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Role of health hazardous ethephone in nutritive values of selected pineapple, banana and tomato

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Abstract

An experimental study of selected pineapple (*Ananas sativus*), banana (*Musa acuminata)* and tomato (*Lycopersicon esculentum*) was investigated on the basis of their biochemical and nutritional properties by the treatment of some doses of ethephone. It was found that the chemically treated samples ripened rapidly than untreated ones. The nutritional properties of chemically ripened fruits as well as market samples (ripe) were shown different from untreated. The chemically ripened samples showed shorter shelf life than non-treated samples. The highest vitamin C content of the selected non-treated fruits (17.5 mg/100 g in pineapple, 13 mg/100 g in banana and 20.2 mg/100 g tomato) and the lowest contentwas found in the market samples (10 mg/100 g in pineapple, 7 mg/100 g in banana and 12.3 mg/100 g tomato), whereas ethephone-treated groups contained the ascorbic acid 14.5 mg/100 g in pineapple, 9 mg/100 g in banana and 19.4 mg/100 g in tomato). Similarly the β-carotene content of ethephone-treated samples (63 µg/100 g in pineapple, 47 µg/100 g in banana and 757 µg/100 g in tomato) and market samples (31 µg/100 g in pineapple, 38 µg/100 g in banana and 512 µg/100 g in tomato) were less than that of control groups (78 µg/100 g in pineapple, 54 µg/100 g in banana and 807 µg/100 g in tomato). The mineral contents of samples in three groups showed ethephone-treated samples indicated less nutritional quality than untreated samples. Higher amount of lead and arsenic were found in all fruits and vegetables in both ethephone-treated and market samples but the concentrations were within acceptable limits.

Key words: Ripening agents, ethephone, nutritional quality, shelf life, fruits.

Introduction

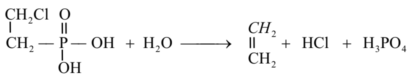
Fruits and vegetables are highly valued in human diet mainly for vitamins and minerals. However, the present consumption rate of fruits and vegetables in Bangladesh is 126 g/day/capita which is far below the minimum average requirement of 400 g/day/capita [7]. For fruits only, the present daily intake is only 14 g/capita as compared to the minimum requirement of 100 g/capita [7]. However, none can ensure us whether this food is safe or not because these days rarely any food item is spared from the malicious practice of food adulteration. Adulterants are used in almost every food-item from milk to fruits, from vegetables to grains. Most of the adulterants that are intentionally added are invisible or they are made invisible by astutely camouflaging with the colour or texture.

Bhuiyan *et al.* [4] found that about three-fourth (74%) of the banana wholesalers used different types of ripening agent for quick ripening of banana in Bangladesh. The role of fruits is well established and known for protecting against major diseases and disorders of the cardiovascular, digestive and endocrine system[10]. However, these are life threatening when adulterated with different types of chemicals, such as calcium carbide (CaC_2), ethylene (C_2H_4), ethephone (2-chloro ethyl phosphoric acid) and other non-recommended pesticides for the ripening of immature fruits rapidly with attractive colour. Nowadays some growers as well as traders in Bangladesh are commercially using some chemicals namely Ripen, Gold-Plus, Profit etc. for the ripening of tomato, papaya, and banana, directly to the fields and processing areas. These chemicals change nutritional properties of fruits and vegetables as well as lead serious health hazards to human beings like cancer, skin irritation, diarrhea, liver disease, kidney disease, gastrointestinal irritation with nausea, vomiting, diarrhea, cardiac disturbances, central nervous system depression and cardiac abnormalities etc. [12]. Children are at particular risk to the harmful side effects of food adulteration, which may lead to serious liver and kidney diseases including various forms of cancer and hepatitis [19]. The children become more irritated and cannot concentrate on their studies due to a lack of nutrition, which directly hinders the brain development [20].

Food safety is essential to maintain nutrition, combat food/waterborne diseases, maintain food quality, and stop food adulterations, being rampant in Bangladesh [11]. Lower nutritional quality of chemical-treated fruits and vegetables and their hazardous effects increases the burden of health in the society. Furthermore it has a longstanding impact on the economic development. Therefore, this is a leading key issue to aware the people as well as warns the government about the serious effect of food adulteration. The study recommended that the government should come forward immediately with special program to solve these deteriorating trend of food adulteration. To combat these unexpected situations the studies on the effects of ripening agents on nutritive values of selected fruits and vegetables were demand of current instances.

Materials and Methods

The experiment was carried out on in the laboratory of Fruit Technology Research Section, IFST, BCSIR, Dhaka during the financial year 2007-2008. Pineapple, banana and tomatoes were freshly collected from Mudhupur, Norshindhi and Chapai-Nawabganj and local market (Kawran Bazar, Dhaka), respectively, for the laboratory analysis. Selected fruits were divided into three experimental groups namely control (non-treated), treated by ethephone and adulterate market sample (ripened). In cases of non-treated, fruits were kept in bamboo basket and covered with straw. For ethephone-treated group green fruits were dipped into different dosages of ethephone (250, 500, 750 and 1000 ppm) for 15 min. When fruits were dipped in ethephone (2-chloro ethyl phosphoric acid) it produced ethylene by the hydrolysis with water:



After treatment samples were taken in different bamboo baskets and covered with straw.When all the fruits were ripened completely pulp and peel were separated from the seeds and each sample was cut into small slices and divided into two parts. One part was for the analysis of vitamin-C, pH, β-carotene, TSS, protein, fat, fiber, moisture and another part for drying to determine the ash, different minerals and toxic elements, arsenic (As) and lead (Pb).

UV-Visible-spectrophotometer (SPECTRONIC GENESYS-5, MILTOI ROY) was used for the determination of vitamin C, β-carotene and minerals in the prepared water samples. Several analytical methods have been reported for the determination of vitamin C using titrimetry [1, 16]. Total ascorbic acid content of fruits was analyzed by a non-spectrophotometric method prescribed by Arya *et al.* [2]. β- carotene of the selected fruits was estimated by liquid chromatographic method as outlined by Sundaresan [5].

Flame photometer was used to determine the content of sodium (Na) and potassium (K) outlined by Rachida *et al.* [21]. Sodium and potassium in solution was atomized into an oxy-hydrogen flame. The flame exits atoms of sodium or potassium, causing them to unit radiation to specific wavelength. The amount of radiation emitted is measured on a flame photometer, under standard condition it is proportional to the concentration of sodium or potassium. Protein was estimated by Kjeldahl method as used by Thiex *et al.* [18] for the crude protein analysis.

Titrimetric method was used for the determination of calcium, magnesium and sugar content [22]. Muffle furness of type Gallen-kamp, Model-S90 NC/NA was used for the determination of minerals present in ash and the fiber ash. The pH meter (type H1 98106 by HANNA) was used for the determination of pH. Hand refractrometer (type ATAGO, Model-9099; 0-90%) was used for the determination of total soluble solids (TSS) or Brix. Chemicals of analytical grade quality and distilled deionized water were used in the analysis. Titratable acidity was expressed as the amount of free acid (mainly as citric acid) in the product (mg/100 g) [26]. Total lipids were extracted by the Soxhlet method as outlined Manirakiza *et al.* [17].

Results and Discussion

Green pineapple, banana and tomato samples were successively treated with ethephone (250, 500, 750 and 1000 ppm). Table 1 shows that pineapple, banana and tomato treated with 1000 ppm of ethephone required less time for ripening (48, 32 and 50 h, respectively) than other treated fruits as well as compared with the non-treated fruits. With high treatment on fruits required less shelf life while lower dosage required longer shelf life indicating high dosage treatment samples reacted rapidly with fruit samples and quick ripening led to spoilage. Application of ethephone before harvesting, increases ripening but accelerates detrimental postharvest changes [8]. Sang and Kwan [25] observed that ethephone application on fruits induced symptoms of tissue degeneration hence physico-chemical changes occurred.

Table 2 shows the changes of physico-chemical properties by the treatment with ethephone to green pineapple, banana and tomato. The fruits ripened with ethephone have more acceptable colour than naturally ripened fruits [23]. This study also identified that the ethephone-treated and market samples had more attractive colour than the control. The moisture contents of pineapple, banana and tomato were 87.79, 65.14 and 85.12% for non-treated control group and 88.05, 70.45 and 87.79% for ethephone-treated group and for market sample 86.61, 68.87 and 89.61% respectively.

Thus, it was observed that the ethephone-treated samples had highest extent of moisture content as compared with the control samples. Shadan and Gholamhossein [24] revealed that ethephone treatment causes a significant increase in fruits weight due to the excess moisture formation.

Ban *et al.* [3] showed that ethephon application stimulated the

Table 1. Observation of ripening time and shelf life of selected pineapple, banana and tomato by using ethephone.

Dose of Ethephone PPm/L	Pineapple		Banana		Tomato	
	Ripening time (hrs)	Shelf life (days)	Ripening time (hrs)	Shelf life (days)	Ripening time (hrs)	Shelf life (days)
Control (without chemical)	164	14	72	7	124	15
250	75	14	49	4	72	12
500	54	12.5	36	3	56	10
750	49	12.0	34	3	54	9
1000	48	10.7	32	3	50	9

Table 2. Changes of physico-chemical properties of pineapple, banana and tomato after ethephone treatment.

Name of sample		Taste	Color	Moisture (%)	pH	Titratble acidity (g/ 100g)	Brix-acid ratio	Sugar-acid ratio
Pineapple	Control	Sour-sweet	Yellowish	88.05	3.6	0.85	11.8	10.9
	Ethephone treated	Sweet	Yellow	87.79	3.7	0.59	17.8	15.8
	Market sample	Sweet	Red-yellow	86.61	3.8	0.46	24.1	21.4
Banana	Control	Sweet	Green	70.45	4.9	0.31	39.7	36.1
	Ethephone treated	Sweet	Yellow	65.14	4.9	0.39	36.2	31.5
	Market sample	Sweet	Yellow	68.87	4.8	0.32	47.5	42.8
Tomato	Control	Sour	Light yellow	85.12	3.5	0.48	29.8	17.4
	Ethephone treated	Less sour	Red Yellow	87.79	3.7	0.40	37.5	23.5
	Market sample	Less sour	Red Yellow	89.61	3.8	0.39	37.7	25.1

decrease in titratable acidity (TA). In this study the fresh fruit pulps collected from local market were less acidic (pH 3.7) than non-treated control groups (pH 3.5). TA of fresh pulps varied from 0.44 to 0.82%. The highest TA (0.82%) was for non-treated control group and the lowest one (0.44%) for market sample. In another study total acidity in juice was significantly reduced by all treatments except 150 ppm ethephone applied to fruit sample [6]. It was observed that there is no direct relationship between TA and pH, although generally the pH increases as the acid content decreases and vice versa. In general, TA relates pretty well to the acid taste of pineapple pulp. Immature or unripe pineapple contains more TA, thus having low pH, but when the pineapple becomes matured and ripened, the TA decreases and pH increases. Therefore, it can be concluded that TA of matured and ripened pineapples will be low and pH will be high [14]. Higher Brix indicates more ripeness of fruits among ripe fruits of the same variety [14].

The Brix/acid ratio varied from 11.8 to 24.1 in pineapple, from 36.2 to 47.5 in banana and from 29.8 to 37.7 in tomato. The highest ratio was recorded for market sample and the lowest one for control group, but the Brix/acid ratio of ethephone-treated samples was very similar to marketed sample. Titratable acidity and Brix/acid ratio are the best parameters to evaluate the maturity and quality of fruits [15]. The sugar/acid ratio varied from 10.9 to 21.4 in pineapple, 31.5 to 42.8 in banana and 17.4 to 25.1 in tomato. The highest ratio was recorded in marketed samples and the lowest one for control group, but the sugar/acid ratio of ethephone- treated samples was very similar to marketed sample.

Table 3 shows the changes of nutritional properties of pineapple, banana and tomato treated by ethephone. Gopalan *et al.* [9] reported that selected fruits and vegetables are not rich source of protein. Maximum protein in fruits was 1.57 to 5.42%.Total mineral content (ash) was observed to vary from 0.61 to 0.95% in pineapple, from 0.93 to 0.97% in banana and from 0.55 to 0.61% in tomato. In the present study the fat and protein contents among the three groups, non-treated control group, ethephone-treated and marketed sample were very negligible.

Total sugar (9.3% in pineapple, 12.3% in banana and 9.4% in tomato) of ethephone-treated group was higher than that of non-treated control groups (9.2% in pineapple, 11.2% in banana and 8.35% in tomato), while the TS values of market sample were much higher than in non-treated control group and all other groups. The high quantity of TS in market sample can be attributed by to the fact that the pineapple, banana and tomato collected from local market were treated with an excessive amount of ethephone. In another study chemically treated fruits produced higher TS content due to the increase in soluble pectin, organic acids and hydrolysis of starch to soluble sugars [12].

The fresh selected fruits and vegetables contain most of the known vitamins. They are a particularly rich source of vitamin C (ascorbic acid). Ascorbic acid is sensitive to change due to the action of oxygen, hence, in the processing of selected fruits and vegetables, contact with air is always avoided. Non-treated control group contained high amount of ascorbic acid (17.5 mg/100 g in pineapple, 13 mg/100 g in banana and 20.2 mg/100 g tomato) and the lowest amount was found in the market samples (10 mg/100 g in pineapple, 7 mg/100 g in banana and 12.3 mg/100 g in tomato) whereas ethephone-treated groups contained the ascorbic acid 14.5 mg/100 g in pineapple, 9 mg/100 g in banana and 19.4 mg/100 g in tomato. Ascorbic acid content of fruits and vegetables decreases even in proper storage treatment due to the prolonged duration of storage [12].

Similarly the β-carotene contents of ethephone-treated samples (63 µg/100 g in pineapple, 47 µg/100 g in banana and 757 µg/100 g in tomato) and market samples (31 µg/100 g in pineapple, 38 µg/

Table 3. Changes of nutritional properties of pineapple, banana and tomato after ethephone treatment.

Name of sample		Total mineral (g/100 g)	Total fat (g/100 g)	Total protein (g/100 g)	Total sugar (g/100 g)	Vitamin C (mg/100g)	β-carotene (µg/100g)
Pineapple	Control	0.61	0.02	1.24	9.25	15	78
	Ethephone treated	0.95	0.03	0.91	9.30	14	63
	Market sample	0.85	0.03	0.85	9.85	10	31
Banana	Control	0.93	0.02	1.37	11.2	13	54
	Ethephone treated	0.94	0.03	1.33	12.3	9	47
	Market sample	0.97	0.03	1.01	13.7	7	38
Tomato	Control	0.61	0.02	1.24	8.35	20.2	807
	Ethephone treated	0.55	0.02	0.91	9.40	19.4	757
	Market sample	0.60	0.02	0.85	9.80	12.3	512

100 g in banana and 512 µg/100 g in tomato) were less than that of control groups (78 µg/100 g in pineapple, 54 µg/100 g in banana and 807 µg/100 g in tomato).

Minerals are important for the various metabolic activities of the living tissue and even more so far the fruit, which exhibits tremendous activity during ripening process. In another study dry matter content in banana pulp of all ripening treatments decreased during ripening, significant variations were found in dry matter content only at the 2nd day of the application of ripening treatments [12]. The results of the analysis of minerals (sodium, potassium, iron, phosphorus, calcium and magnesium) of three groups of samples are shown in Table 4. The sodium and potassium contents in control group of banana (30.6 and 354 mg/100 g, respectively) were higher than in ethephone-treated group (29.2 and 351 mg/100 g) and the samples collected from local market (27.2 and 318 mg/100 g). Very similar patterns of sodium and potassium changes were found in case of pineapple and tomato sample. The iron contents among the three groups, non-treated control, ethephone-treated and marketed samples in all fruits were negligible, but comparatively non-treated control samples contained higher amount than others. Phosphorus content in the ethephone-treated sample (14 mg/100 g in pineapple, 37 mg/100 g in banana and 61 mg/100 g in tomato) was higher than that of non-treated control groups (10 mg/100 g in pineapple, 36 mg/100 g in banana and 58 mg/100 g in tomato), whereas market samples had lower amount of phosphorus. The high amounts of phosphorus in ethephone-treated samples indicate that ethephone is degraded by water resulting in the increase of phosphorus. Calcium and magnesium content was decreased after ethephone treatment in all of groups, and marketed samples also contained lower amounts of calcium and magnesium in all fruits. Values of some minerals were observed to vary and some were similar to those reported earlier [9,13].

Rapid industrialization, urbanization, fertilization, insecticides and pesticides use etc. have resulted in toxic metal pollution of land and water resources. The increasing load of toxic metals has being assimilated and transferred within food chains. High concentration of the heavy metals in food chains results in various health hazards to animal and human beings. Table 5 shows the arsenic and lead contamination of pineapple, banana and tomato treated by ripening agent ethephone. Higher amount of lead was found in all fruits and vegetables in both ethephone-treated and market sample. It was found that the heavy metals, such as As and Pb, contents in all market samples were higher than in control vegetables but the concentration was at acceptable level.

Conclusions

Fruits and vegetables treated with ethephone or other ripening agents ripen faster with attractive colour and flavor but the shelf life and nutrient values decrease. Furthermore, eating of artificially ripened fruits and vegetables is most harmful and responsible for many life-threatening diseases in human beings. Considering its hazardous aspects, the use of ethephone must be strictly monitored and controlled. It is not solely the responsibility of the government, the people must also become aware and avoid consuming contaminated fruits. The guilty must be punished to prevent further spread of such harmful practice. Mass awareness and social resistance are the most effective deterrents to such dangerous activities.

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Table 4. Changes of mineral contents of pineapple, banana and tomato after treated by ethephone.

Name of sample		Sodium (mg/ 100 g)	Potassium (mg/ 100 g)	Iron (mg/ 100 g)	Phosphorus (mg/ 100 g)	Calcium (mg/ 100 g)	Magnesium (mg/ 100 g)
Pineapple	Control	2.2	180	0.37	10	12.3	17.2
	Ethephone treated	1.3	176	0.32	13	10.4	16.3
	Market sample	0.9	152	0.28	8	7.2	14.6
Banana	Control	30.6	354	0.92	36	16.1	31.1
	Ethephone treated	29.2	551	0.77	37	12.8	29.4
	Market sample	27.2	318	0.43	30	13.1	25.5
Tomato	Control	11.1	378	0.58	58	27.2	23.4
	Ethephone treated	10.3	365	0.52	61	24.7	21.6
	Market sample	9.8	332	0.51	63	34.2	17.1

Table 5. Heavy metal contents of pineapple, banana and tomato.

Sample	Pineapple		Banana		Tomato	
	Arsenic (ppm)	Lead (ppm)	Arsenic (ppm)	Lead (ppm)	Arsenic (ppm)	Lead (ppm)
Control (without chemical)	Nil	Nil	Nil	0.12	Nil	0.05
Ethephone treated	Nil	0.12	Nil	0.31	0.025	0.15
Market sample	0.025	0.15	Nil	0.24	0.055	0.60

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