agric. Biol. America.* **1**(5): 886-893.

Abong, G.O., Okoth, M.W., Karuri, E.G., Kabira, J.N. and Mathoko, F.M. (2009). Influence of potato cultivar and stage of maturity on oil content of french fries (chips) made from eight kenyan potato cultivars. *African J. Food Agri. Nutri. Devlpt.* **9**(8): 1667-1682.

Adams, J.B. (2004). Raw materials quality and the texture of processed vegetables. In: Texture in Foods, Solid Foods. (Ed.): D. Kilcast, Woodhead Publ. Ltd.: Cambridge. **2**: 342- 363.

Affleck, I., Sullivan, J.A., Tarn, R. and Yada, R. (2012). Stability of eight potato genotypes for sugar content and French fry quality at harvest and after storage. *Can. J. Plant Sci.* **92**:87-96.

Amoros, W., Espinoza, J. and Bonierbale, M. (2000). Assessment of variability for processing potential in advanced potato populations. CIP Program Report. pp.185-195.

Anwar, J. (1982). Screening of new exotic potato germplasm under Faisalabad conditions. M.Sc. (hons). Thesis, Department of Horticulture, University of Agriculture, Faisalabad.

AOAC. (1990). Official Methods of Analysis. Association of official Analytical Chemist (15th edn), AOAC, Washington, DC, USA.

BBS (Bangladesh Bureau of Statistics). (2013). Monthly statistical year book. Ministry of Planning, Govt. People's Repub. Bangladesh. p. 135.

Bradshaw, J.E. 1994. Quantitative genetics theory for tetrasomic inheritance. In: Bradshaw JE, Mackay GR, editors. Potato genetics. Wallingford, UK: CAB International; p. 71–107.

Brook, R.C., Fick, R.J. and Forbush, T.D. (1995). Potato storagedesign and management. *American Potato J.* **72**:463-480.

Brown, C.R. (2005). Antioxidant in potato. *American J. Potato Res*. **82**: 163-172.

Connor, C.J., Fisk, K.J., Smith, B.J. and Melton, L.D. (2001). Fat uptake in French fries as affected by different potato varieties and processing. *J. Food Sci*. **66**: 903-908.

Das, M., Ezekiel, R. and Sekhawat, G.S. (2001). Quality of dehydrated potato chips produced from fresh and heap stored tubers. *J. Indian Potato Assoc.* **28**(1): 174-175.

Dayal, T.R. and Sharma, K.P. (1987). Sprouting weight loss, internal sprouting and little tuber formation in long stored potatoes subject to repeated di-sprouting. *J. Indian Potato Assoc*. **14**(3-4): 121-123.

Devendra, K., Kual, H.N. and Singh, S.V. (1995). Keeping quality in advanced potato selection during non-refrigerated storage. *J. Indian Potato Assoc.* **22**:105-108.

Elfinesh, F., Tekalign, T. and Solomon, W. (2011). Processing quality of improved potato (*Solanum tuberosum* L.) cultivars as influenced by growing environment and blanching. *African J. Food Sci.* **5**(6): 324-332.

Ezekiel, R. and Dahiya, P.S. (2004). Storage behaviour and processing quality of potatoes stored in heaps and pits in the Maiwa region. *Potato J.* **31**(1-2): 21-28.

Ezekiel, R. and Rani, M. (2006). Oil content of potato chips: Relationship with dry matter and starch contents and rancidity during storage at room temperature. *Potato J.* **33**(1-2): 44-49.

Ezekiel, R., Singh, B. and Dinesh, D.K. (2003). A reference chart for potato chip color for use in India. *J. Indian Potato Assoc.* **30**: 259-265.

Ezekiel, R., Virma, S.C., Sukumaran, N.P. and Shekhawat. G.S. (1999). A Guide to Potato Processor in India. Central potato Research Institute, Shimla, India. Technical Bulletin No.**48**: 14-39.

FAO (Food And Agricultural Organization). (2013). Production Year Book No. 65. Food and Agriculture Organization FAO, Rome, Italy. p. 97.

Feltran, J.C., Lemos, L.B and Vieites, R.L. (2004). Technological quality and utilization of potato tubers. *Sci. Agric.* **61**: 598-603.

Ganga, H. and Kulkarni, U.N. (2014). Optimization and screening of potato varieties for microwave baking. *Intl. J. Farm Sci*. **4**(2): 163-171.

Ganga, H., Kulkarni, U.N., Yenegi, N.B., Basavaraj, N., Uppinal, N. and Ramachandra, K.N. (2013). Study on physical characteristics of potato genotypes. *Karnataka J. Agric. Sci.* **26**(2): 281-284.

Gaur, P.C., Pandey, S.K., Singh, S.V., Kurnar, D., Marwaha, R.S. and Kurnar, D. (1998). Kufri Chipsona-1: A potato variety for processing. *J. Indian Potato Assoc*. **25**(3-4): 113-118.

George, O.A., Michael, W.O., Jasper, K.I. and Jackson, N.K. (2010). Evaluation of selected Kenyan potato cultivars for processing into potato crisps. *Agric. Biol. J. N. Am.* **1**(5): 886-893.

Ghulam, A., Khalid, F., Hafiz, I.A., Hussain, A., Abbasi, N.A. and Ghulam, S. (2011). Assessment of processing and nutritional quality of potato genotypes in Pakistan. *Pakistan. J. Agri. Sci.* **48**(3): 169-175.

Gomez, K.A. and Gomez, A.A. (1984). Statistical procedure for agricultural research. Second Edn. Intl. Rice Res. Inst. John Wiley and Sons. New York. pp. 1-340.

Grewal, J.S., Sharma, R.C. and Saini, S.S. (1992). Agrotechniques for Intensive Potato Cultivation in India. Publications and Informations Divisions, India Council of Agricultural Research, Krishi Anusandhan Bhavan, New Delhi. P.126.

Grewal, S.S. and Uppal, D.S. (1989). Effect of dry matter and specific gravity on yield, color and oil content of potato chips. *Indian Food Packer.* **43**(1): 17-20.

Haan. D. (2009). S: Potato diversity at height: multiple dimensions of farmer-driven in-situ conservation in the Andes. PhD thesis. The Netherlands: Wageningen University.

Hashem, A. (1979). Constraints in the improvement of potato crop in Bangladesh. In: Proc. International Symposium. CIP Region VI, New Delhi and CPRI. August 30 to September 2. pp. 277-282.

Hassanpanah, D., Hassanabadi, H. and Chakhercharnan, A.S.H. (2011). Evaluation of cooking quality characteristics of advanced clones and potato cultivars. *American J. Food Technol.* **6**(1): 72-79.

Horton, D. (1987). Potatoes: Production, Marketing and Programs for Developing Countries. Westview Press, London. pp.19-24.

Iritani, W.M. (1981). Growth and pre-harvest stress and processing quality of potatoes. *American Potato J*. **58**: 71-80.

Iritani, W.M. and Weller, L.D. (1976). Relationship of specific gravity to sugar accumulation in stored Norgold and Russet Burbank potatoes. *American Potato J.* **53**: 57-65.

Kabira, J.N. (2000). French fries and crisps processing characteristics of selected potato varieties in Kenya. African Potato Association, Uganda. pp. 507-511.

Kabira, J.N. and Lamega, B. (2006). Potato processing: Quality evaluation processing for research and food industries application in east and central Africa. Kenya Agricultural Research Institute, Nairobi, Kenya. pp. 9-15.

Khan, A.L., Ali, M.S., Habib, A.K.M.A. and Hussain, M.J. (1984). Effect of planting dates on incidence of tuber rot of potato in natural condition. Proc. 6th Workshop of Potato Research Workers, Potato Res. Centre, BARI, Joydebpur, Gazipur. pp. 133-136.

Khan, A.L., Rashid, A., Bari, M.A., and Habib, A.K.M.A. (1981). Rejuvenation of local varieties through cleaning of yellows. Proc. 4th Workshop of potato Res. Workers, Potato Res. Centre, BARI, Joydebpur, Gazipur. pp. 85-88.

Kita, A. (2002). The influence of potato chemical composition on crisp texture. *Food Chem.* **76**: 173-179.

Kleinkopf, G.E., Westermann, D.T., Wille, M.J. and Kleinschmidt, G.D. (1987). Specific gravity of russet burbank potatoes. *Potato J.* **34**(5): 38-45.

Kulkarni, K.D. and Govinden, N. (1994). Crisp quality of two potato varieties: Effect of dehydration and rehydration. *J. Sci. Food Agric.* **64**(2): 205-210.

Kumar, D. and Ezekiel, R. (2004). Distribution of dry matter and sugars within a potato tuber of potato cultivars grown under short day conditions. *Potato J.* **31**(3-4): 129-134.

Kumar, D., Ezekiel, R. and Khurana, S.M.P. (2003). Effect of location, seasons and cultivar on the processing quality of potatoes. *J. Indian Potato Assoc.* **30**(3-4): 247-251.

Liu, Q., Tarn, R., Lyncch, D. and Niel, M.S. (2007). Physico-chemical properties of dry matter and starch from potatoes grown in Canada. *Food Chem.* **105**: 897-907.

Marwaha, R.S. (1999). Chipping quality and related processing characteristics of Indian potato varieties grown under short day conditions. *J. Food Sci. Technol.* **36**(2): 157-159.

Marwaha, R.S. (2000). Processing quality of low and high sugar potato cultivars as influenced by storage temperature. *J. Indian Potato Assoc.* **27**(1-2): 5-11.

Marwaha, R.S., Kumar, D., Singh, S.V. and Pandey, S.K. (2008). Influence of blanching of potato varieties on chipping quality. *J. Food Sci. Technol.* **45**(4): 364-367.

Marwaha, R.S., Kumar, D., Singh, S.V. and Pandey, S.K. (2009). Chipping and nutritional qualities of Indian and exotic potato processing varieties stored under different conditions. *J. Food Sci. Technol.* **46**(4): 354-358.

Miller, R.A. (1972). Influence of variety, maturity and storage on potato tuber composition and chip color and the role of tuber constituents in chip browning. Diss. *Abst Int*. **33**(7): 3127-3128.

Miller, R.A., Harrington, J.D., and Kuhn, G.D. (1975). Effect of variety and harvest date on tuber sugars and chip color. *Am. Potato J*. **52**:379-386.

Misra, J.B. and Chand, P. (1990). Relationship between potato tubers size and chemical composition. *J. Food Sci. Technol.* **27**(1): 63-64.

MSTAT. (1991). Users manual for MSTAT-C. Michigan State University, East Lansing, Michigan. p. 450.

Pandey, P.C., Luthra, S.K., Singh, S.V., Padey, S.K. and Singh, B.P. (2008a). Kufri Sadabahar: a potato variety for Uttar Pradesh. *Potato J.* **35**:111-117.

Pandey, S.K., Shekhwat, G.S. and Sarkar, D. (2000). Quality attributes of Indian Potatoes for export: Priorities and Possibilities. *J. Indian Potato Assoc.* **27**(3-4): 103-111.

Pandey, S.K., Singh, S.V., Kumar, D., Manivel, P., Marwaha, R.S., Kumar, P., Singh, B.P. and Gupta, V.K. (2008b). Kufri Himsona: A chipping cultivar for Hill regions of India. *Potato J.* **35**(1-2): 1-8.

Pandey, S.K., Singh, S.V., Marwaha, R.S. and Pattanayak, D. (2009). Indian potato processing varieties: Their impact and future priorities. *Potato J.* **36**(3-4): 95-114.

Pedreschi, F. and Moyano, P. (2004). Effect of pre-drying on texture and oil uptake of potato chips. *LWT Food Sci. Technol.* **38**: 599-604.

Peschin, A. (2000). Influence of storage temperature and reconditioning on the biochemical composition of potato tubers. *J. Food Sci. Technol.* **37**(2):126- 129.

Pressey, R. (1969). Role of invertase in the accumulation of sugars in cold stored potatoes. *Am. Potato J.* **46**: 291-297 .

Raj, D. and Lal, B. (2008). Effect of cultivars, cold storage and frying media on yield and processing qualities of potatoes. *J. Food Sci. Technol.* **45**(1): 20-27.

Ramasawmy, G., Goburdhun, D. and Ruggoo, A. (1999). Effect of different preparation technologies on proximate composition and calorie content of potato products. *Sci. Technol. Res. J.* **4**: 181-194.

Rastovski, A., Van Es, A., Hartmans, K.J., Buitelaar, N., Haan, P.R., Maijers, C.P., Van der Schild, J.H.W., Sijbring, P.H., Sparenberg, H. and Van Zwol, B.H. (1981). Storage of potatoes: post-harvest behavior, store design, storage practice and handling. Center for Agricultural Publishing and Documentation, Wageningen, Netherlands. p. 462.

Roy, K.C., and Hossain, A.F. (1981). Prospect of non refrigerated potato store in angladesh. In: Prac. Of 4th workshop on Potato Research Workers, Potato Research centre, BARI. pp. 92-94.

Samotus, B., Niedzwiedz, M., Zolodziej, Z., Leja, M., and czajkowska, B. (1974a). Storage and reconditioning of tubers of Polish varieties and strains. I. Influence of storage temperature on sugar levels in potato tubers of different varieties and strains. *Potato Res.* **17**: 64-81.

Schoenemann, J.A. (1977). Grading, packaging and Marketing potatoes, In: Potatoes production, storing processing, (Ed.). Smith. 2nd Edition. The AVI publishing company Inc., West port, pp. 470-505.

Schwarz, D. and Geisel, B. (2012). Special Storage Problems. This information is adapted from the publication titled Guide to Commercial Potato Production on the Canadian Prairies published by the Western Potato Council, 2003. pp. 1-107.

Segnini S, Dejmek, P. and Oste, R. (1999). Reproducible texture analysis of potato chips. *J. Food Sci.* **64**: 309-312.

Singh, B. and Ezekiel, R. (2008). Reducing sugar content and chipping quality of tubers of potato cultivars after storage and reconditioning. *Potato J.* **35**(1-2): 23-30.

Singh, R.P., Heldman, D. R., and Cargill, B. F. (1976). The influence of storage time and environments on potato chip quality. p : 411-437.

Singh, S.V., Kumar, D., Pandey, S.K., Patel, N.H., Kumar, P., Manivel, P. and Marwaha, R.S. (2005). MP/97-644: A promising hybrid for making potato chips and dehydrated products. *Potato J.* **32**(3-4): 137-138.

Singh, S.V., Marwàha, R.S., Kumar, D., Kumar, P. and Pandey, S.K. (2009). Suitability of potato varieties grown in north-eastern Indian plains for processing. *Potato J.* **36**(1-2): 25-34.

Smith, L.M., Clifford, A.J., Creveling, A.K. and Hamblin, C.L. (1985). Lipid content and fatty acid profiles of various deep-fat-fried foods. *J. America Oil Chem. Soc.* **62**(6): 996-998.

Smith, O. (1955). How to grow potatoes for the chip industry. *Am. Potato J.* **32**:265-271.

Tabatabaeefar, A. (2002). Size and shape of potato tubers. Int. *Agro. Physics.* **10**: 301-305.

Toolangi, T.K. (1995). Potatoes: factors affecting dry matter. Agriculture notes, April. State of Victoria, Department of Primary Industries, USA.

Troncoso, E., Pedreschi, F. and Zuniga, R.N. (2009). Comparative study of physical and sensory properties of pre-treated potato slices during vacuum and atmospheric frying. *LWT Food Sci. Technol.* **42**: 187-195.

Uppal, D.S. (1999). Quality traits and chipping performance of newly released potato varieties. *J. Indian Potato Assoc.* **26**: 139-142.

Uppal, D.S. (2000). Chip color and processing parameters of potatoes grown during spring and autumn in north western plains. *J. Indian Potato Assoc.* **27**(3-7): 141-144.

Uppal, D.S. and Khurana, S.M.P. (2001). Chipping performance of potato varieties grown at different locations. *J. Indian Potato Assoc.* **28**(2-4): 233-236.

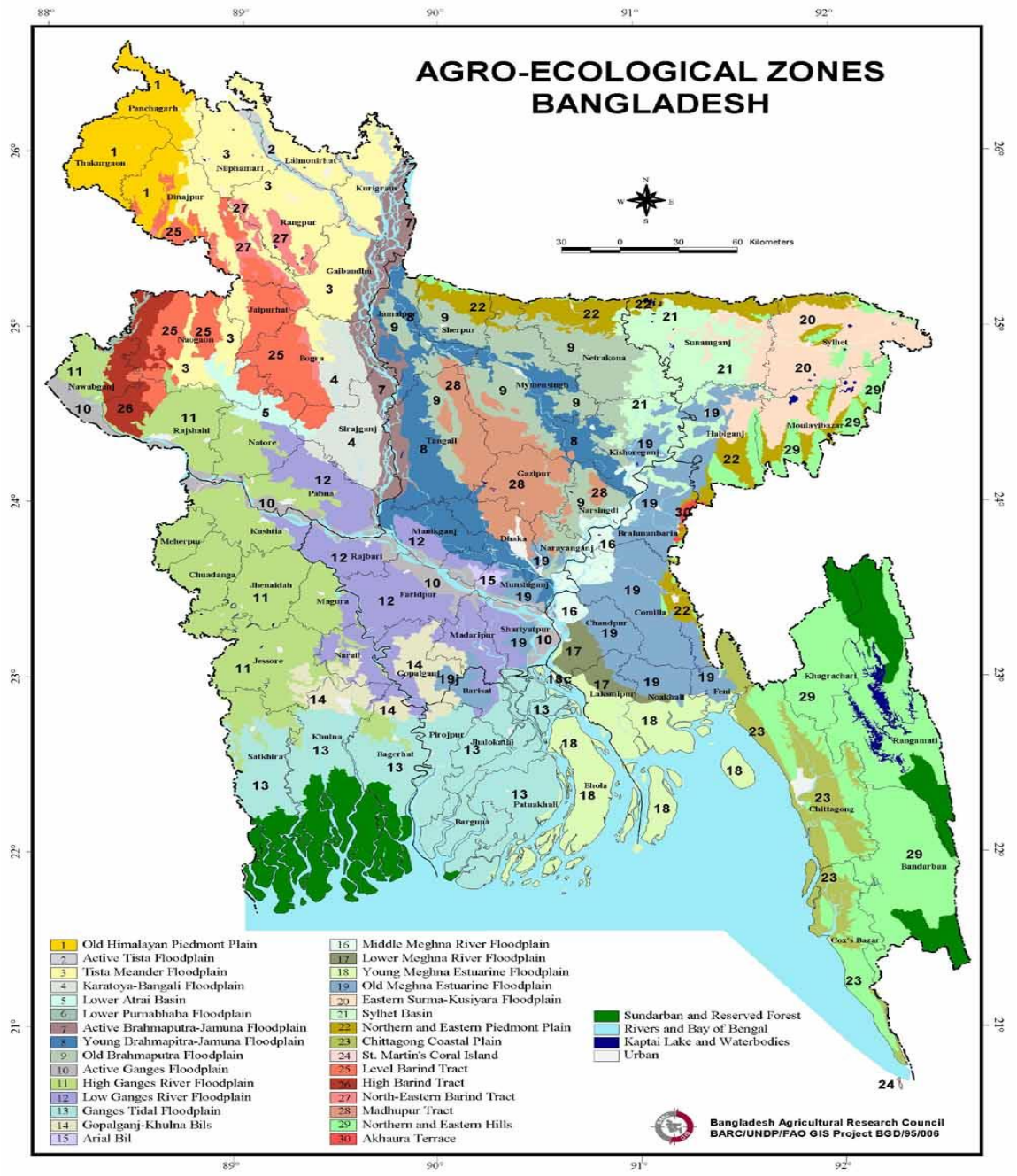
Watada, A. and Kunkel, R. (1955). The variation in reducing sugar content in different varieties of potatoes. *Am. Potato J.* **32**: 132-140.

Wooster, P. and Farooq, K. (1995). National program of germplasm screening, general instructions for trial and guide to data collection. Pak Swiss Potato Development Project, PARC Islamabad, Pakistan. p. 24.

Yaghbani, M., Mohammadzadeh, J. and Najafi, M. (2006). Composition and characterization of starch extraction from various potato cultivars in Golestan province of Iran. *J. Food Sci. Technol.* **43**(6): 667-670.

APPENDIX

Appendix I: The experimental site was shown in the map of AEZ of Bangladesh



Source: BARC, 2010

Appendix II: Analysis of variance (mean square) of skin color of selected potato varieties at 0 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	44.8559**	28.8342**	47.6790**	63.6251**	0.0238**
Error	16	0.1336	0.0939	0.2756	0.0514	0.0013

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix III: Analysis of variance (mean square) of skin color of selected potato varieties at 15 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	34.765**	31.463**	52.697**	71.395**	0.021**
Error	16	0.375	0.375	0.625	0.669	0.001

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix IV: Analysis of variance (mean square) of skin color of selected potato varieties at 30 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	31.621**	27.849**	56.657**	74.764**	0.014**
Error	16	1.386	1.735	1.512	0.589	0.005

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix V: Analysis of variance (mean square) of skin color of selected potato varieties at 45 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	26.221**	24.568**	54.261**	69.307**	0.015**
Error	16	1.926	2.428	1.024	2.176	0.002

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix VI: Analysis of variance (mean square) of skin color of selected potato varieties at 60 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	22.711**	25.759**	56.971**	72.186**	0.016**
Error	16	1.003	0.196	1.496	0.979	0.001

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix VII: Analysis of variance (mean square) of flesh color of selected potato varieties at 0 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	26.221**	7.776**	73.665**	70.6277**	0.008
Error	16	1.063	0.01	0.035	0.054	0.125

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix VIII: Analysis of variance (mean square) of flesh color of selected potato varieties at 15 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	49.180**	7.555**	75.075**	70.232**	0.021**
Error	16	0.050	0.163	0.301	0.346	0.00017

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix IX: Analysis of variance (mean square) of flesh color of selected potato varieties at 30 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	60.301**	7.866**	83.299**	78.386**	0.019**
Error	16	1.503	0.679	0.365	0.387	0.001

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix X: Analysis of variance (mean square) of flesh color of selected potato varieties at 45 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	68.148**	8.903**	81.801	76.042**	0.022**
Error	16	0.214	0.132	1.599	1.681	0.00006

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix XI: Analysis of variance (mean square) of flesh color of selected potato varieties at 60 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	92.780**	9.351**	84.422**	78.334**	0.02**
Error	16	0.305	0.970	2.195	1.778	0.002

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix XII: Analysis of variance (mean square) of weight loss of selected potato varieties at different days after storage

Sources of variation	Degrees of freedom	Mean Square			
		15 DAS	30 DAS	45 DAS	60 DAS
Treatment	7	2.164**	6.914**	10.062**	12.364**
Error	16	0.021	0.007	0.032	0.028

Appendix XIII: Analysis of variance (mean square) of specific gravity of selected potato varieties at different days after storage

Sources of variation	Degrees of freedom	Mean Square				
		0 DAS	15 DAS	30 DAS	45 DAS	60 DAS
Treatment	7	0.0022**	0.0019**	0.0007**	0.0001	0.0011*
Error	16	0.000004	0.0003	0.00007	0.0007	0.0004

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix XIV: Analysis of variance (mean square) of dry matter of selected potato varieties at different days after storage

Sources of variation	Degrees of freedom	Mean Square				
		0 DAS	15 DAS	30 DAS	45 DAS	60 DAS
Treatment	7	42.303**	42.393**	42.894**	40.795**	36.981**
Error	16	0.139	0.054	0.078	0.069	0.094

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix XV: Analysis of variance (mean square) of firmness of selected potato varieties at different days after storage

Sources of variatio	Degrees of freedom	Mean Square				
		0 DAS	15 DAS	30 DAS	45 DAS	60 DAS
Treatme	7	45.431**	45.441**	45.447**	45.507**	77.012**
Error	16	0.0001	0.0001	0.00011	0.000121	0.000121

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix XVI: Analysis of variance (mean square) of total soluble solids of different potato varieties at different days after storage

Sources of variation	Degrees of freedom	Mean Square				
		0 DAS	15 DAS	30 DAS	45 DAS	60 DAS
Treatment	7	2.6887*	2.528**	2.286**	2.004**	1.941**
Error	16	0.0486	0.044	0.018	0.009	0.063

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix XVII: Analysis of variance (mean square) of chips color of selected potato varieties at 0 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	66.089**	54.728**	57.257**	51.764**	3.358**
Error	16	0.959	0.009	0.089	0.195	004

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix XVIII: Analysis of variance (mean square) of chips color of selected potato varieties at 15 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	75.489**	53.345**	59.732**	54.178**	0.083**
Error	16	1.487	0.027	1.579	1.460	0.00014

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix XIX: Analysis of variance (mean square) of chips color of selected potato varieties at 30 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	76.674**	61.364**	60.379**	54.215**	0.089**
Error	16	1.589	0.022	1.542	1.622	0.00012

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix XX: Analysis of variance (mean square) of chips color of selected potato varieties at 45 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	74.697**	57.819**	59.429**	53.249**	0.082**
Error	16	0.522	0.423	1.703	1.305	0.00049

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix XXI: Analysis of variance (mean square) of chips color of selected potato varieties at 60 DAS

Sources of variation	Degrees of freedom	Mean Square				
		L	a	b	Chroma	Hue angle
Treatment	7	74.552**	56.661**	59.955**	53.595**	0.079**
Error	16	1.612	0.058	1.747	1.571	0.00005

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

Appendix XXII: Analysis of variance (mean square) of crispness of selected potato varieties at different days after storage

Sources of variation	Degrees of freedom	Mean Square				
		0 DAS	15 DAS	30 DAS	45 DAS	60 DAS
Treatment	7	2.296**	2.311**	2.383**	2.23**	2.241**
Error	16	0.009	0.0001	0.00004	0.00007	0.00037

* indicates significant at 5% level of probability
** indicates significant at 1% level of probability

LIST OF PLATES

Lal pakhri

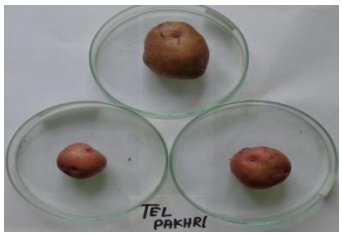
Sada shapla

Bhuta

Jam alu

Deshi sotti

Berma



Tel pakhri

Lady rosetta

Plate 1. Potato varieties