

Study of the Effect of Ethephon Treatment on Proximate Composition of Banana (*Musa Sepientum*)

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Abstract:

Background: Banana is a palatable fruit which is the cheapest source of nutrient available in the market. Wholesalers use Ethephon (2-chloroethyl phosphonic acid) as a ripening agent for the fast ripening of banana. The study was conducted to investigate the effect of the Ethephon as a ripening agent on the proximate composition of Banana.

Materials and Methods: The collected fresh green matured Banana fruits were divided into four lots. The 1st lot was left to ripen naturally without any Ethephon treatment, this event was symbolized as controlled. Then, the 2nd, 3rd, and 4th lots were treated by the immersion in a solution of Ethephon (80%: w/v) for uniform ripening at three different concentrations of 1000ppm, 1500ppm and 2000ppm for 5 minutes. The effect of Ethephon on the proximate composition of banana was observed with exposure duration from day 1 to day 7.

Results: The samples were analyzed for Ash, Moisture, Fat, Fiber, Protein, Total soluble solids, Total Sugar, Reducing Sugar content. The study revealed that the highest content of Ash ($0.93 \pm 0.06\%$ at 1st day), Fiber ($3.10 \pm 0.01\%$ at 1st day), protein ($1.73 \pm 0.02\%$ at 7th day), Total Soluble Solid ($26.05 \pm 0.09\%$ at 5th day), Total Sugar ($22.50 \pm 0.33\%$ at 5th day) and Reducing Sugar ($13.43 \pm 0.09\%$ at 5th day) were found for naturally ripened banana sample while the highest content of Moisture ($74.05 \pm 1.41\%$ at 7th day) and Fat ($0.264 \pm 0.005\%$ at 6th day) were found for the banana sample treated with 2000ppm Ethephon.

Conclusion: Such findings suggest that the use of Ethephon speed up ripening, but affects the nutritional quality of fruits. Thus, it is essential to build awareness among fruit producers, traders, and consumers about its effects on nutritional quality.

Key Word: Banana, Ethephon, Exposure duration, Proximate composition, Ripening agent.

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I. Introduction

Banana (*Musa Sepientum*) is a leading tropical fruit and it is one of the most popular fruit worldwide including Bangladesh. It is estimated that 100 million people survive on banana and plantains as their major energy source¹. The only fruit which is within the buying capacity of poor people is Banana. It is considered to be the number one fruit in Bangladesh considering the year-round availability, popularity, and production. This crop accounts for 40.7% of the entire fruit production in the country². Banana fruits are wholesome and fairly well-balanced source of nutrients containing various mineral salts, a high amount of carbohydrates with a little oil and protein³. Banana is considered to have significant health benefits. Reducing risk of high blood pressure, reducing the risk of strokes, cholesterol-lowering effect, great support to kidney health and has potential as a remedy for heartburn and important to healthy teeth and bones, giving a better contribution to body's immune system, promoting brain health and heart health are some of its significant health benefits⁴.

So maintaining the good quality composition of banana during growing and after harvesting is a prime concern. But there are evidence that artificial ripening agents such as ethanol, methanol, ethylene glycol, ethephon, calcium carbide are used to ripen fruits and vegetables artificially in wholesale markets and by the fruit processing industry to accelerate postharvest ripening of fruit^{5,6,7}. The adverse potential of calcium carbide as a ripening agent has been established. Other chemical ripening agents like ethephon, ethreal and ethylene glycol are also considered hazardous to health and they have to be used within recommended safe limits⁸. Ethephon treated fruits require a lesser amount of time for ripening than other treated fruits as well as compared

with the non-treated fruits⁹. In aqueous solution, Ethephon is decomposed into ethylene, bi-phosphate ion and chloride ion. The released ethylene fastened up the ripening process¹⁰.

Fruit sellers ripen green fruits using artificial methods even during the due season to meet the high demand and make a high profit of seasonal fruits. Several days can be taken for transporting and distributing fruits from the farmer's orchards to consumer's baskets. During this time the naturally ripened fruits may become over ripen and uneatable. Due to the harsh condition of transportation, a part of naturally ripened fruits can also be damaged. It indeed increases great economic loss for the fruit sellers and therefore, fruit sellers sometimes prefer collecting fruits before full maturity and artificially ripen fruits before selling to the consumers to minimize the loss¹¹. The aim of the study was to investigate the effect of the Ethephon as artificial ripening agent on the proximate composition of banana.

II. Material And Methods

The Study was conducted at Fruits Technology Research Section, Institute of Food Science & Technology, Bangladesh Council of Scientific & Industrial Research (BCSIR), Dr. Qudrat-i-Road, Dhanmondi, Dhaka-1205.

Samples Collection: Hands of mature green Banana fruits (scientific name: *Musa sep.* & Local name: Bangla kola) were harvested from a single local farm situated in Cumilla District in the first week of September 2019. Bananas were harvested after approximately 90 to 95 days from flowering. The lengths of Bananas were from 7.5 to 8cm and diameter from 2 to 2.5cm.

Ethephon: Ripen-15, Ethephon 80%:w/v provided by National Agricultural Import and Export Ltd. was used for this Research work. It was in pink liquid form.

Sample treatment: The collected Banana fruits were divided into four lots. The 1st lot was left to ripe naturally without any Ethephon treatment, this is symbolized as controlled. Then the 2nd, 3rd and 4th lots were treated by the immersion in a solution of Ethephon for uniform ripening at three different concentrations of 1000ppm, 1500ppm and 2000ppm for 5 minutes. Then the surfaces of the bananas were air-dried and kept in plastic bags. Then these were stored at 31°C in the ripening room. The flow chart of sample processing steps is given in (Figure no 1. Flow chart of sample processing. The data of various physic-chemical attributes were recorded after 21 hours from treatment which is stated as D1 to D7. Every day, samples were collected at the same time (10.00 am).

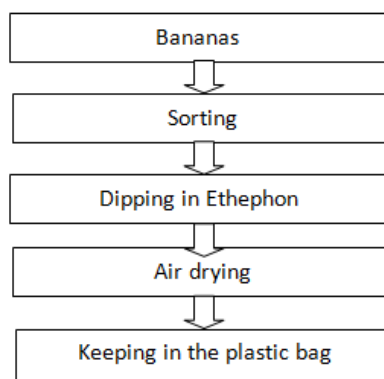


Figure no 1. Flow chart of sample processing.

Proximate analysis of banana

The Ash content was determined by the process of Ranganna¹². Moisture and Crude protein content were determined according to AOAC method¹³. Crude fiber content and total fat content were determined by standard AOAC method¹⁴. The total soluble solid (TSS) was determined with a hand refract-meter¹⁵. Total Sugar (TS) and Reducing sugar (RS) were determined by the method of Ranganna¹².

Statistical Analysis

All data were expressed as mean \pm standard deviation of three replicates. Data were analyzed using general linear model analysis of variance followed by Duncan multiple range test with 95% confidence using Statistical Package for Social Science (SPSS) for Windows version 25.0. P-values less than or equal to 0.05 (p

≤0.05) were considered statistically significant. A bi-variate correlation matrix was formed for the determination of the correlation between characteristics of the proximate composition.

III. Result

Table no1 shows the changes in Ash content (%) during ripening. The higher values of Ash were observed on the 1st day of the ripening period for all four samples. The highest Ash content (0.93±0.06%) was recorded from the controlled (untreated) banana sample and the lowest Ash content (0.75±0.04%) was recorded from the banana sample treated with 2000 ppm Ethephon at 6th day. The values of Ash content were recorded as decreasing with increasing the Ethephon concentration in Sample (Figure no 2).

Table no2: Changes in Ash content (%) during artificial ripening by treatment of Ethephon.

Sample treated with Ethephon	Exposure Duration (Day)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Controlled (0ppm)	0.93±0.06 ^{Aa}	0.87±0.07 ^{Aa}	0.85±0.07 ^{Aa}	0.84 ±0.07 ^{Aa}	0.83±0.10 ^{Aa}	0.82±0.05 ^{ABa}	0.89±0.08 ^{Aa}
1000ppm	0.90±0.07 ^{Aa}	0.85±0.03 ^{Aa}	0.84±0.03 ^{Aa}	0.83±0.06 ^{Aa}	0.82±0.10 ^{Aa}	0.80±0.02 ^{ABa}	0.79±0.03 ^{AB} _a
1500ppm	0.87±0.05 ^{Aa}	0.82±0.00 ^{Abc}	0.81±0.03 ^{Abc}	0.81±0.03 ^{Abc}	0.80±0.02 ^{Abc}	0.84±0.02 ^{ABab}	0.77±0.03 ^{Bc}
2000ppm	0.84±0.05 ^{Aa}	0.81±0.08 ^{ABab}	0.80±0.03 ^{ABab}	0.80±0.01 ^{ABab}	0.79±0.02 ^{ABab}	0.75±0.04 ^{Bb}	0.76±0.05 ^{Ba} _b

Notes: Values sharing the same letter in the same column or same row are not significantly different (p >0.05).

Values are means ± standard deviations of three replicates experiments.

Various capital letters represents the significant difference between mean values in the same column(p ≤0.05).

Various lowercase letters represents the significant difference between mean values in the same row (p ≤0.05).

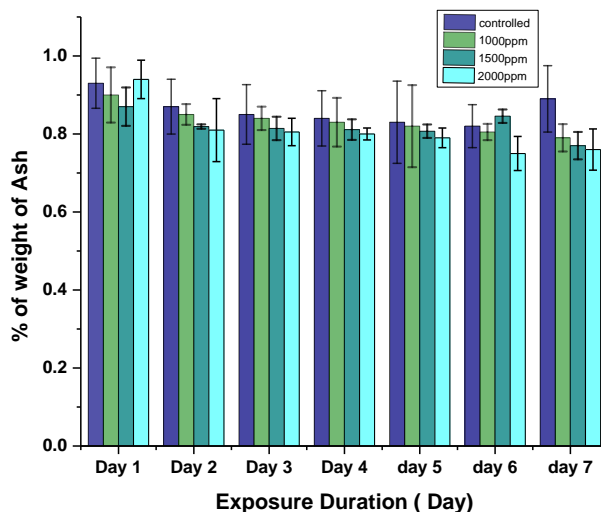


Figure no 3: Ash content of naturally ripened banana and banana ripened with Ethephon at different concentrations (error bars for n=3 samples).

Table no3 shows the changes in Moisture content (%) during ripening. The higher values of Moisture content were observed on the 7th day of the ripening period for all four samples and the highest Moisture content (74.05±1.41%) was recorded from banana sample treated with 2000ppm Ethephon. The values of Moisture content were recorded as increasing with increasing the Ethephon concentration in Sample. The lowest Moisture content (60.09±2.07%) was recorded from the controlled (untreated) banana sample at 1st day. Moreover, Moisture content was increased with the increasing ripening period in this study (Figure no 4).

Table no 4: Changes in Moisture content (%) during artificial ripening by treatment of Ethephon.

Sample treated with Ethephon	Exposure Duration (Day)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Controlled (0ppm)	60.09±2.07 ^{Bc}	63.29±1.79 ^{Bb}	63.54±1.83 ^{Bb}	64.04±1.31 ^{Ab}	64.09±1.32 ^{Cb}	65.39±1.39 ^{Bab}	67.70±1.03 ^{Ca}
1000ppm	61.99±0.29 ^{ABc}	65.16±0.46 ^{ABb}	65.51±1.13 ^{ABb}	66.06±1.02 ^{Ab}	66.32±0.56 ^{Bb}	70.03±1.00 ^{Aa}	70.69±1.72 ^{BCa}

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1500ppm	62.03±0.91 ^{ABd}	64.86±0.61 ^{ABc}	65.52±1.15 ^{ABbc}	66.16±0.99 ^{Abc}	67.17±0.17 ^{ABb}	71.53±0.44 ^{Aa}	72.11±2.09 ^{ABa}
2000ppm	63.24±0.73 ^{Ac}	66.07±1.19 ^{Ab}	66.17±0.49 ^{Bb}	66.33±1.47 ^{Ab}	68.03±0.84 ^{Ab}	72.02±2.02 ^{Aa}	74.05±1.41 ^{Aa}

Notes: Values sharing the same letter in the same column or same row are not significantly different ($p > 0.05$). Values are means ± standard deviations of three replicates experiments. Various capital letters represents the significant difference between mean values in the same column ($p \leq 0.05$). Various lowercase letters represents the significant difference between mean values in the same row ($p \leq 0.05$).

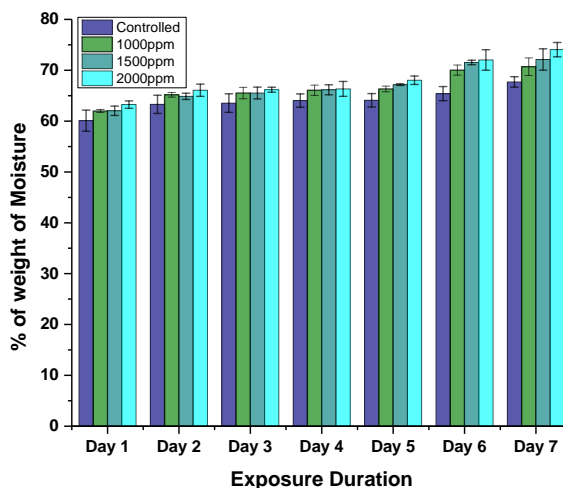


Figure no 5: Moisture content of naturally ripened banana and banana ripened with Ethephon at different concentration (error bars for n=3 samples).

Table no 5 shows the changes in Fiber content (%) during ripening. The higher values of Fiber content were observed on the 1st day of the ripening period for all four samples and the highest Fiber content (3.10±0.01%) was recorded from the controlled (untreated) banana sample. The lowest Fiber content (1.47±0.06%) was recorded from the banana sample treated with 2000ppm Ethephon at the 7th day. The value of Fiber content was recorded as decreasing with increasing the Ethephon concentration in Sample (Figure no 6). There was an inverse correlation between Fiber and Moisture with correlation coefficients -.860 (

Table no 16. Correlation coefficients between proximate compositions of Banana..

Table no 6: Changes in Fiber content (%) during artificial ripening by treatment of Ethephon.

Sample treated with Ethephon	Exposure Duration (Day)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Controlled (0ppm)	3.10±0.01 ^{Aa}	2.78±0.02 ^{Ab}	2.58±0.03 ^{Ac}	2.34±0.03 ^{Ad}	2.47±0.05 ^{Ae}	1.87±0.03 ^{Af}	1.64±0.05 ^{Ag}
1000ppm	2.92±0.04 ^{Ba}	2.67±0.04 ^{Bb}	2.33±0.09 ^{Ac}	2.33±0.05 ^{Ad}	1.91±0.03 ^{ABe}	1.73±0.04 ^{Bf}	1.56±0.075 ^{ABg}
1500ppm	2.81±0.04 ^{Ca}	2.63±0.08 ^{BCb}	2.45±0.05 ^{ABc}	2.26±0.02 ^{Ad}	1.86±0.07 ^{Bc}	1.69±0.08 ^{BCf}	1.58±0.07 ^{ABg}
2000ppm	2.79±0.05 ^{Ca}	2.57±0.04 ^{Cb}	2.36±0.06 ^{Bc}	2.19±0.03 ^{Bd}	1.78±0.09 ^{Cc}	1.73±0.05 ^{Cf}	1.47±0.06 ^{Bg}

Notes: Values sharing the same letter in the same column or same row are not significantly different ($p > 0.05$). Values are means ± standard deviations of three replicates experiments. Various capital letters represents the significant difference between mean values in the same column ($p \leq 0.05$). Various lowercase letters represents the significant difference between mean values in the same row ($p \leq 0.05$).

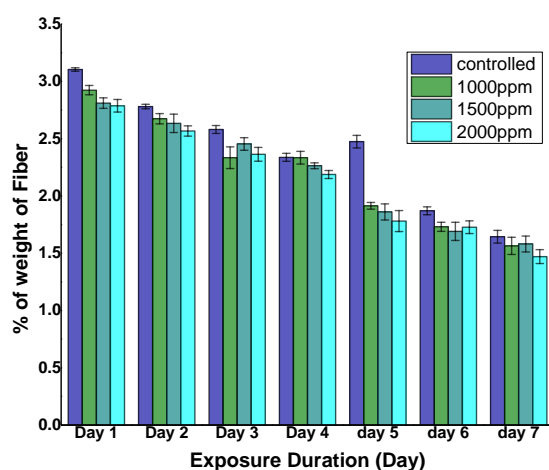


Figure no 7: Fiber content of naturally ripened banana and banana ripened with Ethephon at different concentration (error bars for n=3 samples).

Table no 7 shows the changes in Fat content (%) during ripening. The highest Fat content (0.264±0.005%) was recorded from the banana sample treated with 2000ppm Ethephon at the 6th day. The lowest Fat content (0.015±0.002%) was recorded from the banana sample treated with 1500ppm Ethephon at the 5th day. Amount of lipid of all samples treated with Ethephon at different concentrations changed irregularly with ripening period (Figure no 5).

Table no 8: Changes in Fat content (%) during artificial ripening by treatment of Ethephon.

Sample treated with Ethephon	Exposure Duration (Day)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Controlled(0ppm)	0.045±0.001 ^{BCf}	0.093±0.002 ^{Bc}	0.071±0.000 ^{Bd}	0.061±0.001 ^{Ce}	0.048±0.001 ^{Cf}	0.109±0.001 ^{Bb}	0.184±0.004 ^{Aa}
1000ppm	0.041±0.000 ^{Ce}	0.165±0.007 ^{Aa}	0.158±0.007 ^{Aa}	0.146±0.003 ^{Ab}	0.132±0.005 ^{Dc}	0.124±0.004 ^{Bc}	0.114±0.000 ^{Cd}
1500ppm	0.049±0.001 ^{ABcd}	0.059±0.001 ^{Cc}	0.041±0.001 ^{Cd}	0.028±0.003 ^{De}	0.015±0.002 ^{Bf}	0.123±0.015 ^{Ba}	0.086±0.000 ^{Db}
2000ppm	0.053±0.006 ^{Af}	0.065±0.005 ^{Ce}	0.071±0.002 ^{Be}	0.093±0.004 ^{Bd}	0.196±0.000 ^{Ab}	0.264±0.005 ^{Aa}	0.137±0.001 ^{Bc}

Notes: Values sharing the same letter in the same column or same row are not significantly different ($p > 0.05$).

Values are means ± standard deviations of three replicates experiments.

Various capital letters represents the significant difference between mean values in the same column ($p \leq 0.05$).

Various lowercase letters represents the significant difference between mean values in the same row ($p \leq 0.05$).

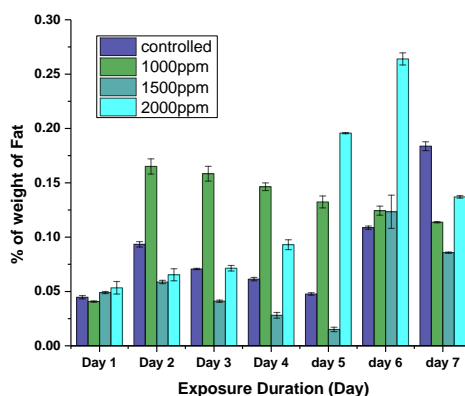


Figure no 8: Fat content of naturally ripened banana and banana ripened with Ethephon at different concentration (error bars for n=3 samples).

Table no 9 illustrates the changes in Protein content (%) during ripening. The higher values of Protein content were observed on the 7th day of ripening period for all four samples. The highest Protein content (1.73±0.02%) was recorded from the controlled (untreated) banana sample at the 7th day. The lowest Protein content (1.43±0.00%) was recorded from the controlled (untreated) sample and sample treated with 2000ppm Ethephon at the 1st day. The results showed that Protein content in samples was decreased with the escalation of the ripening agent used (Figure no 9).

Table no 10: Changes in Protein content (%) during artificial ripening by treatment of Ethephon.

	Sample treated with Ethephon			Exposure Duration (Day)			
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Controlled (0ppm)	1.43±0.01 ^{Cf}	1.48±0.00 ^{Ae}	1.56±0.01 ^{Ad}	1.63±0.02 ^{Ac}	1.67±0.00 ^{Ab}	1.70±0.02 ^{Aa}	1.73±0.02 ^{Aa}
1000ppm	1.48±0.00 ^{Ae}	1.50±0.02 ^{ABcd}	1.53±0.00 ^{Bc}	1.50±0.15 ^{Bd}	1.51±0.00 ^{Bcd}	1.68±0.01 ^{Bb}	1.71±0.02 ^{Aa}
1500ppm	1.45±0.00 ^{Bd}	1.48±0.01 ^{ABcd}	1.48±0.00 ^{Ccd}	1.50±0.02 ^{Bc}	1.51±0.01 ^{Bc}	1.62±0.00 ^{Cb}	1.68±0.04 ^{Aa}
2000ppm	1.43±0.00 ^{Bc}	1.45±0.02 ^{Bde}	1.47±0.00 ^{Cd}	1.48±0.01 ^{Bcd}	1.50±0.03 ^{Bc}	1.58±0.01 ^{Db}	1.62±0.02 ^{Ba}

Notes: Values sharing the same letter in the same column or same row are not significantly different (p > 0.05). Values are means ± standard deviations of three replicates experiments. Various capital letters represents the significant difference between mean values in the same column (p ≤ 0.05). Various lowercase letters represents the significant difference between mean values in the same row (p ≤ 0.05).

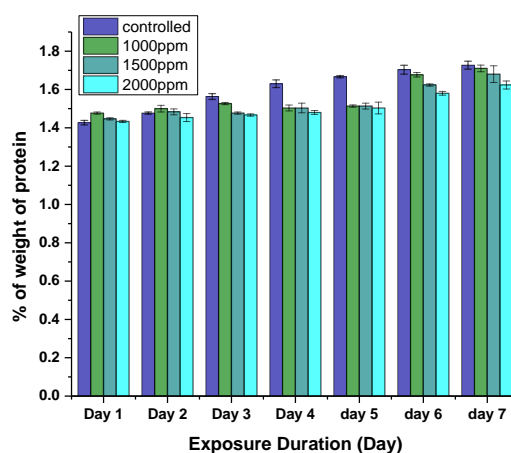


Figure no 10: Protein content of naturally ripened banana and banana ripened with Ethephon at different concentration(error bars for n=3 samples).

Table no 11 records the changes in TSS content (%) during ripening. The higher values of TSS content were observed on the 5th day of ripening period for all four samples and the highest TSS content (26.05±0.09%) was recorded from the controlled (untreated) banana sample at the 5th day. TSS content variation was in trend of increment during the ripening period of day 1 to day 5 for all four samples and in a trend of decrements from day 6 to day 7 (Figure no 11). Total soluble solid had a linear correlation with Total sugar and Reducing sugar with correlation coefficients .789 and .848 respectively (

Table no 16. Correlation coefficients between proximate compositions of Banana.).

Table no 12: Changes in TSS content (%) during artificial ripening by treatment of Ethephon.

Sample treated with Ethephon	Exposure Duration (Day)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Controlled (0ppm)	6.25±0.43 ^{Df}	11.00±0.25 ^{Ce}	16.17±0.29 ^{Bd}	20.17±1.15 ^{Ac}	26.05±0.09 ^{Aa}	22.83±0.29 ^{Ab}	20.33±0.58 ^{Bc}
1000ppm	15.33±0.58 ^{Af}	19.17±0.72 ^{Ad}	20.08±0.63 ^{Ac}	21.17±0.52 ^{Ab}	22.17±0.29 ^{Ba}	20.92±0.14 ^{Bbc}	18.17±0.29 ^{Ce}
1500ppm	14.17±0.52 ^{Bf}	19.00±0.00 ^{Ae}	20.17±0.29 ^{Ad}	21.08±0.38 ^{Abc}	21.58±0.14 ^{Cb}	20.50±0.50 ^{Bcd}	23.92±0.14 ^{Aa}

2000ppm	13.17±0.29 ^{Ce}	18.00±0.66 ^{Bd}	19.50±0.50 ^{Ac}	21.00±1.00 ^{Aab}	21.92±0.14 ^{BCa}	20.17±1.25 ^{Bbc}	19.66±0.76 ^{Bbc}
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Notes: Values sharing the same letter in the same column or same row are not significantly different ($p > 0.05$). Values are means ± standard deviations of three replicates experiments. Various capital letters represents the significant difference between mean values in the same column ($p \leq 0.05$). Various lowercase letters represents the significant difference between mean values in the same row ($p \leq 0.05$).

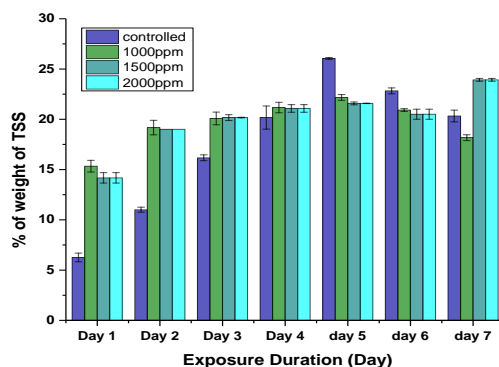


Figure no 12: TSS content of naturally ripened banana and banana ripened with Ethephon at different concentration (error bars for n=3 samples).

Table no 13 and 8 record the changes in TS and RS content (%) during ripening. The higher values of TS and RS content were observed on the 5th day of the ripening period for all four samples. Both of the highest TS and RS content (22.50±0.33% and 13.43±0.09% respectively) were recorded from the controlled (untreated) banana sample at the 5th day. Both the TS and RS content variation was in the trend of increment during the ripening period of day 1 to day 5 for all four samples. After day 5, both TS and RS content began to decline for all four samples (Figure no 8). There was a linear correlation between Total sugar and Reducing sugar with correlation coefficients .925 (

Table no 16. Correlation coefficients between proximate compositions of Banana..

Table no 14: Changes in TS content (%) during artificial ripening by treatment of Ethephon.

Sample treated with Ethephon	Exposure Duration (Day)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Controlled (0ppm)	5.36±0.06 ^{Df}	10.94±0.56 ^{Be}	14.50±0.50 ^{Ad}	18.65±0.33 ^{Ab}	22.50±0.33 ^{Aa}	15.98±0.09 ^{Bc}	10.92±0.23 ^{Dc}
1000ppm	6.79±0.03 ^{Af}	13.94±0.42 ^{Ae}	15.00±0.18 ^{Ad}	16.65±0.05 ^{Bc}	17.00±0.17 ^{Bb}	16.53±0.09 ^{Ac}	17.85±0.07 ^{Aa}
1500ppm	6.38±0.05 ^{Bf}	13.81±0.16 ^{Ad}	14.87±0.10 ^{Ac}	15.78±0.06 ^{Cb}	16.79±0.12 ^{BCa}	14.72±0.06 ^{Cc}	12.34±0.04 ^{Cc}
2000ppm	6.14±0.10 ^{Cf}	13.65±0.02 ^{Ad}	14.60±0.18 ^{Ac}	16.00±0.20 ^{Cb}	16.52±0.04 ^{Ca}	14.45±0.04 ^{Dc}	13.42±0.04 ^{Be}

Notes: Values sharing the same letter in the same column or same row are not significantly different ($p > 0.05$). Values are means ± standard deviations of three replicates experiments. Various capital letters represents the significant difference between mean values in the same column ($p \leq 0.05$). Various lowercase letters represents the significant difference between mean values in the same row ($p \leq 0.05$).

Table no 15: Changes in RS content (%) during artificial ripening by treatment of Ethephon.

Sample treated with Ethephon	Exposure Duration (Day)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Controlled (0ppm)	4.95±0.04 ^{Cg}	8.07±0.02 ^{Df}	10.98±0.08 ^{Bd}	13.14±0.04 ^{Ab}	13.43±0.09 ^{Aa}	12.59±0.02 ^{Ac}	10.88±0.06 ^{Dc}
1000ppm	5.75±0.04 ^{Af}	10.84±0.05 ^{Cc}	11.10±0.17 ^{Bd}	11.89±0.00 ^{Cc}	12.59±0.04 ^{Ca}	11.76±0.11 ^{Cc}	12.14±0.03 ^{Ab}
1500ppm	5.65±0.05 ^{Be}	11.01±0.08 ^{Bd}	11.75±0.02 ^{Ac}	11.87±0.03 ^{Cc}	13.20±0.06 ^{Ba}	12.11±0.16 ^{Bb}	11.03±0.00 ^{Cd}
2000ppm	5.50±0.07 ^{Bf}	11.11±0.00 ^{Ae}	11.89±0.06 ^{Ad}	12.55±0.01 ^{Bc}	13.23±0.00 ^{Ba}	12.75±0.05 ^{Ab}	11.90±0.10 ^{Bd}

Notes: Values sharing the same letter in the same column or same row are not significantly different ($p > 0.05$). Values are means ± standard deviations of three replicates experiments. Various capital letters represents the significant difference between mean values in the same column ($p \leq 0.05$). Various lowercase letters represents the significant difference between mean values in the same row ($p \leq 0.05$).

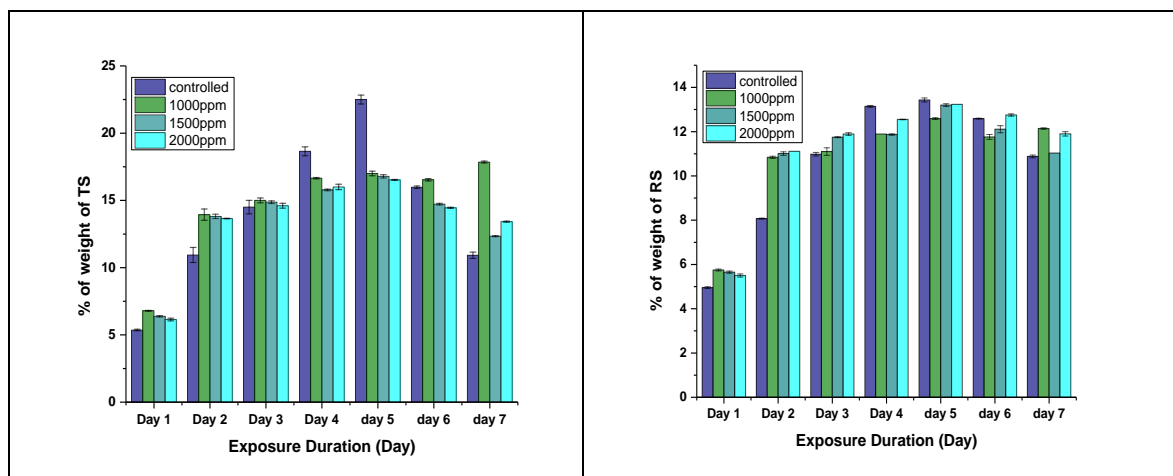


Figure no 8: TS and RS content of naturally ripened banana and banana ripened with Ethephon at different concentration (error bars for n=3 samples).

Table no 16. Correlation coefficients between proximate compositions of Banana.

Sample	Ash	Moisture	Fat	Fiber	TSS	TS	RS	Protein
Ash	1	-.710**	-.343	.696**	-.688**	-.647**	-.772**	-.338
Moisture	-.710**	1	.509**	-.860**	.547**	.394*	.593**	.555**
Fat	-.343	.509**	1	-.504**	.258	.187	.340	.333
Fiber	.696**	-.860**	-.504**	1	-.706**	-.552**	-.703**	-.758**
TSS	-.688**	.547**	.258	-.706**	1	.789**	.848**	.527**
TS	-.647**	.394*	.187	-.552**	.789**	1	.925**	.460*
RS	-.772**	.593**	.340	-.703**	.848**	.925**	1	.485**
Protein	-.338	.555**	.333	-.758**	.527**	.460*	.485**	1

Notes: **. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The units of measurement are : Ash (%); Moisture (%); Fat (%); Fiber (%); Protein (%); Total soluble solid (%); Total Sugar (%) and Reducing Sugar (%).

IV. Discussion

Ethephon is being used as ripening agents for fruits and vegetables by farmers and traders. To evaluate the effect of the use of ethephon on the food value of banana, it was important to investigate the effect of Ethephon by treating it on the proximate composition of banana. The present study was conducted at Fruits Technology Research Section, Institute of Food Science & Technology, Bangladesh Council of Scientific & Industrial Research (BCSIR), Dr. Quadrat-i-Road, Dhanmondi, and Dhaka-1205 and at the Analytical and Environmental Chemistry Research Laboratory, Department of Chemistry, Comilla University, Cumilla, Bangladesh. The study provided a better understanding of the influence of Ethephon on proximate composition over the exposure duration. Ethephon treated samples were found to contain a comparatively low level of food value than the naturally ripened (controlled) banana.

This study revealed that the highest content of Ash ($0.93 \pm 0.06\%$) and Fiber ($3.10 \pm 0.01\%$) were found for a naturally ripened banana at 1st day while such contents of Ethephon treated banana were observed as decrease with a gradual increase in the concentration of Ethephon. These findings are similar to the majority of studies in the literature, which have shown the content of Ash and fiber were decreased with the increasing concentration of artificial ripening agent^{1, 16}. Moreover, Ash content and fiber content were decreased with the increasing ripening period in this study. This trend was supported by earlier reported work¹⁷.

The highest protein content ($1.73 \pm 0.02\%$) was found for naturally ripened banana at the 7th day which was also observed to decrease with the gradual increase in the concentration of Ethephon. Similar findings were reported in previous literature in which protein contents were gradually decreased with an increase in artificial ripening agents¹.

The highest content of TSS ($26.05 \pm 0.09\%$), TS ($22.50 \pm 0.33\%$) and RS ($13.43 \pm 0.09\%$) was found for naturally ripened banana at 5th day. The study revealed that naturally ripened banana had higher TSS, TS and RS content as compare to Ethephon treated Banana. These findings are similar to the majority of studies in the literature in which TS and RS contents were higher in naturally ripened banana as compare to artificially ripened banana¹⁸. The study disclosed that TSS, TS and RS content variation were in the trend of increment during the ripening period of day 1 to day 5 for all four samples. These observations were similar to the earlier reported

studies in which Total sugar variation was in the trend of increment during the ripening period^{18, 19}. The sugar contents were increased slowly in storage time. This means that in the postharvest ripening process, fruits would produce the reducing sugar content more than the consumption of sugar content during the ripening process. After day 5, both TS and RS content began to decline for all four samples. Similar results were found in earlier reported work in which reducing sugar contents were increased gradually, then declined sharply and were used for the respiratory process²⁰. Therefore, sugar content decreased.

The highest content of Moisture (74.05±1.41%) was found for the banana sample treated with 2000ppm Ethephon at 7th day. Such findings of Moisture content were consistent with the previous literature¹. Moreover, Moisture content was increased with increasing ripening period in this study. Similar trends were observed in the previously reported work in which Moisture content was increased with the increasing ripening period¹⁷. As the moisture content increased, the banana softened, which also reveals that within fruit moisture may have migrated from peel to pulp and increase in sugar content in the pulp as a result of starch hydrolysis to sugar¹⁶. The highest content of Fat (0.264±0.005%) was found for the banana sample treated with 2000ppm Ethephon at the 6th day.

V. Conclusion

Such findings suggest that the use of Ethephon speed up ripening, but affects the nutritional quality of fruits and it is necessary to arise massive awareness about its effect on nutrition values and use with appropriate dose might be practiced. Moreover, the responsible administration for surveying and controlling the usage of various growth hormone and ripening agents must be active enough.

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