MATURITY AND POST HARVEST STUDY OF PINEAPPLE WITH QUALITY AND SHELF LIFE UNDER RED SOIL

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ABSTRACT

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A field experiment was conducted at the Horticulture, Food Technology and Rural Industries and IPM laboratories, Bangladesh Agricultural University during the period from July to September, 2003 to study the maturity and post harvest study of pineapple with quality and shelf life under red soil during storage under Madhupur district. The experiment was laid out in the Completely Randomized Design (CRD) with three maturity stages and six post harvest treatments and with three replications. Changes in different physico-chemical aspect of pineapple fruits and shelf-life were studied during the storage period. Stage-I fruit exhibited the maximum shelf-life (21.05 days), while the minimum shelf-life (12.70 days) was recorded in stage-III fruits. The highest shelf-life (27.33 days) was recorded in stage-I fruits under the low temperature treatment. The higher Juice content (64.65%) edible portion (69.80%), reducing sugar (4.89%), total sugar (13.36%), total soluble solid (12.50%) and pH (3.93%) were obtained from stage-III fruits, while stage-I fruits contained higher ascorbic acid (24.41 mg/100g fruit pulp), moisture content (87.28%) and titratable acidity (0.826%) at initial stage. Among the physico-chemical parameters such as, total weight loss, edible portion, juice content, TSS, and p^H increased with the progress of storage period, and total sugar content declined after an initial increased. On the other hand, moisture content, reducing sugar and titratable acidity decreased with the advancement of storage period.

Key words: Maturity, shelf-life, storage period, juice content.

INTRODUCTION

Pineapple (*Ananas comosus* L. Merr.) belongs to the family Bromeliaceae and is one of the most important commercial fruits of the world. This excellent fruit was probably indigenous to Brazil, and it had spread to other parts of tropical America by the time of columbus who took it to Europe (Hayes, 1996). Now a day it is found to grow throughout the tropical and sub-tropical regions of the world. Pineapple is a very popular fruits in Bangladesh with a total production of is 1710 Mt per annum in an area of 14156 hectares of land (BBS, 2002). Pineapple is a good source of carotene and ascorbic acid and is fairly rich in vitamins B and B_2 (Lal and Pruthi, 1995). Pineapple fruits, harvested at different maturity stages, are not of uniform quality, and they show significant variations in the shelf-life and physico-chemical changes during storages (Ahmed and Bora, 1989). In Bangladesh, the peak harvesting period of pineapple is June to August. During this period substandard post harvest handling, storage, poor communication, improper transport and marketing, inadequate processing and preservation facilities cause a glut in the market. As a result, the grower's fail to get a remunerative return of their produce and large portion of harvested fruit is sold at a throw away price. Therefore, the need to reduce post harvest losses of the fruit is of permanent importance.

MATERIALS AND METHOD

The experiment was conducted in the laboratories of the department of Horticulture, Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh during the period from July to September, 2003. The experiment was laid out in Completely Randomized Design (CRD) with three maturity stages and six post-harvest treatments and with three replications. The maturity stages treatments were: Stage – I (S_1) = 14 days before optimum mature stage, stage – II (S_2) = 7 days before optimum mature stage and stage – III (S_3) = optimum mature stage and six post harvest treatments were: control (T_0), 100 ppm GA_3 (T_1), 100 ppm NAA (T_2) low temperature (T_3), covering with straw (T_4) and perforated polythene bag (T_5). The test crop was pineapple fruits of the variety giant Kew. External fruit characteristics were measured by the standard colour chart (IPGRI, 1992). Total weight loss of fruit was determined by the weighing a balance and kept for storage. Percent of weight loss was calculated by using following formula:

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

Where, % WL = Weight loss of fruits in percent
IW = Initial weight of fruits
IW = Final weight of fruits

Moisture content of fruit pulp was estimated, Juice content of fruit pulp was measured by blended with blending machine. The percentage of juice content of the fruit pulp was calculated by using the following formula:
% Juice in fruit pulp = wt. of Juice/wt. of pulp x 100

Edible portion of fruit was determined by balance and pulp to peel ratio was determined by separately weighing pulps and peels of fruits of each treatment and each replication by using electrical balance. Sugar in fruit pulp was measured by the method of Lane and Eynon (1923). Estimation of non-reducing sugar was measured by the following formula:
% Non-reducing sugar = % Total invert sugar - % Reducing sugar.

Estimation of total sugar was determined by the following formula:

% Total sugar = % Reducing sugar +% Non – reducing sugar.

Total soluble solid (TSS) content of fruit Juice was estimated by using Abbe refractometer. A drop of pulp solution squinted from the fruit pulp on the prism of refractometer. The percentage of TSS was obtained from direct reading of the instrument temperature correction were made by using the methods described by Ranganna (1994). Extraction of pineapple Juice was determined by the following formula:

% Titratable acidity = (T X N X V_1 X E / V_2 X W X 1000) X 100
Where, T = Time
N = Normality of NaOH
V_1 = Volume made up
E = Equivalent weight of acid
V_2 = Volume of extract
W = Weight of sample.

TSS to acidity ratio of fruit pulp was calculated using the following formula:

TSS to acidity ratio of fruit pulp = (% TSS content of fruit pulp / % Acidity in fruit pulp)

Ascorbic acid content of fruit pulp was determined to the method of Ranganna (1994) by using 2, 6-Dichlophenol-Indophenol visual Titration method. Shelf-life of pineapple fruits as influenced by different post harvest treatment and maturity stages were calculated by counting the days required to attain the last stage of ripening but the fruits remaining still fit for marketing and eating qualities.

RESULTS AND DISCUSSION

The results have been presented and discussed and possible interpretations have been given under the following headings:

External fruit characteristics

The change in colour during storage was faster in stage-III followed by stage-II and it was slow in stage-I fruits (Table 1.). Fruits treated with low temperature were found to be fresher which was almost similar perforated polythene bag, probably due to less moisture loss from them. The changes of peel colour during storage were faster in 100 ppm NAA treatment than 100 ppm GA_3 treatment.

Total weight loss of fruit

Total weight loss in stage-I fruits was always higher during the entire period of storage (Table 2.). At the 4th day of storage, the total weight loss in stage-I fruits was 5.79% that raise to 12.74% at 12th day. The total weight loss was lowest in stage-II fruits being (4.34%) at 4th day of storage and (4.75%) at 12th day of storage. The weight loss in stage-I fruits was relatively higher probably the high rate of dehydration through a particular mechanism. The maximum weight loss (15.34%) was recorded in control fruits which were closely followed by straw treatment (14.63%) while it was minimum (9.50%) in fruits, those were kept in perforate polythene bags as recorded at 12th day of storage.

Moisture content of fruit pulp

The moisture contents of fruits pulp were 87.28%, 85.80% and 83.6% in stage-I, stage-II and stage-III fruits, respectively, at the day of harvested which decreased gradually with the progress of storage period to 76.18%, 77.25% and 79.07% was recorded at 12th days of storage (Table 2.). All post harvest treatments fruits showed a decline in moisture content with the increasing of storage duration. At 12th day of storage, the highest moisture content (79.33%) was recorded in the fruits treated with low temperature which was statistically similar to covering with straw treatment (78.22%), while it was minimum (76.18%) in control. The highest moisture content (80.12%) was observed in the stage – II fruits with low temperature and it was minimum (74.88%) in stage-I with control fruits as observed at 12th day of storage (Table 3).

Juice content of fruit pulp

Freshly harvested stage-I, stage-II and stage-III fruits contained 61.04%, 63.65% and 64.65% juice respectively, (Table 2) which were increased with increasing period of storage. The Juice content of fruits under all post harvest treatments increased with advancement of storage period. At 12th day of storage the maximum Juice content (72.64%) was recorded in control fruits, while the 100 ppm NAA treated fruits contained the minimum Juice (69.08%). The interaction effect was found to be non significant on the Juice content of fruit pulp.

Edible portion of fruit

The edible portion of the three maturity stages fruit was increased up to 12th day of storage (Table 4). The post harvest treatments had no significant effect on edible portion. The combined effect between stage of maturity and post harvest treatment also showed significant variation in relation to edible portion of fruit during storage.

Pulp to peel ratio

It was observed that highest (2.51) pulp to peel ratio found in stage-III fruits and the lowest (2.05) in stage-I fruits at initial stage. At 12th day of storage, the highest pulp to peel ratio (2.97) was recorded in fruits treated with 100 ppm GA_3, which was statistically similar to that of control and perforated polythene bag treatments (2.96), while it was the lowest (2.72) in fruits treatment with 100 ppm NAA (Table 4). The interaction between the stage of maturity and postharvest treatments in consideration of pulp to peel ratio was non significant during storage period.

Non-reducing sugar content of fruit pulp

The highest non-reducing sugar (8.47%) was recorded in stage-III fruits while it was minimum (6.23%) in stage-I fruits at initial stage (Table 5). Singleton and Gortner (1965) observed similar results in developing pineapple fruits. Among the post harvest treatments control fruits were found to be most effective in checking the decrease in non-reducing sugar content of fruit pulp. The interaction effect was non-significant on this change.

Total sugar content of fruit pulp

The maximum total sugar (13.36%) was recorded in stage-III fruits while it was minimum (10.65%) in stage-I fruits at initial stage. At 12th day of storage, the highest total sugar content (12.10%) was observed in control fruits which was closely followed by low temperature treatment (11.58%), on the other hand it was minimum (10.35%) in fruits treated with 100 ppm GA_3(Table 6). The interaction effect was found to be significant in this contrast.

TSS (Total soluble solid) content of fruit pulp

Stage-III fruits contained the highest TSS (12.05%) while it was minimum (10.19%) in stage-I fruits. Singleton and Botrel *et. al*. (1993) also found similar results. Post harvest treatments were also found significant effects on change in TSS content of fruit Juice during storage. Similar results were reported by Das and Medhi (1996). At 12th day of storage the highest TSS (15.71%) was recorded in stage-III fruits under control, while it was minimum (12.00%) in stage-I fruits under 100 ppm GA_3 treatment (Table 6).

Total titratable acidity in fruit pulp

Freshly harvested stage-I fruits contained the maximum (0.826%) total titratable acidity while the minimum (0.682%) in stage-III fruits. It was decreased with the advancement of storage period. Total titratable acidity of fruit pulp under all post harvest treatments decreased with the advancement of storage period. The interaction between the stage of maturity and post harvest treatments in respect of total titratable acidity was found to be non-significant during storage period.

TSS to acidity ration of fruit pulp

Result showed that the ascorbic acid content was decreased with the progress of ripening of fruits. Among the post harvest treatments, low temperature treatment was found to be the most effective in checking the decrease in ascorbic acid content of fruit pulp. The ascorbic acid content of fruit was significantly influenced by the treatment combinations during storage (Table 6).

Shelf-life of fruit

The maximum shelf-life (21.05 days) was recorded for stage-I fruits followed by stage-II fruits (18.11 days). The maximum shelf-life (23.03 days) was observed in fruit treated with low temperature which was closely followed by 100 ppm GA_3 treatment (20.77 days), where as minimum shelf-life (12.70 days) was recorded in control condition. Analysis of variance showed that there was non significant interaction between the stage of maturity and post harvest treatment in the shelf-life of pineapple fruit but their combined effect was significant. Low temperature prolong the shelf-life in both mature fruits were probably due to the reduction of various gases (O_2, CO_2) exchange from the inner and outer atmosphere as well as slowing down the hydrolysis process (Uddin and Hossain, 1993).

'I'able I. Effects of maturity stage of fruits and postharvest treatments on changes in external characteristics of pineapple fruits during storage period

Days of storage	Maturity stage	Postharvest treatments					
		Control	100 ppm GA_3	100 ppm NAA	Low temperature	Covering with straw	Perforated polythene bag
0	S_1	Light green	Light green	Light green	Light green	Light green	Light green
	S_2	Trace yellow at the stem end	Trace yellow at the stem end	Trace yellow at the stem end	Trace yellow at the stem end	Trace yellow at the stem end	Trace yellow at the stem end
	S_3	$^2/_3{}^{rd}$ yellow	$^2/_3{}^{rd}$ yellow	$^2/_3{}^{rd}$ yellow	$^2/_3{}^{rd}$ yellow	/$_3$" yellow	$^2/_3{}^{rd}$ yellow
4	S_1	Trace yellow at the stem end	Light green	Light green	Light green	Trace yellow at the stem end	Trace yellow at the stem end
	S_2	Half yellow	Trace yellow at the stem end	Trace yellow at the stem end	Trace yellow at the stem end	Half yellow	Half yellow
	S_3	Trace green at the apex	$^1/_3{}^{rd}$ portion of the base became yellow	$^1/_3{}^{rd}$ portion of the base became yellow	$^1/_3{}^{rd}$ portion of the base became yellow	Trace green at the apex	Trace green at the apex
8	S_1	$^2/_3{}^{rd}$ yellow	Trace yellow at the stem end	Trace yellow at the stem end	Light green	$^2/_3{}^{rd}$ yellow	$^2/_3{}^{rd}$ yellow
	S_2	Golden yellow, softening started	Two rows of eyes at the base became yellow	Two rows of eyes at the base became yellow	Two rows of eyes at the base became yellow	Full yellow	Full yellow
	S_3	Rottening started	Half yellow	Half yellow	Light yellow colour	Golden yellow, softening started	Golden yellow, softening started
12	S_1	Full yellow, blackish spot developed	Trace yellow at the stem end	'/$_3{}^{rd}$ portion of the base became yellow	Trace yellow at the stem end	Full yellow	Trace green at the apex
	S_2	Deep yellow, softening started	Two rows of eyes at the base became yellow	Half yellow	Light yellow colour	Deep yellow	Deep yellow softening started
	S_3	Discarded due to rottening	Trace green at the apex	Full yellow, blackish spot developed	Deep yellow	Discarded due to rottening	Discarded due to rottening

S_1: 14 days before optimum mature stage S_2: 7 days before optimum mature stage
S_3: Optimum mature stage DAS: Days after storage

Table 2. Main effects of stage of maturity on changes in weight loss, moisture content and juice content of pineapple fruit during storage

Maturity stage	Weight loss (%) at DAS				Moisture content (%) at DAS				Juice content (%) at DAS			
	0	4	8	12	0	4	8	12	0	4	8	12
S_1	0.00	5.79	8.76	12.74	87.28	84.36	77.73	76.18	61.04	64.94	68.51	69.G2
S,	0.00	4.34	8.34	11.75	85.80	81.94	79.08	77.25	63.G5	68.G7	68.87	69.56
S_3	0.00	4.77	7.74	10.95	83.62	81.21	79.19	79.07	64.G5	71.22	71.63	72.57
LSD (0.05)	-	0.137	0.333	0.454	1.396	1.185	1.111	1.444	1.701	1.445	1.424	1.361
LSD (0.01)	-	0.184	0.447	0.609	1.872	1.589	1.490	1.936	2.281	1.938	1.909	1.825

Table 3. Combined effect of stage of maturity and postharvest treatments on changes in weight loss, moisture content and juice content of pineapple fruit during storage

Treatment combinations		Weight loss (°%) at DAS				Moisture content (%) at DAS				Juice content (%) at DAS			
		0	4	8	12	0	4	8	12	0	4	8	12
S_1	To	0.00	7.32	12.00	16.67	87.49	82.98	76.30	74.88	60.87	68.00	70.73	71.18
	T_1	0.00	6.84	8.05	11.80	87.49	83.28	76.63	75.52	61.06	62.78	67.36	68.98
	T_2	0.00	6.73	8.12	11.97	87.32	84.22	77.25	75.20	61.39	63.25	67.12	67.74
	T_3	0.00	3.98	6.98	10.12	87.46	86.11	80.48	77.95	60.83	65.88	68.08	69.30
	T_4	0.00	5.87	10.28	15.54	87.49	84.65	78.05	76.85	60.76	65.30	68.77	70.05
	T_5	0.00	4.00	7.14	10.33	86.42	84.90	77.68	76.66	61.33	64.40	68.97	70.49
S_2	To	0.00	6.99	11.86	15.37	85.88	80.52	78.05	75.10	63.87	71.20	71.75	73.03
	T_1	0.00	6.05	7.53	10.38	85.76	81.32	78.10	75.36	63.67	66.77	67.97	68.86
	T_2	0.00	6.21	8.14	10.98	85.68	80.98	77.85	75.87	63.41	67.86	67.86	68.10
	T_3	0.00	3.85	6.06	9.64	85.92	83.49	81.33	80.12	63.10	69.53	67.97	69.08
	T_4	0.00	5.26	9.98	14.39	85.80	82.33	80.03	78.39	64.02	68.14	68.66	68.88
	T_5	0.00	3.80	6.49	9.72	85.73	83.00	79.09	78.65	63.87	68.52	69.02	69.43
S_3	To	0.00	5.35	10.05	13.97	83.54	80.02	78.67	78.57	64.40	71.40	72.67	73.71
	T_1	0.00	5.41	7.57	10.02	83.54	80.98	78.77	78.53	64.97	70.20	72.47	73.03
	T_2	0.00	5.89	7.76	10.26	83.45	80.67	79.26	78.77	64.67	70.05	71.08	71.40
	T_3	0.00	3.73	5.87	9.05	83.72	82.56	81.13	79.94	64.60	72.42	70.22	72.41
	T_4	0.00	4.98	9.13	13.95	83.70	81.68	79.20	79.42	64.87	71.97	71.87	72.90
	T_5	0.00	3.26	6.05	8.44	83.74	81.34	78.11	79.20	64.41	71.28	71.46	71.97
LSD (0.05)		-	0.335	0.816	1.112	3.420	2.902	2.722	3.536	4.167	3.540	3.488	3.335
LSD (0.01)		-	0.450	1.095	1.491	NS	3.892	NS	NS	5.587	4.747	4.677	4.471

Table 4. Main effects of stage of maturity on changes in edible portion and pulp to peel ratio of pineapple fruit during storage

Maturity stage	Edible portion (%) at DAS				Pulp to peel ratio at DAS			
	0	4	8	12	0	4	8	12
S_1	64.37	66.69	67.52	68.66	2.05	2.52	2.64	2.84
S_2	68.35	70.88	71.83	71.87	2.31	2.72	2.79	2.90
S_3	69.50	74.07	74.62	73.45	2.51	2.79	2.83	2.99
LSD (0.05)	1.404	1.789	1.449	1.500	0.083	0.077	0.080	0.057
LSD (0.01)	1.883	2.399	1.943	2.011	0.111	0.103	0.107	0.076

Table 5. Main effects of stage of maturity on changes in reducing sugar, non-reducing sugar and total sugar content of pineapple fruit during storage

Maturity stage	Reducing sugar (%) at DAS				Non-reducing sugar (%) at DAS				Total sugar (%) DAS			
	0	4	8	12	0	4	8	12	0	4		12
S_1	4.42	3.84	3.63	3.41	6.23	6.05	6.34	6.35	10.65	9.89	9.98	9.76
S_2	4.57	4.14	3.97	3.74	7.40	7.61	7.79	7.84	11.97	11.75	11.76	11.58
S_3	4.89	4.40	4.14	3.88	8.47	8.55	8.45	8.37	13.36	12.95	12.59	12.25
LSD (0.05)	0.196	0.123	0.121	0.091	0.212	0.191	0.137	0.161	0.246	0.255	0.194	0.195
LSD (0.01)	0.263	0.165	0.162	0.122	0.284	0.256	0.184	0.216	0.329	0.342	0.260	0.261

Table 6. Combined effect of stage of maturity and postharvest treatments on changes in total soluble solid, titratable acidity and their ratio of pineapple fruit during storage

Treatment combinations		Total Soluble Solid (%) at DAS				Titratable Acidity (%) at DAS				TSS:TA at DAS			
		0	4	8	12	0	4	8	12	0	4	8	12
S_1	T_0	10.40	11.92	12.90	13.41	0.816	0.726	0.707	0.692	12.74	16.41	18.24	19.39
	T_1	10.25	10.11	11.20	12.00	0.825	0.790	0.759	0.749	12.42	12.80	14.76	16.05
	T_2	10.15	10.23	11.26	12.01	0.806	0.796	0.746	0.736	12.59	12.86	15.09	16.37
	T_3	1O.O6	11.36	12.06	13.04	0.833	0.735	0.715	0.702	12.08	15.48	16.87	18.60
	T_4	10.11	11.15	12.31	12.84	0.845	0.733	0.709	0.706	11.96	15.20	17.36	18.19
	T_5	10.18	11.10	12.20	12.76	0.830	0.726	0.717	0.713	12.27	15.27	17.00	17.91
S_2	T_o	11.85	12.79	13.46	14.37	0.706	0.636	0.621	0.587	16.77	20.12	21.66	24.51
	T_1	11.67	11.43	12.02	12.86	0.704	0.693	0.676	0.630	16.59	16.50	17.78	20.43
	T_2	11.80	11.36	12.06	13.02	0.721	0.706	0.683	0.627	16.34	16.09	17.67	20.78
	T_3	11.39	12.08	13.05	13.77	0.727	0.646	0.626	0.597	15.66	18.67	20.82	23.05
	T_4	11.77	11.96	12.75	13.66	0.708	0.626	0.622	0.602	16.63	19.13	20.50	22.70
	T_5	11..94	12.10	12.69	13.67	0.716	0.633	0.630	0.611	16.68	19.16	20.15	22.40
S_3	T_o	12..87	14.16	15.32	15.71	0.693	0,623	0.601	0.549	18.57	22.69	25.49	28.64
	T_1	12..36	12.77	13.98	14.43	0.687	0.699	0.638	0.592	18.02	18.28	21.89	24.39
	T_2	12..93	12.85	14.02	14.78	0.697	0.710	0.630	0.585	18.53	18.12	22.28	25.25
	T_3	12.67	14.01	15.02	15.32	0.669	0.645	0.610	0.555	18.93	21.70	24.63	27.67
	T_4	12.33	14.00	14.33	15.16	0.G81	0.650	0.635	0.563	18.10	21.53	22.64	26.93
	T_5	11.82	13.76	14.45	15.22	0.667	0.655	0.614	0.570	17.72	20.99	23.54	26.74
LSD (0.05)		0.907	1.190	1.085	0.712	0.017	0.017	0.017	0.017	1.164	1.453	1.648	1.653
ISD (0.01)		1..216	1.595	1.454	0.955	0.022	0.022	0.022	0.022	1..561	1..946	2..210	2..217

S_1: 14 days before optimum mature stage
S_2: 7 days before optimum mature stage
S_3: Optimum mature stage
T_o: Control
T_1: GA_3 (100 ppm)
T_2: NAA (100 ppm)
T_3: Low temperature
T_4: Covering with straw
T_5: Perforated ploythene bag

CONCLUSION

For immediate consumption as fresh fruit the optimum mature stage appeared to be the best. Earlier harvesting might be appropriate for canning and long distance transport. Keeping the harvested fruits at low temperature or treated with 100 ppm GA_3 appeared to be suitable for extending the shelf-life as well as other quality attributes of pineapple fruits.

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