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Studies on the Performance of UC Davis Chimney Drier for Drying Different Fruits

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Abstract:

An observation on the performance of UC Davis Chimney Drier for different type of fruit crops through drying was carried out at BAU-GPC, Department of Horticulture, Bangladesh Agricultural University, Mymensingh, during January 2016-September 2016. Two banana varieties var. Mehershagar & Amritashagar and pineapple var. Giant Kew fruits were trialed. The collected fruits were washed by running tap water. Peeling off the hard rind of the fruits, then were sliced at reasonable thickness i.e. 0.5 cm, 1.0 cm. After that sliced fruits were placed on tray for drying. Some trays were placed under

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UC Davis Chimney Drier for study and some trays were placed on open condition as control. Under UC Davis Chimney Drier banana slices of 0.5 cm and 1.0 cm dried within 5 days and 6 days, respectively compared to open condition 7 days and 8 days. Temperature within UCD Chimney drier was recorded 47^{0}C to 66^{0}C and in open condition 26^{0}C to 36^{0}C respectively. The results revealed that fruits dried under UC Davis Chimney Drier in general, improved the dry matter & reducing sugar content (%) of fruits as compared to control. It was also observed that moisture content (%), titratable acidity and total sugar content increased under UC Davis Chimney Drier. Non-reducing sugar, reducing sugar content, total sugar content, titratable acidity content varied from each other at different treatments.

Key words: UC Davis Chimney Drier, variety, banana and pineapple.

INTRODUCTION

Fruit has been recognized as a good source of vitamins and minerals, and for their role in preventing vitamin C and vitamin A deficiencies. People who eat fruit as part of an overall healthy diet generally have a reduced risk of chronic diseases. USDA's MyPlate encourages making half your plate fruits and vegetables for healthy eating. Fruits and vegetables are highly valued in the human diet. Fruit are important sources of many nutrients, including potassium, fiber, vitamin C and folate (folic acid). Drying is defined as a process of moisture removal due to simultaneous heat and mass transfer. It is a classical method of food preservation, which provides longer shelf-lighter weight for transportation and small space for storage. The drying process takes place in two stages. The first stage happens at the surface of the drying material at constant drying rate and is similar to the vaporization of water into the ambient. The second stage takes place with decreasing (falling) drying rate. The condition of the second stage determined by the properties of the material being dried.

Drying of crop and fruit products is an important issue for the preservation and conservation of food. Using solar drying system is becoming a1n attractive and alternative food preservation technique over the conventional ones. Chowdhury *et al.,* (2011) presents an energy analysis of solar drying of jackfruit leather in a solar tunnel dryer. Gbaha *et al.,* (2006) designed a direct type natural convection solar dryer using local materials and then tested experimentally by drying cassava, bananas and mango slices. Bukola *et al.,* (2008) presented the design, construction and performance evaluation of a mixed-mode solar dryer for food preservation. The end point may occur before the steady state of the process is reached. In fact, this is preferable when the costs and time of the process are to be minimized. It is possible to operate a drying process to achieve steady state. This is achieved when the dryer's conditions (fruit's equilibrium moisture content) equals the desired result. This requires significant inputs to achieve namely time and energy (El-Sebaii et al., 2002). In practice, the operation of batch dryers is to continue the evaporation until the moisture content is equal to that required, at which point the process is stopped. The food and nutrition situation in Bangladesh is fragile due to inadequate and imbalanced diet intake. Moreover, the products are isolated from rain, storm, windborne dirt, dust, and infestation by insects, rodents and other animals. Chimney dryer is a newly developed technique to dry fruits and vegetables at low cost and minimum time. Chimney dryer has two parts one is drying chamber and another is chimney for exhausting. Drying chamber is constructed by wooden frame which is covered by black or dark color polyethylene. The product is placed on wooden trays along the length of the wooden frame. A clear plastic sheet placed over the trays traps the sun heat and drives water out of the product. The passive solar model designed by UC Davis Professors James Thompson and Michael Reid utilizes the chimney effect to dry products with increased air flow. They

have helped farmers build and test similar models in California, Thailand and Honduras. They were able to achieve excellent results with this incredibly low-cost and low-tech model for drying products like tomatoes and mangoes. The chimney dryer is very simple and can be built for less than $100. Thompson is optimistic the dryer design offers promising new low-tech solutions for farmers. According to Thompson, "The UC Davis Chimney Dryer is a significant improvement in solar drying technology. It heats the drying air like all solar dryers, but it also moves the air past the product at high speed. A chimney provides the air movement and the drying chamber design squeezes air through a small area so it flows five times faster than a typical cabinet drier. Chimney is also constructed by wooden frame which is covered by clear plastic and placed in front of the drying chamber. Four feet above the chimney making 2 feet hole in clear plastic to connect the drying chamber with chimney. The drying mechanism is drying chamber tapes sun heat and creating high speed of hot airflow and this hot air is passed above the product and emits through the chimney. Hence the present study was undertaken with the following objectives: to assess the quality of fruits after drying; to measure the moisture level for fruits preserve; to determine the effect of fruits thickness on chimney drying process; to analyze the nutrient content of fruits after drying; and to know the dry matter percentage (%) of dried fruit sample.

MATERIALS AND METHODS

Location

The experiments were conducted at the BAU Germplasm Centre (BAU-GPC) of the Department of Horticulture & Biochemistry laboratory of Bangladesh Agricultural University, Mymensingh - 2202 during the period from January to September 2016. The experimental area was under the subtropical climate characterized by heavy rainfall during the

months from May to July and scanty rainfall during the rest period of the year.

Preparation of chimney drier

The chimney drier was constructed by wooden frame. The basic materials needed for the drying section and chimney were; one sheet of 4 mil polyethylene film 10m×3m, a 7m×3m , sheet of black nonwoven fabric plus four 2.5m poles and about 4m of thin wood strips to stabilize the chimney poles. The clear plastic is held above the trays with a 6m pieces of wood positioned just above the trays.

Placement of chimney drier

Chimney drier was placed on the roof of the germplasm lab dormitory building at east-west direction for getting optimum light to dry the fruits thorough out the month.

Experimental design and treatments

The experiment was conducted in a Randomized Complete Block Design (RCBD) with 3 replications. Experiment 1: For banana, M: Drying condition (O_1= Open drying, U_1= chimney drying), V: variety (V_1= Mehershagar; V_2= Amritashagar), T: sliced thickness (T_1= 1.0 cm, T_2= 0.50 cm), Experiment 2: For pineapple, U: drying condition (U_1= Open drying,U_2= chimney drying), T: sliced thickness (T_1= 1.0 cm, T_2= 0.50 cm)

Method of drying

The experiment was conducted by two drying method. One was chimney drier method and another one was direct solar drying method. The sliced samples were placed in chimney drier and open condition separately.

Parameters

Temperature (^{0}C), Time to dry (Days), Thickness (cm), Moisture content (%), Dry matter content (%), Storage time, Total sugar

(%), Reducing sugar (%), Non-reducing sugar (%) and Titratable Acidity (%)

Statistical analysis

The collected data were analyzed by analysis of variance (ANOVA Table). A statistical computer package MSTATC was used for analyzing the data. The data were transformed whenever necessary following square root transformation.

RESULTS

Effect of temperature, moisture (%) and dry matter (%) on variety of banana & pineapple

Average temperature was higher (43.01^{0}C) for Amritashagar banana (V_2) than the Average temperature (38.47^{0}C) of Mehershagar banana (V_1) (Fig. 1).

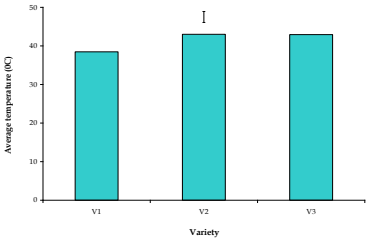

Fig. 1: Effect of average temperature on fruits variety. The vertical bar represents LSD at 1% level of probability. Here, V_1= Mehershagar banana, V_2= Amritashsgar banana, V_3=Pineapple.

Required time to dry was maximum (8.50 days) for pineapple (V_3) whereas minimum required time to dry was for Mehershagar banana (V_1) (Table 1). Moisture (%) was higher (93.99 %) for pineapple (V_3) than the moisture (%) (76.22 %) of Mehershagar banana (V_1). Dry matter content was higher (23.78%) for Mehershagar banana (V_1) whereas lower dry matter content (%) was lower (6.01%) for pineapple (V_3)

Table 1: Effect of variety on required time to dry & dry matter content (%)

Variety	Initial wt (g)	Required Time to Dry	Final wt (g)	Dry matter content (%)
V_1	475.08	5.80	103.47	23.78
V_2	538.83	6.57	90.20	19.13
V_3	1282.08	8.55	71.60	6.01
$LSD_{0.05}$	2.11	0.027	2.98	0.276
$LSD_{0.01}$	2.85	0.036	4.04	0.374
Level of significance	**	**	**	**

** = Significant at 1% level of probability

V_1 = Mehershagar banana, V_2 = Amritashagar banana, V_3 = Pineapple

Effect of temperature, moisture content and dry matter content on condition

It was observed that condition had significant influence on temperature. Here, the higher temperature was (51.09^0C) for UCD Chimney Drier than open condition (31.85^0C) (Fig. 2).

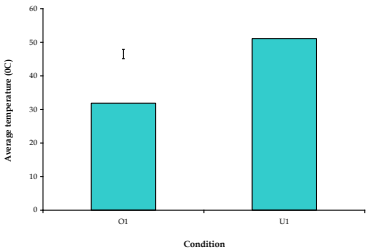

Fig.2: Effect of average temperature on condition. The vertical bar represents LSD at 1% level of probability. Here, O_1= Open condition, U_1= UCD Chimney dry.

Moisture content was high in open condition compare to UCD Chimney Drier (Table 2). Dry matter content was higher (25.98%) for Mehershagar banana under chimney drier condition than the dry matter content was lower (5.51%) for pineapple open condition (V_3O_1).

Table 2: Effect of required time to dry on condition

Condition	**Initial wt (g)**	**Required Time to Dry (Day)**	**Final wt (g)**
O_1	775.61	7.97	82.01
U_1	755.06	5.97	94.83
$LSD_{0.05}$	1.72	0.022	2.44
$LSD_{0.01}$	2.33	0.029	3.30
Level of significance	**	**	**

** = Significant at 1% level of probability
O_1 = Open condition, U_1 = UCD Chimney drier condition

Combined effects of average temperature, moisture (%) and dry matter content (%) on variety and condition

Average temperature was higher (53.74^{0}C) for Amritashagar banana under UCD Chimney drier condition (V_2U_2) than Mehershagar banana under UCD Chimney drier condition (46.06^{0}C) whereas average temperature was higher (32.40^{0}C) for pineapple (V_3O_1) under open condition and lower (30.88^{0}C) for Mehershagar banana under open condition (30.88^{0}C) (Table 3). Moisture (%) was maximum (94.49%) for pineapple open condition (V_3O_1) and minimum moisture (%) was in Mehershagar banana under chimney drier condition. Dry matter content was higher (25.98%) for Mehershagar banana under chimney drier condition than the dry matter content (%) was lower (5.51%) for pineapple open condition (V_3O_1) (Table 3).

Table 3: Combined effects of average temperature, moisture (%) and dry matter content (%) on variety and condition

Variety x Condition	Initial wt (g)	Average temperature (^{0}C)	Required Time to Dry (Day)	Final wt (g)	Moisture (%)	Dry matter content (%)
V_1O_1	471.17	30.88	6.79	97.81	78.42	21.58
V_1U_2	479.00	46.06	4.81	109.13	74.02	25.98
V_2O_1	546.17	32.29	7.59	78.66	84.40	15.61
V_2U_2	531.50	53.74	5.55	101.73	77.35	22.65
V_3O_1	1309.50	32.40	9.53	69.55	94.49	5.51
V_3U_2	1254.67	53.47	7.57	73.64	93.49	6.51
$LSD_{0.05}$	2.98	0.053	0.038	4.22	0.399	0.390
$LSD_{0.01}$	4.04	0.072	0.051	5.72	0.540	0.528
Level of significance	**	**	*	**	**	**

** = Significant at 1% level of probability, * = Significant at 5% level of probability

Effect of average temperature and required time to dry on thickness

Average temperature was higher (41.70^{0}C) for 1 cm thickness of banana and lower (41.24^{0}C) for 0.5 cm thickness of banana (Fig. 3).

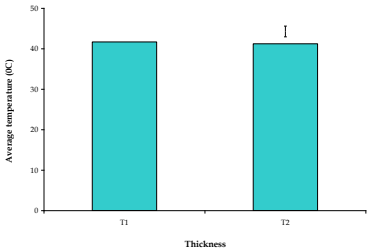

Fig. 3: Effect of average temperature on thickness**.** The vertical bar represents LSD at 1% level of probability. Here, T_1= 0.5 cm, T_2=1.0 cm.

1.0 cm thickness of fruit slices required higher days (7.44 days) to dry and 0.50 cm thickness of fruit slices required lower days (6.44 days) to dry properly (Table 4)**.** It was observed that dry matter content was high in 0.5 cm thickness of banana whereas 11.69% of dry matter in 1.0 cm thickness of banana. Moisture content was high in 1.0 cm thickness of banana whereas 0.5 cm thickness of banana contained low moisture.

Table 4: Effect of required time to dry on thickness

Thickness	Initial wt (g)	Required Time to Dry (Day)	Final wt (g)
T_1	1023.94	7.44	95.08
T_2	506.72	6.50	81.77
$LSD_{0.05}$	1.72	0.022	2.44
$LSD_{0.01}$	2.33	0.029	3.30
Level of significance	**	**	**

** = Significant at 1% level of probability

T_1 = 1.0 cm thickness, T_2 = 0.5 cm thickness

Combined effects of average temperature, required days to dry, moisture (%) and dry matter content (%) on variety and thickness

1.0 cm thickness of Amritashagar banana (V_2T_1) had higher average temperature (43.28^{0}C) and lower average temperature (38.18^{0}C) in Mehershagar banana of 0.50 cm thickness (V_1T_2) (Table 5). 1.0 cm thickness of pineapple (V_3T_1) required higher days to dry (9.00 days) whereas 0.50 cm thickness of Mehershagar banana (V_1T_2) required lower days to dry (5.33 days). 1.0 cm thickness of pineapple (V_3T_1) had higher

percentage (%) of moisture (95.21%) than 0.5 cm thickness of Mehershagar banana (V_1T_2) had lower moisture (%) (70.71%). 0.50 cm thickness of Mehershagar banana (V_1T_2) had higher dry matter content (%) (29.29%) whereas 1.0 cm thickness of pineapple (V_3T_1) had lower percentage (%) of dry matter content (%) (4.79%). Christinal and Tholkkappian (2012) mentioned in their report that chili dried by sun and mechanical dryer at 37^0C gave higher vigor index, germination, root length, shoot length, seedling dry weight, and lower electrical conductivity, moisture content.

Table 5: Combined effects of average temperature, required days to dry, moisture (%) and dry matter content (%) on variety and thickness

Variety x Thickness	Initial wt (g)	Average temperature (^{0}C)	Required Time to Dry (Day)	Final wt (g)	Moisture (%)	Dry matter content (%)
V_1T_1	641.83	38.76	6.33	117.12	81.73	18.27
V_1T_2	308.33	38.18	5.27	89.83	70.71	29.29
V_2T_1	717.00	43.28	7.00	86.07	88.00	12.00
V_2T_2	360.67	42.74	6.14	94.33	73.75	26.25
V_3T_1	1713.00	43.06	9.00	82.06	95.21	4.79
V_3T_2	851.17	42.81	8.11	61.14	92.77	7.23
$LSD_{0.05}$	2.98	0.053	0.038	4.22	0.399	0.390
$LSD_{0.01}$	4.04	0.072	0.051	5.72	0.540	0.528
Level of significance	**	**	**	**	**	**

** = Significant at 1% level of probability

Combined effects of average temperature, required time to dry, moisture (%) and dry matter content (%) on condition and thickness

1.0 cm thickness of fruit slices under UCD Chimney drier condition (U_1T_1) had higher average temperature (51.39^0C) whereas 0.5 cm thickness of fruit slices under open condition (O_1T_2) had lower average temperature (31.70^0C). 1.0 cm thickness of fruit slices under open condition (O_1T_1) had higher days to dry (8.44 days) whereas 0.5 cm thickness of fruit slices under UCD Chimney drier condition (U_1T_2) had lower days to dry (6.44 days) (Table 6). 1.0 cm thickness of fruit slices under UCD Chimney drier condition (U_1T_1) had higher moisture (%)

(88.64%) whereas 0.5 cm thickness of fruit slices under UCD Chimney drier condition (U_1T_2) had lower moisture (%) (74.60%). 0.5 cm thickness of fruit slices under UCD Chimney drier condition (U_1T_2) had higher dry matter content (%) (25.40%) whereas 1.0 cm thickness of fruit slices under UCD Chimney drier condition (U_1T_1) had lower percentage (%) of dry matter content (11.36%).

Table 6: Combined effects of average temperature, required days to dry, moisture (%) and dry matter content (%) on condition and thickness.

Condition x Thickness	Initial wt (g)	Average temperature (^{0}c)	Required Time to Dry (Day)	Final wt (g)	Moisture (%)	Dry matter content (%)
O_1T_1	1032.33	32.01	8.44	97.57	87.99	12.01
O_1T_2	518.89	31.70	7.50	66.45	83.55	16.45
U_1T_1	1015.56	51.39	6.44	92.59	88.64	11.36
U_1T_2	494.56	50.79	5.51	97.08	74.60	25.40
$LSD_{0.05}$	2.43	0.044	0.031	3.44	0.326	0.318
$LSD_{0.01}$	3.30	0.059	0.042	4.67	0.441	0.431
Level of significance	**	**	NS	**	**	**

** = Significant at 1% level of probability, NS = Not significant

Combined effects of average temperature, required days to dry, moisture (%) and dry matter content (%) on variety, condition and thickness

1.0 cm thickness of Amritashagar banana under UCD Chimney drier condition ($V_2U_1T_1$) had higher average temperature (54.09^{0}C) whereas 0.5 cm thickness of Mehershagar banana under open condition ($V_1O_1T_2$) had lower average temperature (30.69^{0}C) (Table 7). 1.0 cm thickness of pineapple under open condition ($V_3O_1T_1$) required higher days to dry (10.00 days) whereas 0.5 cm thickness of Amritashagar banana under UCD Chimney drier condition ($V_2U_1T_2$) required lower days to dry (5.00 days). 1.0 cm thickness of pineapple under UCD Chimney drier condition ($V_3U_1T_1$) had higher moisture (95.36%) whereas 0.5 cm thickness of Amritashagar banana under UCD Chimney drier condition ($V_2U_1T_2$) had lower moisture (65.49%). 0.5 cm thickness of Amritashagar banana under UCD Chimney drier condition ($V_2U_1T_2$) had higher dry matter content (34.51%)

whereas 1.0 cm thickness of pineapple under UCD Chimney drier condition ($V_3U_1T_1$) had lower percentage of dry matter content (4.64%).

Table 7: Combined effects of average temperature, required days to dry, moisture (%) and dry matter content (%) on variety, condition and thickness

Variety x condition x Thickness	Initial wt (g)	Average temperature (^{0}C)	Required Time to Dry (Day)	Final wt (g)	Moisture (%)	Dry matter content (%)
$V_1O_1T_1$	625.00	31.06	7.33	119.26	80.91	19.09
$V_1O_1T_2$	317.33	30.69	6.26	76.37	75.93	24.07
$V_1U_1T_1$	658.67	46.45	5.33	114.97	82.54	17.46
$V_1U_1T_2$	299.33	45.67	4.29	103.29	65.49	34.51
$V_2O_1T_1$	727.67	32.47	8.00	87.37	87.99	12.01
$V_2O_1T_2$	364.67	32.10	7.18	69.95	80.80	19.20
$V_2U_1T_1$	706.33	54.09	6.00	84.76	88.01	11.99
$V_2U_1T_2$	356.67	53.38	5.10	118.70	66.70	33.30
$V_3O_1T_1$	1744.33	32.49	10.00	86.07	95.06	4.94
$V_3O_1T_2$	874.67	32.30	9.07	53.03	93.92	6.08
$V_3U_1T_1$	1681.67	53.63	8.00	78.04	95.36	4.64
$V_3U_1T_2$	827.67	53.31	7.14	69.24	91.62	8.38
$LSD_{0.05}$	4.21	0.075	0.053	5.97	0.564	0.551
$LSD_{0.01}$	5.71	0.102	0.072	8.08	0.764	0.747
Level of significance	**	**	*	**	**	**

** = Significant at 1% level of probability, * = Significant at 5% level of probability

Nutritional analysis of Mehershagar, Amritashagar banana and pineapple of their dried sample

It was observed that variety had significant influence on titratable acidity (Table 8). Titratable acidity was higher (4.69%) in Amritashagar banana (V_2) whereas lower (3.28%) in pineapple (V_3) sample. Total sugar content was higher (26.24%) in pineapple (V_3) sample than the Amritashagar banana (V_2) in lower (21.42%).

Reducing sugar content was higher (4.10%) in Mehershagar banana (V_1) whereas Amritashagar banana (V_2) in lower reducing sugar content (21.42%) (Fig. 4).

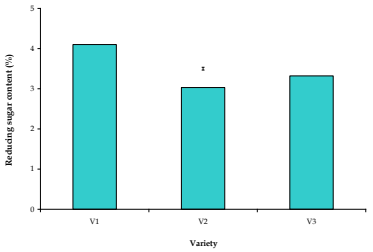

Fig. 4: Effect of reducing sugar content on fruits variety. The vertical bar represents LSD at 1% level of probability. Here, V_1= Mehershagar banana, V_2= Amritashsgar banana, V_3=Pineapple.

Non-reducing sugar content was higher (19.46%) in Mehershagar banana (V_1) whereas Amritashagar banana (V_2) in lower reducing sugar content (18.39%) (Fig. 5).

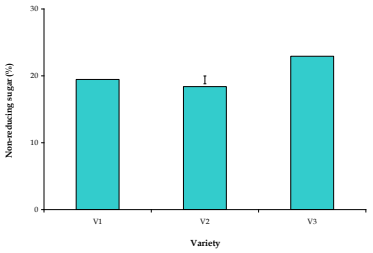

Fig. 5: Effect of non-reducing sugar content on fruits variety. The vertical bar represents LSD at 1% level of probability. Here, V_1= Mehershagar banana, V_2= Amritashsgar banana, V_3=Pineapple.

Table 8: Effect of titratable acidity on variety

Variety	**Titratable acidity (%)**
V_1	3.85
V_2	4.69
V_3	3.28
$LSD_{0.05}$	0.113
$LSD_{0.01}$	0.153
Level of significance	**

** = Significant at 1% level of probability

V_1 = Mehershagar banana, V_2 = Amritashagar banana, V_3 = Pineapple

Effect of titratable acidity (%), total sugar (%), reducing sugar (%) and non-reducing sugar (%) on condition

It was observed that condition had significant influence on titratable acidity. Titratable acidity was higher (5.45%) in open condition (O_1) than UCD Chimney drier condition (U_1) (Table

9). Total sugar content was higher (26.62%) under open condition (O_1) and lower (20.86%) under UCD Chimney drier condition (U_1)**.** (Fig. 6)

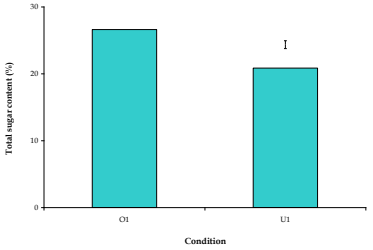

Fig. 6: Effect of total sugar content on condition. The vertical bar represents LSD at 1% level of probability. Here, O_1= Open condition, U_1= UCD Chimney dry.

Reducing sugar content was higher (3.65%) under open condition (O_1) and lower (3.31%) under UCD Chimney drier condition (U_1) (Fig. 7)**.**

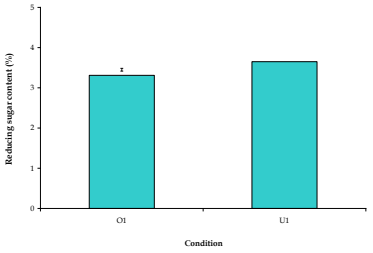

Fig. 7: Effect of reducing sugar content on condition. The vertical bar represents LSD at 1% level of probability. Here, O_1= Open condition, U_1= UCD Chimney dry.

Non-reducing sugar content was higher (23.31%) under open condition (O_1) and lower (17.21%) under UCD Chimney drier condition (U_1) (Fig. 8)**.**

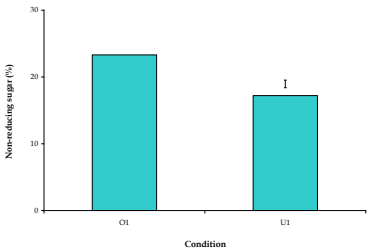

Fig. 8: Effect of non- sugar content on condition. The vertical bar represents LSD at 1% level of probability. Here, O_1= Open condition, U_1= UCD Chimney dry.

Table 9: Effect of titratable acidity on condition

Condition	**Titratable acidity (%)**
O_1	5.45
U_1	2.42
$LSD_{0.05}$	0.092
$LSD_{0.01}$	0.125
Level of significance	**

** = Significant at 1% level of probability
O_1 = Open condition, U_1 = UCD Chimney drier condition

Combined effects of titratable acidity (%), total sugar (%), reducing sugar (%) and non-reducing sugar (%) on variety and condition

Titratable acidity was higher (8.74%) under open condition of Amritashagar banana (V_2O_1) whereas lower (0.64%) under UCD Chimney drier condition for Amritashagar banana(V_2U_2)(Table 10). Total sugar content was higher (30.97%) under open condition for pineapple (V_3O_1) whereas lower (18.18 %) under UCD Chimney drier condition for Amritashagor banana (V_2U_2). Reducing sugar content was higher (4.13%) under UCD Chimney drier condition for Mehershagor banana (V_1U_2) and lower (2.88%) under UCD Chimney drier condition for Amritashagor banana (V_2U_2). Non-reducing sugar content was higher (28.29%) under UCD Chimney drier condition for pineapple whereas lower (15.30%) under UCD Chimney drier condition for Amritashagor banana (V_2U_2). Haque (1979)

studied the jackfruits from ten selected plants grows in Bangladesh Agricultural University Campus and its surrounding villages were subjected to chemical analysis for the composition of their perianths which included total soluble solids, reducing sugar and non-reducing sugar where the average total sugar, reducing sugar and non-reducing sugar contents of jackfruits found 19.26%, 10.00% and 9.26% respectively; while range of total sugar (15.38 to 26.30), reducing sugar (5.98 to 18.12) and non-reducing sugar (3.98-14.61) percent respectively.

Table 10: Combined effects of titratable acidity (%), total sugar (%), reducing sugar (%) and non-reducing sugar (%) on variety and condition

Variety x Condition	Titratable acidity (%)	Total Sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)
V_1O_1	4.22	24.23	4.08	20.16
V_1U_2	3.48	22.89	4.13	18.76
V_2O_1	8.74	24.67	3.18	21.49
V_2U_2	0.64	18.18	2.88	15.30
V_3O_1	3.41	30.97	2.68	28.29
V_3U_2	3.15	21.52	3.96	17.56
$LSD_{0.05}$	0.160	0.282	0.119	0.274
$LSD_{0.01}$	0.217	0.382	0.161	0.372
Level of significance	**	**	**	**

** = Significant at 1% level of probability

Effect of titratable acidity (%), total sugar (%), reducing sugar (%) and non-reducing sugar (%) on thickness

It was observed that thickness had significant influence on titratable acidity (Table 10). Titratable acidity was higher (4.22%) in 1.0 cm of thickness (T_1) whereas lower (3.65%) in 0.5 cm of thickness (T_2). Total sugar content was higher (26.99%) in 1.0 cm of thickness (T_1) and lower (20.49%) in 0.5 cm of thickness (T_2) (Fig. 9).

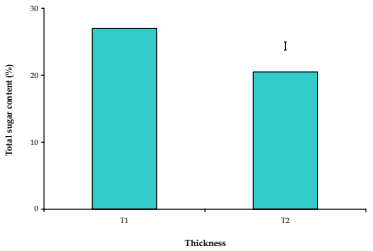

Fig. 9: Effect of total sugar content on thickness. The vertical bar represents LSD at 1% level of probability. Here, T_2= 0.5 cm, T_1=1.0 cm.

Reducing sugar content was higher (4.51%) in 0.5 cm of thickness (T_2) and lower (2.46%) in 1.0 cm of thickness (T_1) (Fig. 10).

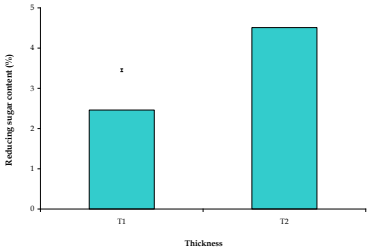

Fig. 10: Effect of reducing sugar content on thickness. The vertical bar represents LSD at 1% level of probability. Here, T_1= 0.5 cm, T_2=1.0 cm.

Non-reducing sugar content was higher (24.53%) in 1.0 cm of thickness (T_1) and lower (15.99%) in 0.5 cm of thickness (T_2) (Fig. 11).

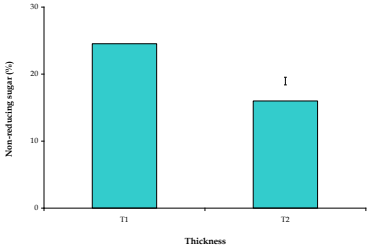

Fig. 11: Effect of non-reducing sugar content on thickness. The vertical bar represents LSD at 1% level of probability. Here, T_1= 0.5 cm, T_2=1.0 cm.

Table 11: Effect of titratable acidity (%) on thickness

Thickness	Titratable acidity (%)
T_1	4.22
T_2	3.65
$LSD_{0.05}$	0.092
$LSD_{0.01}$	0.125
Level of significance	**

** = Significant at 1% level of probability

T_1 = 1.0 cm, T_2 =0.5 cm

PANEL TEST

Panel test on banana cv. Mehershagar

After six months of storage banana cv. Mehershagar slices both from UCD Chimney Drier and open conditions were tested by the post graduate students and faculties of BAU. Panel test had been conducted among 48 persons. The summary of panel test's result given below. After six months storage banana slices dried under UCD Chimney Drier showed bright and quality compared to open conditions irrespective of thickness (Table 12).

Table 12: Panel test on appearance of the slices after six months of storage cv. Mehershagar

Thickness (Cm)	Drying Method	Appearance (%)			
		Excellent	Good	Fair good	Not good
1.00	UCD	25	25	33.33	16.67
	OPEN	0	8.33	25	66.67
0.50	UCD	16.67	41.67	9.33	33.33
	OPEN	0	25	16.67	58.33

Regarding taste, banana slices dried under UCD Chimney Drier showed better than open conditions (Table 13)

Table 13: Panel test on taste of the slices after six months of storage cv. Mehershagar

Thickness (Cm)	Drying Method	Taste (%)			
		Excellent	Good	Fair good	Not good
1.00	UCD	41.67	41.67	8.33	8.33
	OPEN	8.33	25	8.33	58.54
0.50	UCD	33.33	50.00	16.67	0
	OPEN	0	33.33	16.67	50.00

Panel test on banana cv. Amritashagar

After six months of storage banana cv. Amritashagar slices both from UCD Chimney Drier and open conditions were tested by the post graduate students and faculties of BAU. Panel test had been conducted among 55 person.The summary of panel test's result given below. After six months storage banana slices dried under UCD Chimney Drier showed bright and quality compared to open conditions irrespective of thickness (Table 14)

Table 14: Panel test on appearance of the slices after six months of storage cv. Amritashagar

Thickness (Cm)	Drying Method	Appearance (%)			
		Excellent	Good	Fair good	Not good
1.00	UCD	25	33.33	33.33	8.33
	OPEN	0	8.33	25	66.67
0.50	UCD	25	41.67	16.67	16.67
	OPEN	0	25	16.67	58.33

Regarding taste, banana slices dried under UCD Chimney Drier showed better than open conditions (Table 15)

Table 15: Panel test on taste of the slices after six months of storage cv. Amritashagar

Thickness (Cm)	Drying Method	Taste (%)			
		Excellent	Good	Fair good	Not good
1.00	UCD	41.67	41.67	8.33	8.33
	OPEN	8.33	8.33	25	58.34
0.50	UCD	33.33	50.00	8.33	8.33
	OPEN	0	33.33	16.67	50.00

DISCUSSION

Effect of Thickness

The experiment was conducted with two levels of Thickness (0.5 cm & 1.0 cm). 0.5 cm thickness of fruits produced higher dry matter content (34.51%) than the 1.0 cm thickness of fruits (4.94%). 1.0 cm of thickness fruit slices required more days(7.44 days) to dry than 0.5 cm of thickness of fruits (6.50 days). Moisture percentage was more in 1.0 cm thickness of fruits (88.31%) on the contrary to 0.5 cm of thickness of fruits

(79.08%). Mehershagar banana required less days to dry (5.27 days) whereas pineapple needed to dry more days (9.00 days). In open condition 0.5 cm thicknesses of fruits required 7.50 days where 1.0 cm thickness of fruits required 8.44 days. But in case of chimney drier both thickness (0.5 cm & 1.0 cm) of fruits required less days to dry than open condition i.e. 5.51 days & 6.44 days respectively.

Effect of Condition

The variations due to different conditions under the study were highly significant (Table 2). For open condition (O_1) average temperature was less (31.85^{0}c) than the UCD Chimney drier condition (U_1) (51.09^{0}c). As average temperature was high in case of UCD Chimney drier condition (U_1) so it required less days to dry (5.97 days) than open condition (O_1) (7.97 days). Dry matter content was high (18.38 %) but moisture (%) was low (81.62%) for UCD Chimney drier condition (U_1) and vice – versa of open condition (O_1) e.g. Dry matter content was low (14.23 %) but moisture (%) was high (85.77%). Among the three varieties of fruits pineapple under open condition percentage moisture had high (94.49%) so it's dry matter content was lowest (5.51%) among the fruit varieties.

Effect of Variety

Varietal effect has significant influence on average temperature, required days to dry, moisture content (%) and dry matter content (%). In case of Mehershagar banana it required 5.80 days to dry which was lowest among all varieties. Moisture content (%) was 76.22% and dry matter content (%) was 23.78% for Mehershagar banana. But in case of Amritashagar banana it required highest average temperature (43.01) to dry. Dry matter content was lowest in case of pineapple (6.01%).

Nutritional analysis

Titratable acidity was higher (4.690%) in Amritashagar banana (V_2). Total sugar percentage, reducing sugar and non-reducing sugar for Amritashagar banana (V_2) was 21.42%, 3.03% & 18.39% respectively. Total sugar as well as non-reducing sugar was higher (26.24%) & (22.93%) in pineapple (V_3) respectively. But in case of condition, UCD Chimney drier condition (U_1) had lower titratable acidity (2.42%), total sugar content (20.86%) and non-reducing sugar (17.21%) whereas only reducing sugar content was higher (3.65%) compare to open dry condition. 1.0 cm thickness of fruit slices had higher titratable acidity (4.22%) and reducing sugar content (4.51%). On the other hand 0.50 cm thickness of fruit slices had higher total sugar content (26.99%) and non-reducing sugar content (24.53%).

Panel test

From the above results it could be easily said that the dried sample under chimney drier had more acceptance comparison to open condition. Although their appearance were not good at all but the taste both of them differed from one another. In case of cv. Mehershagar 1.00 cm & 0.5 cm thickness of banana under UCD Chimney drier 41.67% acceptance for 0.5 cm thickness of banana on appearance which was denoted as good. But in open condition both 0.5 cm & 1.0 cm thickness of banana 66.67% denoted as not good. The dried sample under chimney drier 41.67% denoted as excellent for 1.0 cm thickness of banana having taste but 50% denoted as good for 0.5 cm thickness of banana. In open condition both of the thickness (1.0 cm & 0.5 cm) had no acceptancy on appearance and taste for banana var. Mehershagar. In case of var. Amritashagar, between the thickness of 0.5 cm & 1.0 cm drying by UCD had more appearance compared to open condition. 41.67% people denoted as good by observing it's physical appearance but 50% people remarked as good by testing its dry matter content of 0.5 cm thickness of var. Amritashagar banana. According to overall

condition under UCD Chimney drier 0.5 cm thickness of banana had more acceptancy compared to 1.0 cm thickness of banana between the two varieties i.e. var. Amritashagar and var. Mehershagar.

CONCLUSION

This experiment was conducted to investigate the performance of UC Davis Chimney Drier for drying different type of fruits. It may be concluded that thickness of 0.50 cm gave better dry matter content (%) and required less days to dry compare to 1.0 cm thickness of sliced fruits. In case of condition UCD Chimney drier was very helpful to dry in advance than open condition. Color of the dried sample of fruits was more attractive under UCD Chimney drier. Moisture content (%) was very high in open condition than UCD Chimney drier. Reducing sugar (%) was high in UCD Chimney drier. So it may be recommended that to get high amount of reducing sugar UCD Chimney drier system may be used to dry. After all UCD Chimney drier system may be suggested to use in case of early drying or within short period of time rather than conventional drying method. Panel test of dried fruits under UCD Chimney drier had higher acceptability compared to open condition. 0.5 cm thickness of banana's dried slices under UCD Chimney Drier had higher appearance (%) & taste value (%). So it may be recommended that UCD Chimney Drier would be helpful to dry fruit specimens compared to open condition drying method.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper

REFERENCES

1. Bukola O, Bolaji and Ayoola P Olalusi (2008): Performance Evaluation of a Mixed-Mode Solar Dryer 11(4) 225-231.
2. Chowdhury MMI, Bala BK, Haque MA 2011: Research paper, energy and exergy analysis of the solar drying of jackfruit leather.
3. Christinal V Tholkkappian P 2012: Seed quality in chili influenced by the different types of drying methods.
4. El-Sebaii AA, Aboul-Enein S, Ramadan MRI, El- Gohary HG 2002: Empirical correlations for drying kinetics of some fruits and vegetables. Energy 27(9) 845- 859.
5. Gbaha P, Yobouet Andoh H, Kouassi Saraka, J Kamenan Koua B, Toure S 2006: Experimental investigation of a solar dryer with natural convective heat flow. *Renewable Energy*. In Press, Corrected Proof.
6. Haque MA 1979: Nutritive value of jackfruit. *Bangladesh Journal of Agricultural Science 4*(1) 9-12.