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Studies on the performance of UC Davis chimney dryer on drying of jackfruit leather

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ABSTRACT

An observation on the performance of UCD (University of California, Davis) chimney dryer on drying of leather was carried out at BAU–GPC, Bangladesh Agricultural University, Mymensingh, during February 2017-October 2017. Puree juice was prepared from two jackfruit varieties (*viz.* BAU Kathal–1, BAU Kathal–2) and placed on dryer trays with 0.50 cm and 1.0 cm thickness. The pureed juice was dried under two conditions, *viz.* UC Davis chimney dryer or at open condition with net (control). Required times to dry the jackfruit leather were significantly less (8.25 days) under UCD chimney dryer condition than that with net condition (12.75 days). Higher dry matter content (15.84%), final TSS (38.17 Brix%), storage time (247.75 days) were found in UCD chimney dryer than the those of net condition (13.67%, 0.0% and 24.42 days, respectively). Relative humidity and moisture content were higher (61.25% and 86.33%, respectively) in open with net than the UCD chimney dryer (44.79% and 84.16%, respectively). Leather thickness of 0.50 cm required less time (9.33 days) to dry than those with 1.0 cm thickness (11.67 days). Higher dry matter (18.22%) and longer storage (137.42 days) were observed with 0.50 cm leathers than those of 1.0 cm thick leather (11.29% and 134.75 days, respectively). The panel test confirmed higher quality of jackfruit leather (55.0% aroma, 57.0% color and 51.0% taste) under UCD chimney dryer than open with net condition (35.83%, 34.0% and 33.34%, respectively). Leather thickness of 0.50 cm gave higher values in panel test (50.0% aroma, 47.50% color and 48.0% taste) than those with 1.0 cm (40.48%, 44.0% and 36.33% respectively) thickness of jackfruit leather.

Keywords: UC Davis chimney dryer, variety, jackfruit leather, storage

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1 Introduction

Jackfruits is the largest of all cultivated fruits. It is oblong to cylindrical and typically 30 to 40 cm in length, although it can sometimes reach 90 cm. Jackfruits usually weigh 4.5 to 30 kg (commonly 9 to 18 kg), with a maximum reported weight of 50 kg. It is a multiple aggregate fruit (i.e. it is formed by the fusion of multiple flowers in an inflorescence). Jackfruit has been reported to contain high levels of protein, starch, calcium, and thiamine (Burkhill, 2000). The bulbs (excluding the seeds) are rich in sugar, fairly well in carotene and also contain vitamin C (Bhatia et al., 1955).

A recent study on postharvest losses in both industrialized and developing nations revelaed that farmers lose over 40% of the value of their produce before it reaches the final consumer (Gustavsson et al.,

2011) especially during the peak harvest period there is often a significant overabundance of produce. In developing countires, the surplus harvest cannot be stored for long periods due to unavailability of cold storage or other infra-strcutures (Stiling et al., 2012). Therefore, there is a need to inexpensively preserve produce postharvest. Among the various methods of produce preservation available, solar drying has commonly been accepted as the simplest and least expensive technique and is a resource that is underutilized in many areas (Mwithiga and Kigo, 2006; Bolaji and Olalusi, 2008). Such drying under hostile climate conditions leads to severe losses in the quantity and quality of the dried product. These losses related to contamination by dirt, dust and infestation by insects, rodents and animals (Madhlopa et al., 2002).

Many attempted have been made to overcome the limitaitons of open solar drying system. Chimney dryer is a newly developed technique to dry fruits and vegetables at low cost and minimum time. This passive solar model designed by Professors James Thompson and Michael Reid of the University of California, Davis (Reid and Thompson, 2008) utilizes the chimney effect to dry products with increased air flow.

The present study was undertaken to determine how thickness of jackfruit layer and drying condition affect the qaulity and preservation quality of dried jacfruit leather.

2 Materials and Methods

The experiment was conducted at the BAU Germplasm Centre (BAU–GPC) (24°43′4.0″N, 90°25′51.5″E) of Bangladesh Agricultural University during the period from February to October 2017. The chimney dryer was constructed by wooden frame. The basic materials needed for the drying section and chimney were; one sheet of 4 mm polyethylene film 10 m × 3 m, 7 m × 3 m , sheet of black nonwoven fabric plus four 2.5 m poles and about 4 m of thin wood strips to stabilize the chimney poles. The clear plastic was held above the trays with a 6 m pieces of wood positioned just above the trays.

Chimney dryer was placed on the roof of the germplasm dormitory building at east-west direction for getting optimum light to dry the fruits thorough out the month. The experiment was conducted by two drying method. One was chimney dryer method and another one was sun drying (open with net condition) method. Mature (ripe) jackfruits of two varieties (BAU Kathal–1 and BAU Kathal–2) for leather preparation were collected from BAU–GPC to evaluate the performance of UC Davis chimney dryer and injuries, damage and rotten products were separated from the good one. Jackfruits leathers are made by pouring pureed juices into a flat surface for drying when dried the juices is pulled from the surface and rolled. It gets the name 'Leather' from the fact that when pureed juice is dried, it's shiny and has the texture of leather. Jackfruits juices were extracted manually from jackfruits. Leather was prepared from the jackfruits juices. Then the cleaned jackfruits juices for leather were placed (trays) in chimney dryer and open with net condition for drying with desired thickness at 1.0 cm and 0.50 cm separately.

The experiment was conducted in a randomized complete block design (RCBD) with 3 replications. The experiment consisted of three factors, *viz.* M: drying condition (C1: chimney drying and C2: open with net,); V: variety (V1 = BAU Kathal-1,V2 = BAU Kathal-2); and T: slice thickness (T1 = 1.0 cm, T2 = 0.50 cm). The following parameters were studied e.g; required time to dry (d), drying temperature (°C), moisture content (%), dry matter content (%), relative humidity (%), total soluble sugar (Brix %) (initial and final) and storage time (d). Thermometers and hygrometers were used for taking temperature and humidity data daily until the samples dried. Moisture content (MC) was calculated according to the following formula and expressed as percentage.

$$MC\ (\%) = \frac{IW - FW}{IW} \times 100 \qquad (1)$$

where, IW = initial weight of sample before chimney and open with net drying (g) and FW = final weight of sample after chimney and open with net drying (g).

The products were meshed into a mortar and a drop of from these was placed on the prism of the refractometer and percent of total soluble solids were obtained from direct reading. The drying leather were preserved in air tight polythene bag at room temperature for nine months. Panel test was conducted of jackfruit leather from UCD chimney dryer and open with net conditions by the under graduate students, post graduate students and respected teachers of BAU by considering (smelling, visual observation and tasting) the aroma (%), color (%) and taste (%) after the nine month storage periods.

The collected data were analyzed by analysis of variance. A statistical computer package MSTAT–C was used for analyzing the data. The analysis was performed by F-test and significance of the difference between pairs of lines means was evaluated by the Least Significance Difference (LSD) test at 5% and 1% level of probability.

3 Results

3.1 Storage quality

3.1.1 Varietal difference

Average temperature was higher (47.30 °C) for V2 than V1 (44.21 °C) (Table 1). Required time to dry was

(a) Open chimney dryer (b) Chimney dryer trays (c) Prepared chimney

(d) Jackfruit pulp (e) Jackfruit juice under chimney dryer (f) Open with net drying condition

Figure 1. Different steps of drying jackfruit juice under UC Davis chimney dryer and open with net drying condition

maximum 11.25 d for V1 whereas minimum required time to dry was 9.75 d for V2 (Table 1). Moisture content was higher (85.39%) for V2 than that of V1 (85.11%). Dry matter content was higher (14.89%) for V1 whereas lower dry matter content was recorded (14.62%) for V2. Initial TSS was higher (21.58%) for V1 and lower (20.25%) for V2 variety. Final TSS was higher (21.58%) for V1 and lower (20.25%) for V2. Relative humidity was higher (53.35%) for V1 whereas lower relative humidity (%) was 52.96% for V2. Storage times were higher (143.08 d) for V1 whereas lower storage time was (129.08 d) for V2 varieties.

3.1.2 Effect of drying condition

There was higher temperature requirement (64.28 °C) for UCD chimney drying condition than that of the open condition (30.23 °C). Storage time was higher (247.75 d) under chimney dryer condition than the open with net condition (24.42 d). It was observed that drying condition had significant influence on required times to dry. Required times to dry was higher (12.75 d) in open with net condition compare to UCD chimney drying condition (8.25 d) (Table 1). Moisture content was high in open condition (86.33%) compare to UC Davis chimney dryer (84.16%). Final TSS was higher (38.17%) under UCD chimney drying condition than the open-net condition (0.0%). Relative humidity was higher (61.52%) under open with condition than the UCD chimney drying condition (44.79%). Dry matter content was higher (15.84%) under UCD chimney drying condition than the dry matter content in open with net condition (13.67%).

3.1.3 Variety and drying condition interaction

Average temperature was higher (64.72 °C) for V1 under UCD chimney drying condition than V2 (63.83 °C). However, it was higher for V2 (30.7 °C) than V1 (29.70 °C) under open with net conditions (Table 1). Required times to dry was higher (14.0 d) in open with net condition (V1O1) compare to UCD chimney drying condition (8.0 d) V2 (V2U1). Moisture content was maximum (86.76%) for open condition (V2O1) and minimum moisture conetent was in 84.01% (V2U1) under UCD chimney drying condition. Dry matter content was higher (15.99%) under UCD chimney drying condition (V2U1) than the dry matter content of V2 (13.24%) for open condition (V2O1). Relative humidity was higher (61.75%) under open with condition in V1O1 than at UCD chimney drying condition in V2U1 (44.63%). Storage time was higher (257.83 d) under UCD chimney drying condition in V1U1 than in open with net condition at V2O1 (20.50 d).

Table 1. Effects of variety, condition and thickness, and their combined effect on quality parameters of jackfruit leathers

	Time to dry (d)	Avg. tem. (°C)	ITSS (Brix%)	FTSS (Brix%)	Initial wt. (g)	Final wt. (g)	DM (%)	Moisture (%)	Storage time (d)	RH (%)
Variety (V)										
BAU khatal-1 (V1)	11.25	47.21	21.58	20.17	433.5	62.67	14.89	85.11	143.08	53.35
BAU khatal-2 (V2)	9.75	47.3	20.25	18	479	70	14.62	85.39	129.08	52.96
$LSD_{0.01}$	0.506	0.077	0.054	0.45	2.79	2.12	0.234	0.234	0.734	0.067
Sig. level	**	**	**	**	**	**	**	**	**	**
Condition (C)										
UCD (C1)	8.25	64.28	20.92	38.17	603.25	90.33	84.16	15.84	247.75	44.79
Open with net (C2)	12.75	30.23	20.92	0	309.25	42.33	86.33	13.67	24.42	61.52
$LSD_{0.01}$	0.506		0.054	0.45	2.79	2.12	0.234	0.234		0.067
Sig. level	**	**	NS	**	**	**	**	**	**	**
V × C										
V1 × C1	8.5	64.72	21.5	40.33	589.5	87.5	15.69	84.31	257.83	44.95
V1 × C2	14	29.7	21.67	0	277.5	37.83	14.09	85.91	28.33	61.75
V2 × C1	8	63.83	20.33	36	617	93.17	15.99	84.01	237.67	44.63
V2 × C2	11.5	30.77	20.17	0	341	46.83	13.24	86.76	20.5	61.28
$LSD_{0.01}$	0.715	0.109	0.077	0.636	3.94	3	0.331	0.331	1.038	0.094
Sig. level	**	**	**	**	**	*	**	**	**	**
Thickness (T)										
1.0 cm (T1)	11.67	47.51	20.92	18.92	561.25	67.08	88.71	11.29	134.75	53.31
0.5 cm (T2)	9.33	47	20.92	19.25	351.25	65.58	81.78	18.22	137.42	53
$LSD_{0.01}$	0.506	0.077	0.054	0.45	2.79	2.12	0.234	0.234	0.734	0.067
Sig. level	**	**	NS	*	**	*	**	**	**	**
V × T										
V1 × T1	12.17	47.51	21.67	20	529.5	62.5	11.45	88.55	142	53.53
V1 × T2	10.33	46.92	21.5	20.33	337.5	62.83	18.33	81.67	144.17	53.17
V2 × T1	11.17	47.52	20.17	17.83	593	71.67	11.13	88.87	127.5	53.08
V2 × T2	8.33	47.08	20.33	18.17	365	68.33	18.1	81.9	130.67	52.83
$LSD_{0.01}$	0.715	0.109	0.077	0.636	3.94	3	0.331	0.331	1.04	0.094
Sig. level	**	**	**	NS	**	*	NS	NS	NS	*
C × T										
C1 × T1	9.67	64.56	21	37.83	731.5	87.33	11.93	88.07	245.33	45.08
C1 × T2	6.83	64	20.83	38.5	475	93.33	19.75	80.25	250.17	44.5
C2 × T1	13.67	30.47	20.83	0	391	46.83	10.65	89.35	24.17	61.53
C2 × T2	11.83	30	21	0	227.5	37.83	16.68	83.32	24.67	61.5
$LSD_{0.01}$	0.715	0.109	0.077	0.636	3.94	3	0.331	0.331	1.04	0.094
Sig. level	**	NS	**	*	**	**	**	**	**	**
V × C × T										
V1 × C1 × T1	9.67	65.11	21.67	40	709	84.67	11.94	88.06	256	45.23
V1 × C1 × T2	7.33	64.33	21.33	40.67	470	90.33	19.43	80.57	259.67	44.67
V1 × C2 × T1	14.67	29.9	21.67	0	350	40.33	10.95	89.05	28	61.83
V1 × C2 × T2	13.33	29.5	21.67	0	205	35.33	17.23	82.77	28.67	61.67
V2 × C1 × T1	9.67	64	20.33	35.67	754	90	11.91	88.09	234.67	44.93
V2 × C1 × T2	6.33	63.67	20.33	36.33	480	96.33	20.07	79.93	240.67	44.33
V2 × C2 × T1	12.67	31.03	20	0	432	53.33	10.34	89.66	20.33	61.23
V2 × C2 × T2	10.33	30.5	20.33	0	250	40.33	16.13	83.87	20.67	61.33
$LSD_{0.01}$	1.011	0.154	0.109	0.9	5.57	4.24	0.468	0.468	1.47	0.133
Sig. level	NS	**	NS	NS	NS	**	**	**	**	**

NS = not significant

3.1.4 Effect of leather thickness

Average temperature was higher (47.51 °C) for 1.0 cm thickness of jackfruit leather and lower (47.0 °C) for 0.50 cm thickness of jackfruits varieties (Table 1). Jackfruit leather of 1.0 cm thickness required more days (11.67 d) to dry properly than that of 0.50 cm thickness (9.33 d). Moisture content was high (88.71%) in 1.0 cm thickness of jackfruit leather whereas 0.50 cm thickness of jackfruit leather contained lower moisture (81.78%). TSS was higher (19.25%) in 1.0 cm thickness of jackfruit leather whereas 0.50 cm thickness of jackfruit leather contained lower TSS (18.92%). Relative humidity was higher (53.31%) in 1.0 cm thickness of jackfruit leather whereas 0.50 cm thickness of jackfruit leather contained lower moisture (53.0%) (Table 1). Storage time was higher (137.42 d) in 0.50 cm thickness of jackfruit leather whereas 1.0 cm thickness of jackfruits pulp contained lower storage time (134.75 d). It was observed that dry matter content was higher in 0.50 cm thickness of jackfruit leather (18.22%) whereas 11.29% of dry matter in 1.0 cm thickness of jackfruit leather.

3.1.5 Variety and leather thickness interaction

Thickness of 1.0 cm jackfruit leather (V2T1) had higher average temperature (47.52 °C) than the 0.50 cm thick leathers (46.92 °C) (V1T2) (Table 1). Thickness of 1.0 cm jackfruit leather (V1T1) required higher days to dry (12.17 d) whereas 0.50 cm thickness of jackfruit leather (V2T2) required lower days to dry (8.33 d). Thickness of 1.0 cm jackfruit leather (V2T1) had higher percentage of moisture (88.87%) than 0.50 cm thick jackfruit leathers (V1T2) (81.67%). Thickness of 0.50 cm jackfruits varieties (V1T2) had higher dry matter content (18.33%) whereas 1.0 cm thickness of jackfruit leather (V2T1) had lower percentage of dry matter content (11.13%). Thickness of 1.0 cm jackfruit leather (V1T1) had higher percentage of relative humidity (53.53%) than 0.50 cm thickness of jackfruit leather (V2T2) had lower relative humidity (52.83%). Thickness of 0.50 cm jackfruit leather (V1T2) had longer times storage periods (144.17 days) than 1.0 cm thickness of jackfruit leather (V1T1) had lower storage periods (127.50 d).

3.1.6 Drying condition and leather thickness interaction

Thickness of 1.0 cm jackfruit leather under UCD chimney drying condition (U1T1) had higher average temperature (64.56 °C) whereas 0.50 cm thickness of fruit slices under open with net condition (O1T2) had lower average temperature (30.0 °C) (Table 1). Thickness of 1.0 cm jackfruit leather under open condition (O1T1) had higher days to dry (13.67 d) whereas 0.50 cm thickness of jackfruit leather under UCD chimney drying condition (U1T2) had lower days to dry (6.83 d). Thickness of 1.0 cm jackfruit leather under open with net condition (O1T1) had higher moisture (89.35%) whereas 0.50 cm thickness of jackfruit leather under UCD chimney drying condition (U1T2) had lower moisture (%) (80.25%). Thickness of 0.50 cm jackfruit leather under UCD chimney drying condition (U1T2) had higher dry matter content (%) (19.75%) whereas 1.0 cm thicknesses of jackfruit leather under open with net condition (O1T1) had lower percentage (%) of dry matter content (10.65%). Thickness of 1.0 cm jackfruit leather under UCD chimney drying condition (U1T2) had lower relative humidity (%) (44.50%) whereas 0.50 cm thicknesses of jackfruit leather under open with net condition (O1T1) had higher percentage (%) of relative humidity (61.53%). Thickness of 0.50 cm jackfruit leather under UCD chimney drying condition (U1T2) had longer storage time (250.17 days) whereas 1.0 cm thickness of jackfruit leather under open with net condition (O1T1) had lower storage periods (24.17 d).

3.1.7 Variety, drying condition and leather thickness interaction

Thickness of 1.0 cm jackfruit leather under UCD chimney drying condition (V1U1T1) had higher (65.11 °C) average temperature whereas 0.50 cm thickness under open condition (V1O1T2) had lower average temperature (29.50 °C) (Table 1). Thickness of 1.0 cm jackfruit leather under open condition (V1O1T1) required more days to dry (14.67 d) whereas 0.50 cm thickness of jackfruit leather under UCD chimney drying condition (V2U1T2) required minimum days to dry (6.33 d). Thickness of 1.0 cm jackfruit leather under open with net condition (V2O1T1) had higher moisture (89.66%) whereas 0.50 cm thickness of jackfruit leather under UCD chimney drying condition (V2U1T2) had lower moisture (79.93%). Thickness of 0.50 cm jackfruit leather under open with net condition (V2U1T2) had higher dry matter content (20.07%) whereas 1.0 cm thickness of jackfruit leather under UCD chimney drying condition (V2O1T1) had lower percentage of dry matter content (10.34%). Thickness of 0.50 cm jackfruit leather under UCD chimney drying condition (V1U1T2) had lower relative humidity (44.67%) whereas 1.0 cm thickness of jackfruit leather under open with net condition (V1O1T1) had lower percentage of relative humidity (61.83%). Thickness of 0.50 cm jackfruit leather under UCD chimney drying condition (V1U1T2) had longer storage times (259.67 d) whereas 1.0 cm thickness of jackfruit leather under open with net dryer condition (V2O1T1) had shorter storage times (20.33 d).

Table 2. Effects of variety, condition and thickness, and their combined effect on aroma, color and taste of jackfruit leathers

	Aroma (%)	Color (%)	Taste (%)
Variety (V)			
BAU khatal-1 (V1)	46.67	46.5	43.67
BAU khatal-2 (V2)	44.17	45	40.67
LSD0.01	0.48	0.4	
Level of significance	**	**	**
Condition (C)			
UCD (C1)	55	57.5	51
Open with net (C2)	35.83	34	33.34
LSD0.01	0.48	0.4	0.33
Level of significance	**	**	**
V × C			
V1 × C1	46.67	46.67	38
V1 × C2	46.67	46.34	43.34
V2 × C1	63.34	68.34	64
V2 × C2	25	21.67	23.34
LSD0.01	0.68	0.57	0.47
Level of significance	**	**	**
Thickness (T)			
1.0 cm (T1)	50	44	36.33
0.5 cm (T2)	40.84	47.5	48
LSD0.01	0.48	0.4	0.33
Level of significance	**	**	**
V × T			
V1 × T1	45	45	34.67
V1 × T2	48.34	48	46.67
V2 × T1	33.34	47	38
V2 × T2	55	43	49.34
LSD0.01	0.68	0.57	0.47
Level of significance	**	**	**
C × T			
C1 × T1	36.67	43	49.34
C1 × T2	73.34	72	52.67
C2 × T1	26.67	23	20
C2 × T2	45	45	46.67
LSD0.01	0.68	0.57	0.47
Level of significance	**	**	**
V × C × T			
V1 × C1 × T1	66.67	66	49.33
V1 × C1 × T2	26.67	20	26.67
V1 × C2 × T1	23.33	22.67	20
V1 × C2 × T2	70	70	66.67
V2 × C1 × T1	46.67	70.67	56
V2 × C1 × T2	80	73.33	72
V2 × C2 × T1	30	23.33	20
V2 × C2 × T2	20	20	26.67
LSD0.01	0.97	0.81	0.67
Level of significance	**	**	**

** = significant at 1% level of siginificance

3.2 Panel test

3.2.1 Varietal difference

Through panel test (smelling, visual observation and tasting) aroma was higher (46.67%) of V1 and lower (44.17%) of V2 of jackfruit leather drying products (Table 2). Color was higher (47.50%) of V1 and lower (45.0%) of V2 of jackfruit leather. Taste was higher (43.67%) of V2 and lower (40.67%) of V1 of jackfruit leather drying products.

3.2.2 Efect of drying condition

Aroma was higher (55.0%) in UCD chimney drying condition than open with net condition (35.83%) (Table 2). Color of leathers under UCD chimney drying condition was higher (57.0%) and open with net color was lower (34.0%) of the leather. Taste was higher (51.0%) of leathers under UCD chimney drying condition and lower (33.34%) of open with net condition.

3.2.3 Variety and drying condition interaction

Aroma of jackfruit leathers was higher (63.34%) under UCD chimney drying condition in V2U1 and was lower (25.0%) in open with net condition at V201 (Table 2). Color of jackfruit leathers was brighter (68.34%) under UCD chimney drying condition in V2U1 and was lower (21.67%) in open with net condition at V201 varieties. Leather taste was higher (64.0%) under UCD chimney drying condition in V1U1 than was lower (23.34%) in open with net condition at V201 varieties.

3.2.4 Effect of leather thickness

Aroma was higher (50.0%) for 0.50 cm thickness and lower (40.48%) for 1.0 cm thickness of jackfruit leather dryer products. Color was higher (47.50%) for 0.50 cm thickness and lower (44.0%) for 1.0 cm thickness of jackfruit leather dryer products. Taste was higher (48.0%) for 0.50 cm thickness and lower (36.33%) for 1.0 cm thickness of jackfruit leather (Table 2).

3.2.5 Variety and leather thickness interaction

Higher aroma was found in 0.50 cm jackfruit leather (V2T2) (55.0%) than 1.0 cm thickness of jackfruit leather (V2T1) (33.34%) (Table 2). Thickness of 05cm jackfruit leather (V2T2) was bright (47.0%) color whereas 1.0 cm thickness of jackfruit leather (V2T1) was 43.0% color. Thickness of 0.50 cm jackfruit leather (V2T2) was higher (49.34%) in taste whereas 1.0 cm thickness of jackfruit leather (V1T1) was lower (34.67%) taste.

3.2.6 Drying condition and leather thickness interaction

Jackfruit leathers of 0.50 cm thickness under UCD chimney drying condition gave higher (73.34%) aroma whereas 1.0 cm thickness of products gave lower (36.67%) aroma (Table 2). Otherwise 0.50 cm thickness of jackfruit leather was higher (45.0%) aroma than 1.0 cm products (26.67%) under open with net condition. Thickness of 0.50 cm jackfruit leather under UCD chimney drying condition was higher bright (72.0%) color whereas 1.0 cm thickness of products was lower (43.0%) color content. Otherwise 0.50 cm thickness of jackfruit leather was higher bright (45.0%) color than 1.0 cm products (23.0%). Thickness of 0.50 cm jackfruit leather under UCD chimney drying condition was higher (52.67%) taste whereas 1.0 cm thickness of products was lower (49.34%) taste. Otherwise 0.50 cm thickness of jackfruit leather was higher (46.67%) taste than 1.0 cm leather (20.0%).

3.2.7 Variety, drying condition and leather thickness interaction

Thickness of 0.50 cm jackfruit leather was higher (80.0%) aroma of V2U1T2 than 1.0 cm thickness of lower (46.67%) of V2U1T1 under UCD chimney drying condition (Table 2). Otherwise 0.50 cm thickness leather was higher (70.0%) aroma of V1U1T2 than 1.0 cm thickness was 23.33% of V1U1T1. Thickness of 0.50 cm jackfruit leather was higher bright color (73.33%) of V2U1T2 under UCD chimney drying condition and 1.0 cm thickness was (20.0%) of V2O1T1 under open with net condition. Thickness of 0.50 cm jackfruit leather was higher taste (72.0%) of V2U1T2 under UCD chimney drying condition and 1.0 cm thickness was (20.0%) of V1O1T1 under open with net condition.

4 Discussion

The variations due to different conditions under the study were highly significant. For open condition (O1) average temperature was less (30.23 °C) than the UCD chimney drying condition (U1) (64.28 °C). Similar results were reported by other researchers (Rahim et al., 2017; Raju et al., 2013; Okilya et al., 2010; Jaturonglumlert and Kiatsiriroat, 2010; Lahsasni et al., 2004). As average temperature was high in case of UCD chimney drying condition (U1), so it required minimum days to dry (8.25 d) than open condition (O1) (12.75 d). Similar results on required times to dry were also reported by other researchers Chowdhury et al. (2011); Okilya et al. (2010); Bena and Fuller (2002); Sutar and Prasad (2011). Dry matter content was high (15.84%) but moisture (%) was low (84.16%) for UCD chimney drying condition (U1) and vice versa of open condition (O1) e.g. dry matter

Figure 2. Color of jackfruit leather under UC Davis chimney dryer and open with net condition

content was low (13.67%) but moisture (%) was high (86.33%).

As temperature was higher under UCD chimney drying condition so the moisture content decreased rapidly under UCD chimney drying condition condition than open with net condition. Similar results also on moisture content of processed fruits as affected by drying were observed by other reseachers (Rahim et al., 2017; Jaturonglumlert and Kiatsiriroat, 2010; Abedin, 2007; Okilya et al., 2010). Relative humidity was higher (61.52%) for open with net condition than chimney dryer condition (44.79%). With the increased of temperature the relative humidity is decreased. At the UCD chimney drying condition, temperature was high as a result relative humidity was lower than open condition. Rahim et al. (2017); Forson et al. (2007) and Lahsasni et al. (2004) discussed similar results on relative humidity. Final TSS was highest (38.17% Brix) and storage periods are longer (247.75 d) under UCD chimney drying condition but final TSS and storage periods was lowest (0.0% Brix and 24.42 d, respectively) under open with condition. Saxena et al. (2013) found similar result. TSS was increased under UCD chimney drying condition but under open with net it was 0.0% because it was affected by fungus. Other researchers (Rahim et al., 2017; Raju et al., 2013; Seveda, 2013; Christinal and Tholkkappian, 2012; Sharma et al., 2009) accomplished the similar results on storage times.

The experiment was conducted with two levels of thickness (1.0 cm and 0.50 cm). Thickness of 1.0 cm thickness jackfruit leather required more days (11.76 d) to dry than 0.50 cm of thickness of leather (9.33 d). Rahim et al. (2017) found the similar results on thickness of required times to dry. Moisture content was higher in 1.0 cm thickness of leather (88.71%) than 0.50 cm of thickness (81.78%). Thickness of 0.50 cm jackfruit leather produced higher dry matter content (18.22%) than 1.0 (11.29%). Rahim et al. (2017) observed the similar results on thickness moisture content. Storage times (137.42 days) and final TSS (19.25% Brix) was higher in case of 0.50 cm but storage time (134.75 d) and final TSS (18.92% Brix) was lower for 1.0 cm leather. Rahim et al. (2017) discussed the similar results on thickness of TSS and storage times. In open with net condition 1.0 cm thickness of jackfruit leather required 13.67 days where 0.50 cm required 11.83 days. Rahim et al. (2017) and Gbaha et al. (2007) found the similar results on required times to dry. But in case of chimney dryer both thickness (1.0 cm and 0.50 cm) of leather required less days to dry than open with condition i.e. 9.67 days and 6.83 days respectively. Similar result was also found by Rahim et al. (2017).

Thickness of 1.0 cm leather of open condition was low solar dry matter content (10.65%) where 0.50 cm of open condition was (16.68%). Rahim et al. (2017) and Hawlader (2003) observed the similar results.

However, thickness of chimney dried leather was higher dry matter content than open with net condition i.e. 11.93% and 19.75%, respectively. In open with net condition moisture content was higher both (1.0 cm and 0.50 cm) thickness i.e. 89.35% and 83.35% respectively than UCD chimney drying condition (88.07% and 80.25%). Thickness of 1.0 cm and 0.50 cm leather storage times are lower i.e. 24.17 days and 24.67 days for open with net condition than 1.0 cm and 0.50 cm thickness (245.33 d and 250.17 d) at UCD chimney drying condition. Rahim et al. (2017) and Hawlader (2003) discussed the similar results. Varietal effect has highly significant influence on aroma, color and taste. In case of V1 the aroma was higher (46.67%) than other jackfruit leather variety. Color was brightly high (46.50%) in V1 variety of jackfruit leather. Taste was high (43.67%) of V2 variety of leather. The variations due to different conditions under the study were highly significant. For open with net condition (O1) jackfruit leather was fewer (35.83%) aroma (%) than the UCD chimney drying condition (U1) (55.0%).

Rahim et al. (2017) and Condori et al. (2001) accomplised the similar results. The color (%) of the leather was higher bright (57.50%) in chimney than open with net (34.0%). Similar results were reported by other researchers (Rahim et al., 2017; Al-Amin et al., 2015; Clydesdale, 1993). Taste (%) was lower (51.0%) in open with net condition than in UCD chimney drying condition (33.34%). Rahim et al. (2017) and Raju et al. (2013) discussed the similar results. The experiment was conducted with two levels of thickness (1.0 cm and 0.50 cm). Thickness of 1.0 cm jackfruit leather was lower (40.48%) aroma than 0.50 cm (50.0%). The color was bright high (47.50%) in 0.50 cm thickness leather and lowest (44.0%) in 0.50 cm thickness. The taste of jackfruit leather was high (48.0%) at 0.50 cm and low (36.33%) at 1.0 cm thickness.

In chimney condition 0.50 cm thickness leather was higher (73.34%) aroma (%) than 1.0 cm thickness (26.67%) at open with net condition. The color is highly bright (72.0%) in 0.50 cm thickness level of chimney dryer condition than open with net condition at 1.0 cm (23.0%). Thickness of 0.50 cm dried leather was high (52.67%) taste in chimney condition than 1.0 cm (20.0%) at open with net. Similar result was also found by Rahim et al. (2017) on thickness of aroma, color and taste. According to overall condition under UCD chimney drying condition, 0.50 cm thickness of jackfruit leather had more acceptances compared to 1.0 cm thickness of leather between the two varieties of dried leather. From the above results it could be easily said that the dried leather under chimney dryer had more acceptance comparison to open condition.

5 Conclusions

UCD chimney dryer is very effective to dry jackfruit leather considering the speed of drying, taste and preservation qaulities of dried jackfruit leathers. Thin spread of jackfruit juice should be used for effective drying and quality of jackfruit leathers.

Conflict of Interest

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

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