Journal of Life Sciences Research
Vol. 4, No. 1, 5-13, 2017
ISSN (E) 2408-9184: / ISSN (P) 2518-0126
DOI: 10.20448/journal.504.2017.41.5.13

Modeling of Potato Shelf Life on Evaporative Cooling Storage

Md. Ashrafuzzaman Gulandaz[1]
Abu Sayed[2]
M Nur-A-Alam[3]
M.A. Hossain[4]
Mahedi Hasan[5]
Mashiur Rahman[6]


(✉ Corresponding Author)

[1]*Farm Machinery and Post-harvest Engineering Division, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh*
[2]*Department of Agricultural Engineering, EXIM Bank Agricultural University Bangladesh, Chapainawabganj, Bangladesh*
[3]*Department of Farm Power and machinery, Bangladesh Agricultural University, Mymensingh, Bangladesh*
[4]*Workshop Machinery and Maintenance Division, Bangladesh Rice Research Institute, Gazipur, Bangladesh*
[5]*Machinary Repair and Maintenance Division, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh*
[6]*M.Sc Student in Sustainable Energy Engineering, Danmarks Tekniske Universitet, Danmark*

Abstract

A model of evaporative cooling storage system was designed to increase potato shelf life for improving potato storage system. Two cultivars of potato 'Diamant' (100 gm and 51 gm per tuber) and 'LalPakri (23 gm and 11 gm per tuber) were placed on four shelves of the bin. Each shelf holds 240 kg of potato from 23 march 2013 to December 2013. Potato spoilage, sprouting, shrinkage, moisture content, vitamin C and total sugar content of potato were measured. Experimental results revealed that potato spoilage progressively increased from April to November and sprouting of potato gradually increased from June to October, but stopped in November. The cumulative spoilage and sprouting were much lower in the improved bin compared to traditional farmer's practices. Shrinkage of potato was found higher in farmer's practice than that of storage bin from October to November. Moisture content of potato was higher during May and reduced gradually to the lowest value during November in both of practices. No significant difference was found in two practices on vitamin-C content. Sugar content of 'Diamant; potato was lower in the storage bin during November. According to data analysis and regression curve storage bin model was more appropriate for both cultivars than farmer practice and significantly more appropriate for 'LalPakri' potato.

Keywords: Evaporative cooling storage, Shelf life, Spoilage, Spouting, Shrinkage.

Citation | Md. Ashrafuzzaman Gulandaz; Abu Sayed; M Nur-A-Alam; M.A. Hossain; Mahedi Hasan; Mashiur Rahman (2016). Modeling of Potato Shelf Life on Evaporative Cooling Storage. Journal of Life Sciences Research, 4(1): 5-13.
History:
Received: 14 March 2017
Revised: 10 April 2017
Accepted: 18 April 2017
Published: 26 April 2017

Publisher: Asian Online Journal Publishing Group

Contribution/Acknowledgement: All authors contributed to the conception and design of the study.
Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no conflict of interests.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study was reported; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained.
Ethical: This study follows all ethical practices during writing.

Contents

1. Introduction

Potato (*Solanum tuberosum* L.) is one of the most important, non-cereal tuberous crops [1]. It is the world's third-largest food crop in terms of human consumption [2] and the fourth most consumed food crop after rice, wheat and maize [3]. The potato cultivation has been increased considerably over the past years. Recently, Bangladesh produces 9 million mT of potatoes whereas 1.5 million mT of potatoes get wasted per year [4] due to insufficient storage facilities [5].This trend to increase of potato production in Bangladesh is the great challenge in terms of cold storage. At recent time two-thirds of the total produce does not find any space in the cold storage and major part of which is consumed shortly after harvest and the rest is kept in traditional storage [6]. These systems have no temperature control. As a result, a substantial portion of it lose weight gradually and ultimately get shriveled, rotten or sprouted due to lack of storage system. The quantity of potato is virtually reduced, in the long run, to less than 70 percent of the original production Ahmad [7]. According to Ahmad [7] and Alauddin [8] potato production is directly proportional to its preservation space. Therefore, if storage facilities are not increased, the production of potato cannot be increased considerably. Hossain and Miah [9] shows that only 28% of total production (81%) are used for daily consumption during the peak potato production and remaining about 53% creates a surplus which have to store over the next 6 months from May to November. So, it requires improve short term storage system to prevent spoilage. Evaporative Cooling System (ECS) is an improved storage system with a small store house where potato could be stored in bulk on a raised platform inside an insulated closed structure. Evaporative cooling is a physical phenomenon in which evaporation of a liquid, typically into surrounding air, cools an object or a liquid in contact with ECS. Evaporative cooling occurs when air, that is not too humid, passes over a wet surface; the faster the rate of evaporation the greater the cooling. An evaporative cooler reduces the storage temperature and also increases the relative humidity within the optimum level of the storage thereby keeping the fruits and vegetables fresh. It can be used for short term preservation after harvested [10]. Potatoes are sometimes stored in a separate house made of corrugated iron (C.I) sheet and bamboo. It could be 5 x10 m sized 45-50 cm above ground and can store 100-150 tons of potato for 3-4 months. It was found less efficient as there is no forced ventilation system. It could be improved by installing solar operated exhaust fan with evaporative cooling system for increased cooling effect so that shelf life of stored potato could be increased by at least 4-5 months beyond harvest season [11]. The major development was made by adding a regulated fan speed, water flow rate and wetted-thickness. This was possible as a result of varying temperature and relative humidity within the facility [12]. Effective cold storage of bagged potatoes depends on many interrelated geometric and operating parameters. A clear knowledge of this relationship helps to design and operate the cold storage under optimum conditions to maintain potato quality during long term storage [13]. About 37% of farmers used indigenous storage methods for potatoes for commercial purposes. The quantity stored ranged from 51 to 200 quintals per farmer, for periods of up to 90 days [14]. The concept of water-cooling a roof has a long history but it is estimated that less than 60 million square feet of roof have ever been water cooled. Potato production is directly proportional to its preservation space. Therefore, if the storage facilities are not increased the production of potato could not be increased considerably [7, 8]. Evaporative cooling is a physical phenomenon in which evaporation of a liquid, typically into surrounding air, cools an object or a liquid in contact with it. Evaporative cooling occurs when air, that is not too humid, passes over a wet surface; the faster the rate of evaporation the greater the cooling. The main object of this study was to develop a model of evaporative cooling storage system to increase potato shelf life.

2. Materials and Methods

A potato storage bin was installed inside a newly built Post-harvest Preservation and Processing Laboratory of the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. The study was started on 1st April 2013 and continued up to December 2013.

2.1. Improved Storage Bin for Experimentation

Improved ECS was constructed using locally available material such as cement, sand and Mile steel (M.S) rod. Reinforced cement concrete and bricks were used to build the evaporative chamber having 2.0 m diameter and 0.5 m depth at the bottom of the store (Fig. 1). At least half of the chamber holds verb missing water all the time so that rest of the brick block (having water socking properties) at upper portion could get wet by capillary action. Water was poured in to the evaporative chamber time to time to maintain a constant level of water. An outside transparent plastic tube indicated the required level of water. A forced air ventilation by a rotary exhaust fan, powered by solar panel, located at the top of the storage bin helped accelerate evaporate water from the evaporative chamber kept below the storage bin. Cool and moist air flow helped maintain the inside storage temperature below the air temperature inside the bin. Two exhaust fans (each 300 mm diameter), placed on the top of the storage bin and powered by three solar panels forced the inside air out so that the potato get fresh air/oxygen from outside the bin. These exhaust fans generated an airflow rate of 0.6 $m^3m^{-2}.sec^{-1}$ and was operational only during 12 hours day time.

2.2. Potato Varieties

'**Diamant**' (100 gm and 51 gm per tuber) and '**LalPakri** (23 gm and 11 gm per tuber) purchased from local market of Nunuz Bazar, Kalaiupozilla of Joypurhat district were stored inside the bin on 25 March 2013. Before loading into the bin the potatoes were sorted and allowed several days for curing. Potatoes were stored in four different shelves. Each shelf contained four categories of potatoes (**LalPakri-**small, **LalPakri-**large, **Diamant-**small and **Diamant-**large). All potatoes were stored in nylon netted sack of 10 kg each. In addition, ten small nylon netted sack of one kg potato from each category was placed in each shelf for determination of moisture content, vitamin C, and total sugar. Equivalent Farmers' Traditional Storage (here after called Farmer's Practice) was also maintained inside the laboratory with the same categories of the potato. The same four categories of potato were stored in this method with **LalPakri-**small (120 kg), **LalPakri-**large (85 kg), **Diamant-**small (110 kg) and **Diamant-**large (115 kg).

2.3. Design of Experiment

The principle of Completely Randomized BlockDesign (CRBD) with 3 factors, 4 replications was considered for experimentation. There were eight treatment combinations(2 x 2 x 2 = 8) as follows:

Factor A (Storage condition – 2 levels) : (a) Improved storage (b) Normal storage
Factor B (**Varieties** of potato – 2 levels) : (a) 'Diamant' (b) 'LalPakri'
Factor C (Size of tubers – 2 levels) : (a) Large (b) Small

Sixty kg (in 6 bags) potatoes of each of (a) **Diamant** Large (about 100 gm per tuber), (b) **Diamant** Small (about 51 gm per tuber), (c) **LalPakri** large (about 23 gm/tuber) and (d) **LalPakri** small (11 gm per tuber) were loaded on all the 4 shelves of the Improved Storage Bin as per loading pattern shown in Fig.2(a). In total, 960 kg potatoes were loaded into the Improved Storage Bin for experimentation. For the Equivalent Farmers' Traditional Storage (Farmer's Practice) 115 kg of **Diamant** Large, 110 kg of **Diamant** Small, 85 kg of **LalPakri** large and 120 kg of **LalPakri** small potatoes were kept on C.C. floor (over a bamboo mat with a thin layer of dry sand) inside the same room in which the Improved Storage bin was located shown in Fig. 2(b)**.** Potato samples were taken from both the storage conditions 15 days interval on the same day of sample collection.

2.4. Experimentation

Air temperature above four shelves (inside the bin) and the temperature of potato at sixteen points were recorded by a data logger and Lab View software shown in Figs.3 (a) and 3(b). Air flow through the bin, relative humidity of air inside the bin, and ambient air temperature were measured. Sample potato was taken at 15 days interval from 16 different cells of the shelves to find out the spoilage, sprout, moisture content, vitamin C, and total sugar content. The collected data were analyzed for meaningful interpretation and model development. Subsequently, an optimum potato storage design for farm household has been reported.

2.5. Determination of Mean Weight of Potato

Two hundred potatoes from each size group of each **variety** were taken randomly and were weighted. The average weight of the potato for a particular size of the particular variety was calculated dividing the total weight by 200. Thus, mean weight per tuber of each category was determined.

2.6. Determination of Potato Spoilage

Number of potato spoiled (i.e. unacceptable due to rotten) was recorded by observation method at 15 days interval for all categories and population of potato kept in the sacks. The amount (by weight) of spoiled potato was calculated by multiplying the number of spoiled potato found by the mean weight per potato tuber. Similarly, same method was followed to determine the spoilage found in farmer's traditional practice. Thus, monthly spoilage of potato was obtained for both the storage methods.

2.7. Determination of Nutritional Parameters

2.7.1. Vitamin-C Content

Vitamin-C (Ascorbic acid) content of potato samples taken in fifteen days interval from four different shelves of the experimental storage bin as well as from farmer's practice was determined by Titration method. All the required chemicals including the dye (2,6-Dichlorophenol indophenol) was standardized. After that, a required amount of potato sample was taken and made volume by Meta phosphoric acid (HPO_3). Next 1 ml 40% formaldehyde and 0.1 ml HCl were added. This was titrated with the standard dye to a light pink color (end point), which persisted for 10-15 seconds.

2.7.2. Total Sugar Content

The total sugar content of potato sample taken in fifteen days interval from four different shelves of the Improved Storage Bin as well as farmer's traditional practice was determined by the LANE and ENYON method. The sugar content was estimated by determining the volume of the unknown sugar solution required to completely reduce a measured volume of Fehling's solution. All the required reagents were prepared following the standardization procedure of the Fehling's solution. Then the sample was prepared. The amount of reducing sugar was determined by titration against Fehling's solution A and B when brick red color was obtained. Finally, the total sugar was determined by titration against Fehling's solution A and B.

2.7.3. Moisture Content

The moisture content (wet basis) of the potato sample taken in fifteen days interval from four different shelves of the Improved Storage Bin as well as farmer's practice was determined by the oven dry method. Empty weight of crucible and the weight of the potato sample were determined. Then the crucible with sample was placed in an air oven and dried at a temperature of 100 to 105^{0}C for 24 hours. After drying, the crucible was removed from the oven and placed inside desiccators. It was weighted again. From these weights, the moisture content of each potato sample was calculated.

2.7.4. Sprouting

The method of eye observation and measurement of length of sprouts were considered in estimating the percent of potato sprouted in each sack kept in four shelves of the storage bin as well as potato from farmer's traditional store. It was observed at an interval of fifteen days when potato samples was taken for determination of other parameters mentioned above.

2.7.5. Shrinkage

The shrinkage of potato by volume was estimated by observation method and scaled using Likert scale (0-5) of quality assessment. Zero (0) and 5 indicates 0% and 50% shrinkage by volume, respectively.

2.8. Economic Benefit

Ignoring the fixed cost of the facilities, calculation of the gross economic benefit using improved storage bin may be calculated using the following model. The model determines the relative savings of potato from loss in the Improved Storage Bin over farmer's traditional storage.

$$B = p^{*}[(ps - plsp^{*}ldsp - plsk^{*} ldsk)] \quad \text{..... (1)}$$

where

B = Gross benefit in the Improved Storage Bin over farmer's storage in any month, Tk.kg-1
p = Unit market price of potato, Tk.kg^{-1}
ps = Percent of potato saved
plsp = Price loss factor for sprouting, fraction
ldsp = Percent loss difference due to sprouting
plsk = Price loss factor for shrinkage, fraction
ldsk = Percent loss difference due to shrinkage

The optimum duration of potato stored in the Improved Storage Bin may be determined by the time point (month) when the economic benefit (B) becomes maximum. Mathematically, it could be obtained by taking first derivative of the benefit Equation (1) and equating to zero value. Graphically, it may be obtained by plotting the Equation (1) in ordinary graph paper.

3. Results and Discussion

3.1. Development of Improved Sorage Bin

Storage was used to restrain and properly holds the material, also to prevent or minimize the damage to the material which might occur due to moisture condensation or excess temperature. A storage system was installed shown in Fig. 4 at post-harvest Preservation and Processing Laboratory, DFPM, BAU from April 2013 to December 2013.

3.2. Potato Condition

Table 1 shows that after the end of April, there was no loss of potato in both improved bin and farmer's practice. From May potato began spoilage; about 99.17 and 98.74% of **Diamant** small (DS) and **Diamant** large (DL) respectively, and 98.90 and 98.74% of **Lalpakri** small (LPS) and **Lalpakri** large (LPL) respectively were found in Storage Bin where 98.51, 97.46, 97.48 and 95.96% of DS, DL, LPS and LPL respectively, were found in Farmer's practice. In the end of May potato saving difference of Storage Bin and Farmer's practice in DS, DL, LPS and LPL were 0.66, 1.28, 1.41 and 2.59% respectively. This table also shows that the storage Bin always saved more percentage of potato than that of Farmer's practice. At the end of July for DL and LPS and end of November for DL the Farmer's practice saves more than Storage Bin. Finally, Storage Bin saves 9.10, 7.46 and 10.85% more DS, LPS and LPL respectively than Farmer's practice at the end of November.

3.3. Spoilage of Potato

Spoilage of potato for both two cultivars is presented in Table 2. This shows that at the end of November the spoilage of DS was 43.43 kg in Improved Bin while in Farmer's Practice it was 57.44 kg. In Improved Bin the spoilage of DL was 54.15 kg and in Farmer's practice it was 60.19 kg at the end of November. Similarly the spoilage of LPS and LPL were 40.27 kg and 45.83 kg respectively in Improved Bin and 51.47 kg and 60.34 kg respectively in Farmer's Practice. On the other hand the spoilage of potato in both two storage system and two **varieties** and two replication at the end of November were about 1.5 times more than the spoilage of potato at the end of October.

The generated equation and the value of R^2 from these graph are shown in Table 3. Table 3 shows that from the curve equation, the value of R^2 lies between 0.991 to 0.999 which is significant. In case of Improved Storage Bin the values were 0.998, 0.998, 0.999 and 0.996 for DS, DL, LPS and LPL respectively.

3.4. Vitamin-C Content

Table 4 shows the vitamin-C content of potato for the both two varieties of potato. Though Initially the Vitamin-C content was same but at the end of May the Vitamin-C content were found 8.6 mg and 8.55 mg for DS and DL **variety** respectively in Improved Bin; 8.6 mg and 8.5 mg for DS and DL **variety** in Farmer's Practice; 7.3 mg each for LPS and LPL variety in Improved Bin; 7.2 mg and 7.3 mg for LPS and LPL variety in Farmer's Practice. But this study found that the Vitamin-C content of DS and DL variety becomes 8.15 mg and 8.1 mg respectively in Improved Bin and 7.8 mg each in Farmer's Practice. On the other hand the Vitamin-C content of LPS and LPL were 7 mg and 6.95 mg respectively in Improved Bin and 6.8 mg each for Farmer's practice. Fig. 5(a) shows that in improved storage bin the value of R^2 are 0.999 and 0.997 respectively for DS and DL and 0.995 and 0.996 for DS and DL respectively in Farmer's Practice. Fig. 5(b) shows that in improved storage the value of R^2 are 0.995 and 0.981 respectively for LPS and LPL. and 0.996 each for LPS and LPL in Farmer's Practice. The values are also significant.

3.5. Sugar Content

There were no changes in sugar content of potato in both varieties up to August. But after August the sugar content become increases and finally at the end of November it was found 0.887 mg and 0.88 for DS and DL respectively in Improved Bin and 0.9 mg and 0.89 mg for DS and DL respectively for Farmer's practice (Table 5). Again in case of **LalPakri** variety the sugar content is always same and finally it was found 0.82 each for LPS and LPL in storage Bin and Farmer's practice at the end of November.

3.6. Moisture Content

Table 6 shows the moisture content of potato for the both two varieties of potato. Though Initially the moisture content was same but at the end of May the moisture content was found 80.5% and 79.92% for DS and DL variety respectively in Improved Bin; 80.87 and 79.68% for DS and DL **variety** in Farmer's practice; 78.16 and 77.07% for LPS and LPL **variety** respectively in Improved Bin; 77.23 and 77.48% for LPS and LPL variety respectively in Farmer's practice. But this study found that the moisture content of DS and DL variety become 78.37 and 78.53% respectively in Improved Bin and 79.24 and 77.85% respectively in Farmer's practice. On the other hand the moisture content of LPS and LPL were 75.98 and 75.54% respectively in Improved Bin and 75.15 and 75.77% respectively for Farmer's practice.

3.7. Potato Sprouting

Table 7 shows that first two month of the experiment there were no sprout in potato. Cumulative percent of sprouted potato having sprout length greater than 10 mm were considered. Sprouting begins from the month of June. The rate of sprouting in improved storage Bin always less than Farmer's practice. And Fig. 6 shows sprouted potato in the year of 2013. The value of R^2 from Table 7 is 0.999 each in Diamant in both improved Bin and Farmer's practice, **LalPakri** in both improved Bin and Farmer's Practice. Sprouting of potato gradually increased from June to October, but stopped in November.

3.8. Shrinkage

The shrinkage rate is zero upto June in both **varieties** of potatoes in both two condition. The condition of shrinkage rate of both two storage system were similar upto september. For both **Diamant** and **LalPakri** varieties in Improved Bin the shrinkage rate were less than Farmers Practice shown in Fig. 7.

3.9. Economic Benefit

The price trend of potato is presented in Table 8. This price trend was used to calculate the gross benefit of use of Improved Storage Bin over farmer's traditional practice. Gross benefit decreases with increased rate of sprouting and shrinkage. The price loss due to sprouting and shrinkage considered here were 10 and 80%, respectively. Ignoring fixed cost of the storage methods, the gross benefit by using improved storage bin over farmer's practice was calculated using Equation no. 1. Fixed cost has been ignored here because of use of laboratory version of the storage structure and cannot be compared until a farmer version is available. Therefore, only the variable costs were considered. It reveals that the maximum gross benefit of storing **Diamant variety** using improved storage bin found in the month of October. Beyond October the gross benefit started decreasing due to price loss for higher level of shrinkage and/or sprouting. In other words, **Diamant variety** could be stored up to seven months after harvest. On the other hand, **LalPakri** could be stored in the improved storage bin for longer period with higher profit. This was mainly due to higher market price of **LalPakri** than that of **Diamant variety**. **LalPakri** would bring gross profit by Tk. 2.57 per kg.(calculated using market price of November 2013) over Farmer's Practice, if stored up to November. On the other hand, **Diamant variety** would bring gross profit by Tk. 1.34 per kg over Farmer's Practice, if stored up to November. [1Tk = 0.012 US $).

4. Conclusions

Experimental results revealed that potato spoilage gradually increased proportionally with the months. This trend was found in farmers' traditional practice. But percentage of cumulative spoilage was much lower in the improved bin compared to traditional farmer's practices. No significant difference of spoilage was found among different layers of potato laid inside of the improved bin. Spoilage of potato progressively rose from April to November. But it became Sprouting was found from the mid of June. It was higher in farmer's practice than that of storage bin. Sprouting of potato gradually increased from June to October, but stopped in November. Shrinkage of potato was almost same in both of the practices but found higher in farmer's practice than that of storage bin from October to November. Moisture content of potato was higher during May, but reduced gradually to the lowest value during November in both of the practices. But moisture content was higher in November than that of the farmers' practice. No significant difference was found in two practices on vitamin-C content, but sugar content of *Diamant* potato variety was found lower in the storage bin during November. The regression model is appropriate for both the (**Diamant** and **LalPakri**) varieties but more appropriate for **LalPakri** variety.

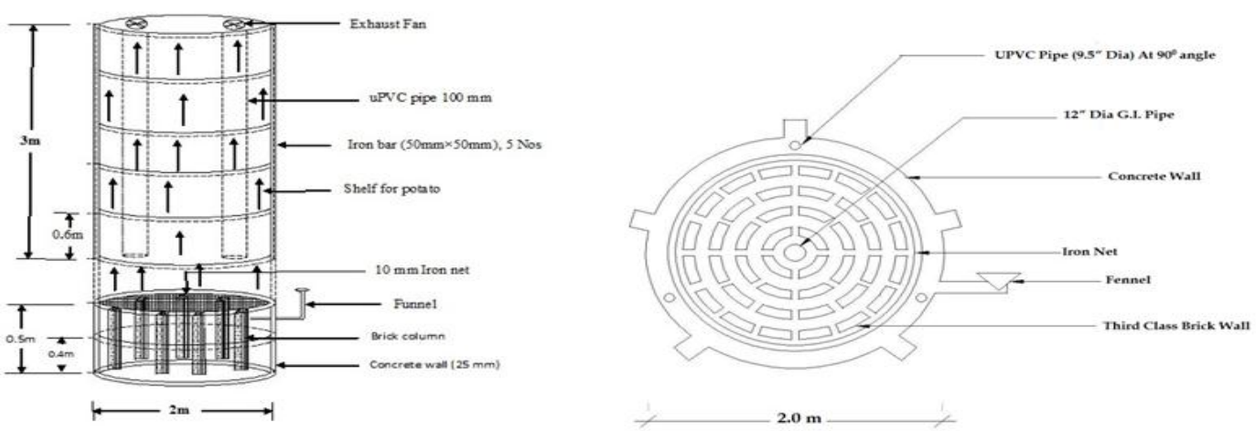

Figure-1. (a) Improved potato storage bin (drawing) (b) Evaporative cooling chamber

Source: AutoCAD Drawing

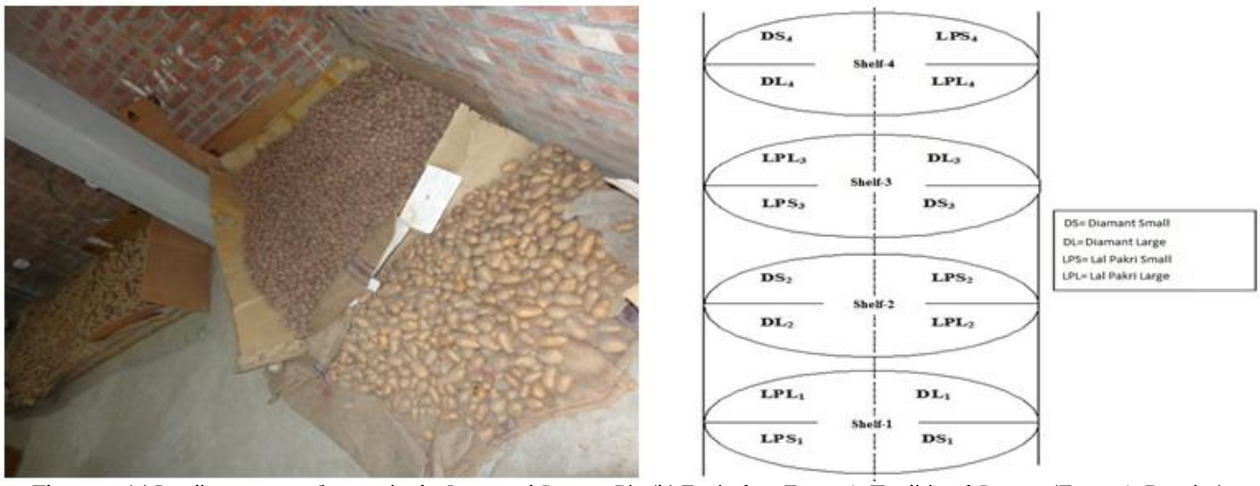

Figure-2. (a) Loading pattern of potato in the Improved Storage Bin (b) Equivalent Farmer's Traditional Storage (Farmer's Practice)
Source: Lab work (2013)

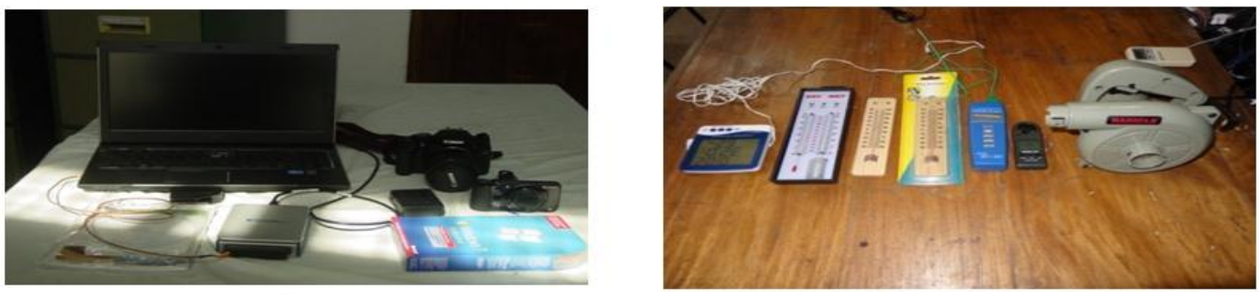

Figure-3. (a) data logger (b) digital thermometer, hygrometer, anemometer and blower
Source: Lab work (2013)

Figure-4. (a) Improved Potato Storage bin (b) Evaporative Cooling Chamber (c) Potato loaded Improved Storage Bin with experimental set-up
Source: Lab work (2013)

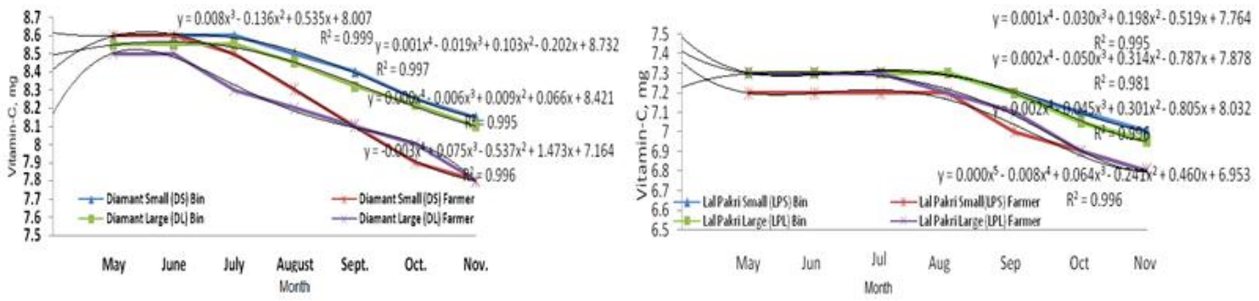

Fig-5. Vitamin-C content of potato in (a) Diamant variety (b) LalPakri variety
Source: Excel Data manipulation (2013)

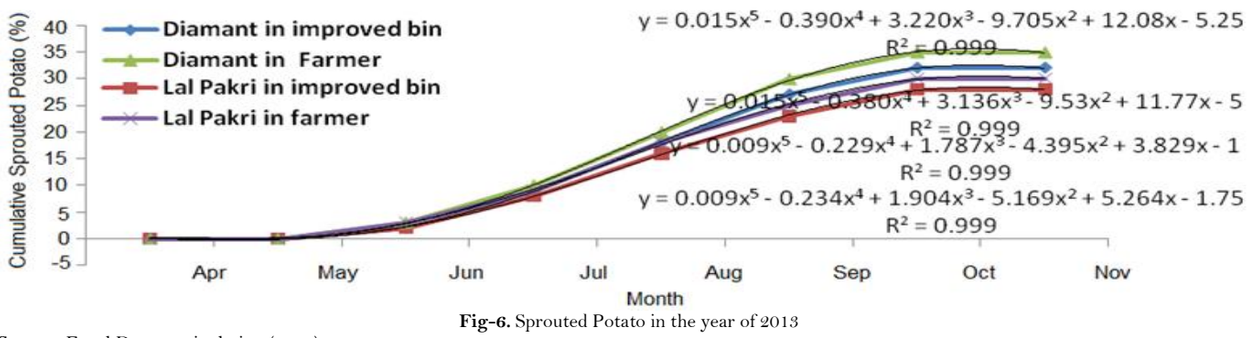

Fig-6. Sprouted Potato in the year of 2013
Source: Excel Data manipulation (2013)

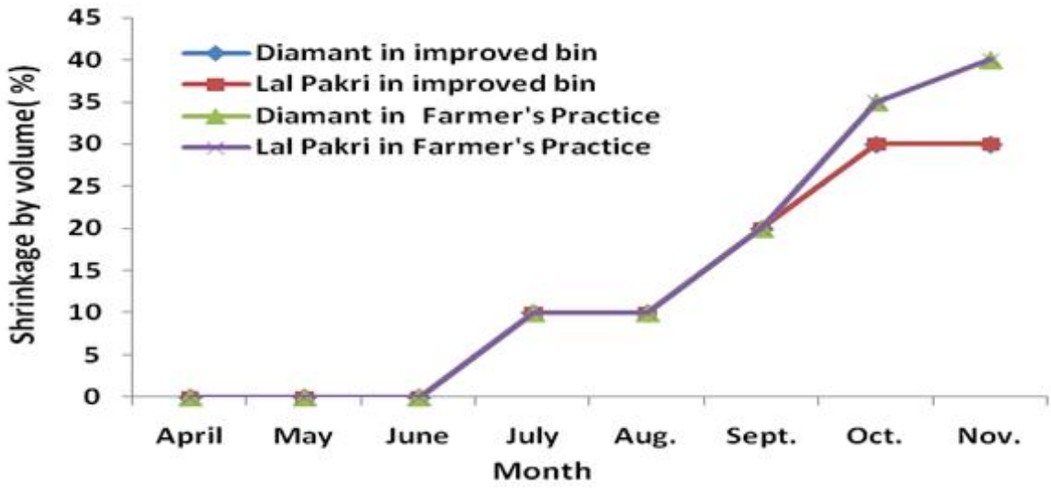

Fig-7. Shrinkage of different varieties of Potato in the year of 2014

Source: Excel Data manipulation (2013)

Table-1. Potato saving status the end of month in both storage system

Month	Variety	Farmer (kg)	Bin (kg)	Farmer (%)	Bin (%)	% Difference
Apr (4)	DS	110	240	100.00	100.00	0.00
	DL	115	240	100.00	100.00	0.00
	LPS	120	240	100.00	100.00	0.00
	LPL	85	240	100.00	100.00	0.00
May (5)	DS	108.36	238.00	98.51	99.17	0.66
	DL	112.08	236.97	97.46	98.74	1.28
	LPS	116.98	237.35	97.48	98.90	1.41
	LPL	81.57	236.50	95.96	98.54	2.58
Jun (6)	DS	107.08	236.87	98.82	99.53	0.71
	DL	110.16	234.35	98.29	98.89	0.60
	LPS	116.02	236.06	99.18	99.46	0.28
	LPL	80.09	235.26	98.20	99.48	1.28
Jul (7)	DS	105.90	235.38	98.90	99.37	0.47
	DL	108.45	230.62	98.44	98.41	-0.04
	LPS	114.53	230.47	98.72	97.63	-1.09
	LPL	78.11	230.73	97.52	98.07	0.55
Aug (8)	DS	102.92	233.12	97.19	99.04	1.85
	DL	104.51	226.39	96.37	98.16	1.79
	LPS	108.52	219.98	94.75	95.45	0.70
	LPL	74.21	222.83	95.01	96.58	1.57
Sep (9)	DS	90.71	219.72	88.14	94.25	6.12
	DL	91.61	208.04	87.66	91.89	4.24
	LPS	96.02	195.90	88.48	89.05	0.57
	LPL	65.43	200.74	88.17	90.09	1.92
Oct (10)	DS	75.41	190.74	83.13	86.81	3.68
	DL	66.84	167.68	72.96	80.60	7.64
	LPS	74.93	168.30	78.04	85.91	7.88
	LPL	50.20	165.37	76.72	82.38	5.66
Nov (11)	DS	46.81	135.74	62.07	71.17	9.10
	DL	45.77	113.02	68.47	67.40	-1.07
	LPS	58.23	143.34	77.71	85.17	7.46
	LPL	33.71	128.98	67.15	77.99	10.85

Source: Field work (2013)

Table-2. Spoilage of Potato

Month	Diamant Variety (kg)				LalPakri Variety (kg)			
	DS (Bin)	DS (Farmer)	DL (Bin)	DL (Farmer)	LPS (Bin)	LPS (Farmer)	LPL (Bin)	LPL (Farmer)
Apr (4)	0	0	0	0	0	0	0	0
May (5)	0.83	1.49	1.26	2.54	1.10	2.52	1.45	4.03
Jun (6)	1.3	2.65	2.35	4.21	1.64	3.32	1.97	5.76
Jul (7)	1.92	3.72	3.90	5.69	3.97	4.56	3.86	8.10
Aug (8)	2.86	6.43	5.67	9.11	8.34	9.57	7.15	12.69
Sep (9)	8.44	17.53	13.31	20.33	18.37	19.98	16.35	23.02
Oct (10)	20.52	31.44	30.13	41.87	29.87	37.56	31.09	40.94
Nov (11)	43.43	57.44	54.15	60.19	40.27	51.47	45.83	60.34

Source: Field work (2013)

Table-3. The value of R^2 from the curve equation obtained by the spoilage of potato

Variety	Storage	Equation	R^2
DS	Improved Storage Bin	$y=0.0385x^3-7.059x^2+42.27x-81.35$	0.998
	Farmer's Practice	$y=0.353x^3-6.029x^2+34.63x-64.79$	0.998
DL	Improved Storage Bin	$y=0.0385x^3-6.796x^2+39.96x-76.07$	0.998
	Farmer's Practice	$y=0.256x^3-3.877x^2+20.48x-35.65$	0.991
LPS	Improved Storage Bin	$y=-0.066x^4+2.00x^3-20.83x^2+90.96-142.1$	0.999
	Farmer's Practice	$y=-0.098x^4+3.073x^3-33.29x^2+151.8x-246.5$	0.998
LPL	Improved Storage Bin	$y=0.156x^3-2.078x^2+9.413x-13.94$	0.996
	Farmer's Practice	$y=0.260x^3-4.21x^2+24.75x-47.65$	0.997

Source: Field work (2013)

Table-4. Vitamin-C content of potato

Month	Diamant Variety (mg)				LalPakri Variety (mg)			
	DS (Bin)	DS (Farmer)	DL (Bin)	DL (Farmer)	LPS (Bin)	LPS (Farmer)	LPL (Bin)	LPL (Farmer)
May (5)	8.6	8.6	8.55	8.5	7.3	7.2	7.3	7.3
Jun (6)	8.6	8.6	8.55	8.5	7.3	7.2	7.3	7.3
Jul (7)	8.6	8.5	8.55	8.3	7.3	7.2	7.3	7.3
Aug (8)	8.5	8.3	8.45	8.2	7.3	7.2	7.3	7.2
Sep (9)	8.4	8.1	8.32	8.1	7.2	7	7.2	7.1
Oct (10)	8.25	7.9	8.22	8	7.1	6.9	7.05	6.9
Nov (11)	8.15	7.8	8.1	7.8	7	6.8	6.95	6.8

Source: Field work (2013)

Table-5. Total Sugar (gm) Content of Potato

Month	Diamant Variety (gm)				LalPakri Variety (gm)			
	DS (Bin)	DS (Farmer)	DL (Bin)	DL (Farmer)	LPS (Bin)	LPS (Farmer)	LPL (Bin)	LPL (Farmer)
May (5)	0.86	0.86	0.86	0.86	0.79	0.79	0.79	0.79
Jun (6)	0.86	0.86	0.86	0.86	0.79	0.79	0.79	0.79
Jul (7)	0.86	0.86	0.86	0.86	0.79	0.79	0.79	0.79
Aug (8)	0.86	0.86	0.86	0.86	0.79	0.79	0.79	0.79
Sep (9)	0.865	0.865	0.865	0.865	0.8	0.8	0.8	0.8
Oct (10)	0.876	0.88	0.873	0.88	0.81	0.81	0.81	0.81
Nov (11)	0.887	0.9	0.88	0.89	0.82	0.82	0.82	0.82

Source: Field work (2013)

Table-6. Moisture content (%, wb) of potato

Month	Diamant Variety				LalPakri Variety			
	DS (Bin)	DS (Farmer)	DL (Bin)	DL (Farmer)	LPS (Bin)	LPS (Farmer)	LPL (Bin)	LPL (Farmer)
May (5)	80.5	80.87	79.92	79.68	78.16	77.23	77.07	77.48
Jun (6)	80	80.8	79.9	79.56	77.62	77.15	76.92	77.35
Jul (7)	79.81	80.69	79.9	79.47	77.23	77.04	76.83	77.25
Aug (8)	79.57	80.43	79.65	79.22	77.08	76.68	76.64	77.01
Sep (9)	79.24	80.09	79.35	78.7	76.75	76.03	76.36	76.6
Oct (10)	78.84	79.61	78.96	78.23	76.41	75.57	75.98	76.12
Nov (11)	78.37	79.24	78.53	77.85	75.98	75.15	75.54	75.77

Source: Field work (2013)

Table-7. Potato Sprouting in Different Varieties

Month	Improved Bin		Farmer's Practice		Difference value	
	Diamant	LalPakri	Diamant	LalPakri	Diamant	LalPakri
Apr (4)	0	0	0	0	0	0
May (5)	0	0	0	0	0	0
Jun (6)	2	2	3	3	1	1
Jul (7)	9	8	10	9	1	1
Aug (8)	18	16	20	18	2	2
Sep (9)	27	23	30	25	3	2
Oct (10)	32	28	35	30	3	2
Nov (11)	32	28	35	30	3	2

Source: Field work (2013)

Table-8. Price Trend of Potato in the year of 2013

Month	Diamant Variety (Tk.Kg^{-1})		LalPakri Variety (Tk.Kg^{-1})	
	Govt. price	Market price	Govt. price	Market price
Apr (4)	11.00	11.00	13.00	13.00
May (5)	11.00	13.00	13.50	16.00
Jun (6)	11.00	13.00	13.00	16.00
Jul (7)	10.50	15.00	15.00	22.00
Aug (8)	10.00	14.00	18.00	20.00
Sep (9)	9.00	13.00	18.00	20.00
Oct (10)	9.00	14.00	18.00	22.00
Nov (11)	10.00	15.00	19.00	24.00

Source: Field work (2013)

References

[1] T. Buckseth, A. K. Sharma, K. K. Pandey, B. P. Singh, and R. Muthuraj, "Methods of pre-basic seed potato production with special reference to aeroponics – a review," *Scientia Horticulturae*, vol. 204, pp. 79–87, 2016. *View at Google Scholar | View at Publisher*

[2] CIP, "CIP: International Potato Centre." Retrived from http://cipotato.org/potato/facts, n.d.

[3] NETAFIM, "Netafim South Africa." Retrived from www.netafim.co.za/offering/irrigation/agriculture/field/potato/?id=80,2017, n.d.

[4] A. Douma, "Collective potato cold storage facility for small-scale farmers in Bangladesh." Retrived from: https://challenges.openideo.com/challenge/agricultural-innovation/improve, 2016.

[5] H. Kibar, "Design and management of postharvest potat (Solanum Tuberosum L.) storage structures," *Ordu Journal of University of Science and Technology*, vol. 2, pp. 23-48, 2012. *View at Google Scholar*

[6] P. Hajong, M. M. Moniruzzaman, and M. I. A. Rahman, "Storage system of potato in Bangladesh," *Universal Journal of Agricultural Research*, vol. 2, pp. 11-17, 2014. *View at Google Scholar*

[7] K. U. Ahmad, "Potato post-harvest technology," in *Proceedings of the 2nd Workshop of Potato Research Workers. Bangladesh Agricultural Research Institute (BARI)*, Joydebpur, Dhaka, Bangladesh, 1979.

[8] M. Alauddin, "How to Increase cold storage capacity in Bangladesh," in *Proceedings of the 2nd Workshop of Potato Research Workers, BARI, Joydebpur. Dhaka, Bangladesh*, 1979.

[9] M. A. Hossain and M. M. A. Miah, "Post-Harvest losses and technical efficiency of potato storage systems in Bangladesh." Retrieved from http://www.nfpcsp.org/agridrupal/sites/default/files/Ayubfinal_Report_CF2.pdf, 2009.

[10] B. O. Libe, S. A. Pukumab, and C. E. Odo, "Principles and application of evaporative cooling systems for fruits and vegetables preservation," *International Journal of Current Engineering and Technology*, vol. 3, pp. 1000-1006, 2013. *View at Google Scholar*

[11] M. M. Hossain and M. S. Ali, *Potato storage and management (A Bangla Promotional Booklet).* Dhaka: Potato Programme of ATDP/IFDC, 2000.

[12] M. K. Chourasia, T. K. Goswami, and K. Chowdhury, "Temperature profiles during cold storage of bagged potato es: Effects of geometric and operating parameters," *Transactions of the ASAE*, vol. 42, pp. 1345-1351, 1999. *View at Google Scholar*

[13] L. A. Sanni, "Development of evaporative cooling storage system for vegetable crops," M.Sc. Project Report, Department of Agricultural Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria, 1999.

[14] P. S. Dahiya, V. S. khatana, S. G. Ilangantileke, and J. P. S. Dabas, "Potato storage patterns and practices in Meerut District, Western Uttar Pradesh, India. Patterns and Practices in Meerut District, Western Uttar Pradesh, India," *Social Science Department, Working Paper No. 1997-2, , International Potato Center (CIP). Lima, Peru*, 1996.