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EFFECTS OF ETHYLENE DOSE AND BIOLOGICAL RIPENING AGENTS ON QUALITY AND SELF LIFE OF BANANA (*Musa paradisiacal L.)* IN GOKULESHWOR, BAITADI

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ABSTRACT

A study was carried out at horticulture laboratory of Gokuleshwor Agriculture and Animal Science Collage, Gokuleshwor Baitadi, Nepal during June 19 to July 01, 2018 to evaluate the effects of different ethylene doses and biological ripening agents on quality and self-life of banana. This research was conducted on Complete Randomized Design (CRD) with five treatments and four replications. The treatments consisted of five different ripening agents i.e. T_1 = Control, T_2 = Biological ripening agent (equal proportion of ripe banana + ripe apple + asuro), T_3 = 250 ppm ethophon, T_4 = 500 ppm ethophon and T_5 = 750 ppm ethophon. In experiment, ten banana fingers were used as destructive sample and six fingers were used as non- destructive method of sampling. The research result showed that the maximum TSS (27^0 Brix) and TA (0.936%) was found in T_3 (250 ppm ethephon) and minimum TSS (13.0 ^{0}Brix) and TA (0.488%) was observed in in T_1 (control). Likewise, the highest pH (6.22) was found in T_1 (control) and least (4.27) was observed in T_5 (750 ppm ethophon). Also, minimum physiological loss in weight (22.23%) was observed in T_2 (Equal proportion of ripe banana + ripe apple + asuro) and maximum (32.53%). in T_5 (750 ppm ethophon). Similarly, maximum firmness (10.70 Kg/cm^2) was observed in T_2 (Equal proportion of ripe banana + ripe apple + asuro) and minimum firmness (9.51 Kg/cm ^{2}) was observed in T_5 (750 ppm ethophon). This study suggest that, for effective ripening of banana T_3 (250 ppm ethophon) respond best result and for increasing the self-life of banana T_2 (Equal proportion of ripe banana + ripe apple + asuro) was found best biological agent.

Keywords: Ripening, Fingers , Ethepone, Asuro, Total soluble solid

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1. INTRODUCTION

Banana is one of the popular fruit in the world. The name 'Banana' is derived from the Arabic word 'banan' which means 'finger' (boning, 2006). Banana, belongings to the family of musacea, is a large herb with a pseudo stem and consists of concentric layers of leaf sheaths rolled into a cylinder. Banana is grown worldwide and occupies 5th position on production in world and 4th position in nepal. The top ten countries which grow and provide substantial quantities of banana are India, Philippines, China, Eucador, Brazil, Indonesia, Mexico, Costa Rica, Colombia and Thailand (FAO, 2009). Banana can be grown from terai to 1500 m altitude of mid hills, in the Nepalese geophysical situation, where frost does not occur usually. The major production areas are terai, valleys and river basins (Bhusal 2008). In Nepal chitwan is the largest producer of banana. (MOAD,2075).

Banana is well known for its high nutritive value and many other health benefits. The flowers in bronchitis, dysentery and ulcer; cooked flowers are considered a good food for diabetics. The astringent plant sap used in cases of epilepsy, leprosy, fevers, hemorrhages, acute dysentery and diarrhea. Roots and seeds are used to treat digestive disorders. Peel and pulps both antifungal and antibiotic components. The antibiotic acts against bacteria. A fungicide in the peel and pulp of green fruits is active against a fungus disease of tomato plants. Norepinephrine, dopamine, and serotonin are also present in the ripe peel and pulp. The first two elevate blood pressure; serotonin inhibits gastric secretion and stimulates the smooth muscle of the intestines (Kumar, 2012). 100gm fresh weight of the edible part of the banana contains 385 mg of potassium (Aurore, Parfait & Fahrasmane 2009). Potassium is beneficial to maintain cell metabolism, regulate heart rhythm, enhance nerve and muscle excitability, reduce the risk of stroke and prevent cancer (Van Duyn & Pivonka, 2000; Aurore *et al.*, 2009).

Ethylene is associated with the ripening of many fruits and banana being a climateric fruit, it plays an important role in ripening (Klee & Giovannoni, 2011). physiological chanages in banana accompains its ripening with indicates the gradual rise and then fall (Thompson, 2015). Bright color is an important visible indicator of maturity and ripeness in fruit such as bananas. The pigments involved in color change in banana peel are chlorophylls, carotenes and xanthophylls found in chloroplasts and chromoplasts. Color changes are associated with the breakdown of chlorophyll as the fruit ripens and the unmasking of caritenoid pigments that are already present (Kays, 1991; Tucker, 1993).

2. MATERIALS AND METHODS

2.1 Experiment location detail

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The present study was conducted in Horticulture laboratory of Gokuleshwor Agriculture and Animal Science Collage, Gokuleshwor, Baitadi. It lies in Dilashaini rural municipality of Sudurpashim province with latitude 24°75' North& longitude 80°50' East and elevation of 700masl (Google earth,2018).

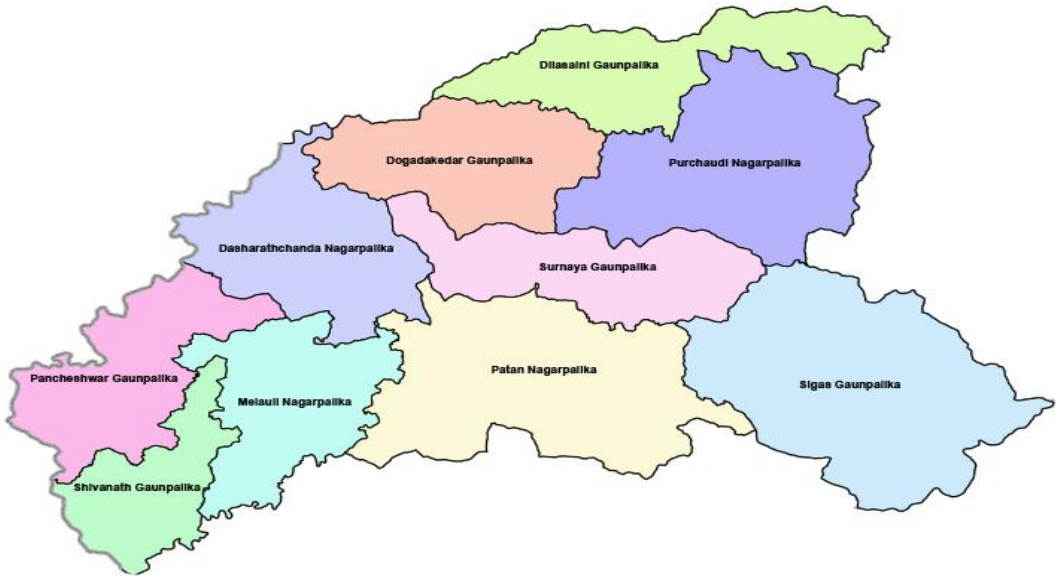

Figure 1: Map of Baitadi district

2.2 Preparation of experimental sample

Freshly mature, green stage banana (Musa paradisiaca L.) were brought from the local farmers field of Gokuleshwor, baitadi. The bananas were harvested on 19 june 2018, and were brought to laboratory. The harvested fruits were washed in fresh and clean water and were allowed to dry for one and half hours in order to remove the field heat and clean properly. In nondestructive sample six fingers were kept in each with wrapping by paper, which were used to determine physiological loss in weight. In destructive sample ten fingers were kept in each which were used to measure Total soluble solid (TSS), Titrable acidity (TA), PH and Firmness.

2.3 Experimental design

The experimental set up was done in completely randomized Design (CRD) with five treatments and four times replication.

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R_1T_1	R_2T_3	R_3T_5	R_4T_2
R_1T_2	R_2T_4	R_3T_1	R_4T_3
R_1T_3	R_2T_5	R_3T_4	R_4T_1
R_1T_4	R_2T_2	R_3T_3	R_4T_5
R_1T_5	R_2T_1	R_3T_2	R_4T_4

Figure 2: Layout of experimental design

2.4 Treatments detail

There were five different treatments were used for the study and they were allotted as follows:

T1 : control

T2 : biological ripening agent (Mixture of ripe banana, apple and leaves of asuro, 50 gm.)

T3 : Ethephon 250ppm

T4 : Ethehpon 500ppm

T5 : Ethephon 750ppm

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Reading was taken every two days interval at 2PM Physiological loss in weight was taken from the non destructive sampling procedure while the destructive procedure was followed for the observation of TSS, TA, PH and firmness.

2.5 Observation Parameters

2.5.1 Total soluble solid

The total soluble solid (°Brix) was determined by hand held Refractometer. A drop of juice was squeezed from the banana fruit sample on the prism of the Refractometer and TSS content was recorded at two days interval.

Figure 3: Refractometer

2.5.2 Titrable acidity (TA)

TA was measured by the method of titration, using standardized 0.1% NaOH solution and phenolphthalein indicator. TA was quantified by titrating juice of the banana was missed in 10ml of distilled water.

$$TA\ (\%) = \frac{NB * VB * milliequivalent\ Wt.of\ predominant\ acid * 100 * df}{Volume\ of\ Sample}$$

Where,

TA= Titrable Acidity

NB = Normality of base (NaOH)

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VB = Volume of the base

D.F.= Dilution factor

Milli-equivalent wt. of predominant acid i.e. citric acid = 0.064

2.5.3 pH of the fruits juice

pH of the fruit juice was measured by using automatic digital pH meter.

2.5.4 Physiological loss in weight (PLW)

It was calculated as the percentage weight loss of the initial weight. Initial weight of each sample was taken. The weight of a sample was taken on two days interval after setting of the experiment. Weight loss was measured with the help of digital balance having capacity to weight from two gram to 30 kilogram. The formula used for this calculation was:

$$Physiological\ Loss\ in\ Weight\ (\%) = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} * 100$$

2.5.5 Firmness

Firmness of the sample was measured with the help of hand held penetrometer at two days interval.

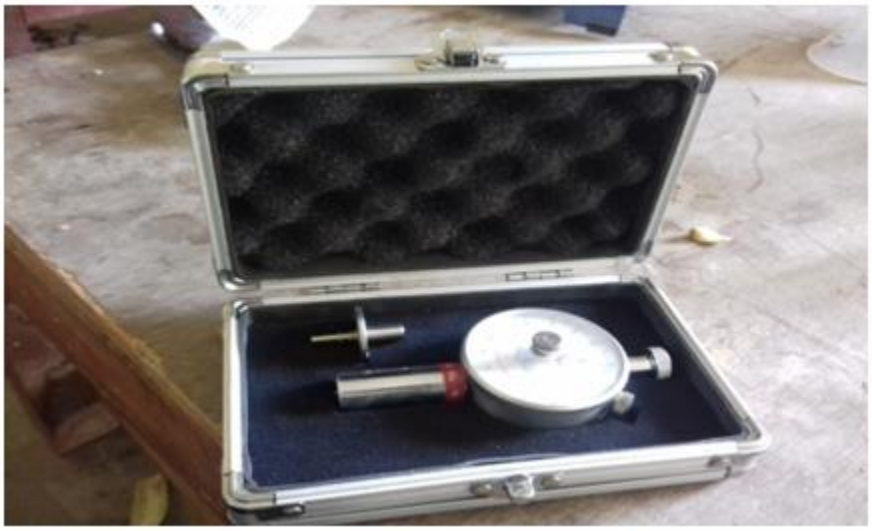

Figure 4: Penetrometer

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2.6. Data analysis

Data entry, compilation and analysis was done by using Microsoft excel (2007) and computer software Gen-stat (2015).

3. RESULT AND DISCUSSION

3.1 Total soluble solid (TSS)

Table 2: Effect of different ripening treatments on Total Soluble Solid (°Brix) of banana at different days

Treatment	Total Soluble solid (TSS)						
	Day 0	Day 2	Day 4	Day 6	Day 8	Day 10	Day 12
T_1=Control	5.025	7.65^{b}	7.05^{c}	8.68^{c}	19.50^{b}	15.5_{b}	13.0^{b}
T_2= Bio-agent	5.00	7.12^{b}	11.50^{b}	12.25^{b}	18.68^{ab}	24.8^{a}	22.25^{a}
T_3= 250 ppm ethephon	4.90	18.95^{a}	22.75^{a}	23.50^{a}	23.38^{a}	23.5^{a}	27.0^{a}
T_4= 500 ppm ethephon	5.025	18.23^{a}	23.75^{a}	23.26^{a}	23.50^{a}	25.5^{a}	24.75^{a}
$T_5$750 ppm ethephon	5.050	18.88^{a}	21.25^{a}	23.15^{a}	23.50^{a}	24.2^{a}	26.25^{a}
F-test	0.094	<.001	<.001	<.001	0.043	0.016	<.001
Sem (±)	0.6753	2.651	1.798	1.235	2.095	4.96	3.505
LSD	0.1135	3.995	2.71	1.862	4.062	7.47	5.282
CV	1.5	18.7	10.4	6.8	12.4	23.9	15.5
Grand mean	5	14.17	17.26	18.25	21.71	20.7	22.65

Mean with same letter within column do not differ significantly at p=0.05.Bio agent (ripe apple, ripe banana, asuro), SEM=standard error of mean, LSD=least significance difference, CV = coefficient of variation,*significant at 5 % and **significant at 1% level of significance, NS= Non-significant.

TSS of banana was significantly influenced by different treatments. Data shows that TSS was found increasing with increase in number of days. At zero days, there is not significant difference between ethophone treated and nontreated (control and bio-agent).

Similarly, at 6th day TSS was found maximum in T3(250ppm ethopone) 23.50 ^{0}brix and least in T1 (control) 8.68^{0}brix, which is highly significant.

High value of TSS indicates hasten of ripening whereas low mean value of TSS indicates delay of ripening. Increase in TSS is due to biochemical reaction and decrease in TSS is due to

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decrease in pH of banana during storage condition. Increase of TSS is due to hydrolysis of starch into soluble sugars such as sucrose, glucose and fructose (Maduwanthi & Marapana 2017).

3.2 Titrable acidity

Table 4: Effect of different ripening treatments on Titrable acidity of banana at different days

TreatmentTitrable acidity (%)							
	Day 0	Day 2	Day 4	Day 6	Day 8	Day 10	Day 12
T_1=Control	0.264^a	0.312^a	0.448^b	0.488^b	0.512^a	0.608^a	0.512^a
T_2=Bioagent	0.264^a	0312^a	0.344^b	0.51^b	0.544^a	0.560^a	0.512^a
T_3=250ppm Ethepone	0.272^a	0.315^a	0.608^a	0.936^a	0.584^a	0.664^a	0.592^a
T_4=500 ppm Ethepone	0.280^a	0.320^a	0.680^a	0.872^a	0.472^a	0.648^a	0.576^a
T_5=750 ppm Ethepone	0.272^a	0.312^a	0.696^a	0.776^a	0.544^a	0.656^a	0.680^a
F-test	0.792	0.9	<.001	<.001	0.841	0.818	0.376
Sem (±)	0.02066	0.02225	0.0906	0.1337	0.1415	0.1614	0.1301
LSD	0.3113	0.03353	0.1366	0.2015	0.2133	0.2432	0.196
CV	7.6	7.1	16.3	19.3	26.6	25.7	22.6
Grand mean	0.2714	0.312	0.555	0.693	0.531	0.627	0.574

Mean with same letter within column do not differ significantly at p=0.05.Bio agent (ripe apple, ripe banana, asuro), SEM=standard error of mean, LSD=least significance difference, CV = coefficient of variation,*significant at 5 % and **significant at 1% level of significance, NS= Non-significant.

The above table showed that the titrable acidity level increased during the preservation time from 0 to 6 days in all treatments. No significant difference was observable among all treatments at second days of ripening. At 6th day, there was significant difference between ethylene treated sample and other sample. The highest acidity was observed at 6th day (0.936%) in the treatment T_3 (250 ppm of ethepone concentration). After 6th days the acidity gone continuously decreased in ethepone treated sample and the acidity continuously increased up to 10th days in T_1 (control) and T_2(bio-agent) then starts decreasing in order.

The amount of acid did not show much of that variability in the sample with ethephon treatment, but it had the significant difference with non ethephon treatment samples. Bananas changed with

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ripening process, so damage process began to appear at the same time. The internal enzyme systems of bananas along with the development of microbial fermentation takes place strongly, that results increase in acidity in bananas fruits. It is also due to the aerobic respiration and under the effect of ethylene from ethephon, and the banana will ripe quickly (Ton et al., 2008). The decreases in titrable acidity due to the utilization of organic acids in various bio-degradable reaction (Zomo et.al., 2014)

3.3 PH

Table 5: Effect of different ripening treatments on pH of banana at different days

Treatment	PH						
	Day 0	Day 2	Day 4	Day 6	Day 8	Day 10	Day 12
T1=Control	6.55^{a}	6.42^{b}	6.22^{b}	6.3^{b}	6.38^{b}	6.42^{b}	6.45^{b}
T2=Bio-agent	6.47^{a}	6.27^{b}	5.9^{b}	6^{b}	6.12^{b}	6.2^{b}	6.35^{b}
T3=250 ppm Ethephon	6.57^{a}	4.95^{a}	4.67^{a}	4.75^{a}	5^{a}	5.32^{a}	5.35^{a}
T4=500 ppm ethephon	6.52^{a}	4.7a	4.52^{a}	4.57^{a}	5.6^{a}	5.7^{a}	5.83^{a}
T5=750 ppm Ethephon	6.55^{a}	4.52^{a}	4.27^{a}	4.52^{a}	5.55^{a}	5.65^{a}	5.8^{a}
F-test	0.444	<.001	<.001	<.001	0.071	0.005	0.931
Sem (±)	0.0827	0.1245	0.1612	0.2008	0.614	0.3672	0.665
LSD	0.1246	0.1876	0.243	0.3027	0.925	0.5534	1.002
CV	1.3	2.3	3.1	3.8	11.2	6.3	12
Grand mean	6.545	5.375	5.12	5.29	5.47	5.835	5.56

Mean with same letter within column do not differ significantly at p=0.05.Bio agent (ripe apple, ripe banana, asuro), SEM=standard error of mean, LSD=least significance difference, CV = coefficient of variation,*significant at 5 % and **significant at 1% level of significance, NS= Non-significant.

The Table showed that, in different ripening agent the pH value decrease from 0 day to 4th days and then increase slightly 4th days towards 12th days of ripening agent.

In the treatment T1 (control) from 0 day to 4th day pH decrease from 6.55 to 6.23,6th days increase slightly 6.45 and then up to 6th days to 12th days decrease from 6.45 to 5.65.In treatment (T2) bio-agent showed 0 days to 4th days value was decrease and then increase slightly 4th days towards 12th days (5.9 to 5.75). Similarly other ethepone treatments showed same pattern value, decrease at first 0 days to 4th days and then increase slightly from 4 days to 12 days.

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At initial stage of treatment (T1- T5) identical PH 6.50 was found. In the second days the PH was highest in the control (T1) 6.43 and lowest was in the ethopone 750ppm (T5) 4.25. In the treatment the value was decreasing till 4th days and increasing from the 4th days to 12th day. At the 10th days highest PH was observed in control T_1 (6.43) and lowest was observed in 250ppm ethopone 5.33. When the fruit progress towards ripening the Titratable acidity (TA) percentage goes on increasing it mean the PH value goes on decreasing in the fruit. Fruit having higher TA% can be considered more ripened than that having lower TA%. Titratable acidity denotes the maturity period of banana. In general, tritrable acidity increase towards maturity but in our reasarch it is increased at first then slightly decreases at 6th days and then increased at the end of research. Similar type of observation recorded by Banis sharma and singh (2017) who observed increase up to 6th day of treatment and then decrease slightly up to 12th days.

3.4 Physiological loss of weight (PLW)

Table 3: Effect of different ripening treatments on Physiological loss of weight (PLW) of banana at different days

Treatment	Physiological loss in weight % (PLW)					
	Day 2	Day 4	Day 6	Day 8	Day 10	Day 12
T_1= Control	5.26^{a}	9.48^{a}	14.17^{a}	18.12^{b}	22.20^{b}	26.49^{ab}
T_2=Bioagent	2.54^{b}	5.51^{b}	9.70^{b}	13.72^{c}	17.68^{c}	22.23^{c}
T_3= 250ppm ethepone	5.12^{a}	9.64^{a}	15.02^{a}	19.73^{ab}	23.93^{ab}	28.39^{ab}
T_4=500 ppm ethepone	5.17^{a}	10.95^{a}	17.1^{a}	22.00^{ab}	26.45^{ab}	31.44^{ab}
T_5=750 ppm ethepone	5.04^{a}	11.28^{a}	17.75^{a}	22.27^{a}	27.41^{a}	32.53^{a}
F-test	<.001	<.001	0.001	0.001	0.001	0.004
Sem (±)	0.817	1.46	2.205	2.497	2.753	3.37
LSD	1.231	2.201	3.324	3.764	4.149	5.08
CV	17.7	15.6	15	13	11.7	11.9
Grand mean	4.61	9.31	14.73	19.17	23.53	28.22

Mean with same letter within column do not differ significantly at p=0.05.Bio agent (ripe apple, ripe banana, asuro), SEM=standard error of mean, LSD=least significance difference, CV = coefficient of variation,*significant at 5 % and **significant at 1% level of significance, NS= Non-significant.

The table no 4.2 showed that there were highly significant difference among bio-agent and other treatment. Among the different treatment bio-agent showed lowest percentage of weight loss whereas highest percent weight loss was observed in t5. During experiment it was observed that

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the wt. loss was minimum in initial days and gradually increases with increase in days and reaches the maximum value in 12th day. Bio-agent showed lowest % of wt. loss (22.23) and ethephon 750 ppm showed highest % of wt. loss (32.53) in 12th day. The increased in PWL during ripening may be due to increased transpiration, respiration and dehydration. Respiration causes a weight loss because a carbon atom is lost from the commodity each time a carbon-dioxide molecule is produced from an absorbed oxygen molecule and evolved into the atmosphere.

Higher respiration rates increase the temperature thus increasing production and loss of water. Water loss or dehydration means a loss in fresh weight. This in turn affects the appearance, texture, and in some cases the flavor. Water loss also affects crispiness and firmness (Simon and Straus, 2010).

3.5 Firmness

Table 6: Effect of different ripening treatments on Firmness of banana at different days

TreatmentFirmness (Kg/Cm^2)				
	Day 0	Day 2	Day 4	Day 6
T_1= Control	12.7^a	12.43^a	11.45^a	10.70^a
T_2=Bioagent	12.55^a	11.90^{ab}	11.35^a	10.70^a
T_3=250 ppm Ethepone	12.2^a	11.62^{ab}	10.70^{ab}	9.95^{ab}
T_4=500 ppm Ethepone	13.15^a	11.90^{ab}	10.40^{ab}	9.625^a
T_5=750 ppm ethepone	12.75^a	11.25^b	10.25^b	9.5111^b
F-test	0.31	0.217	0.061	<.001
Sem (±)	o.601	0.674	0.647	0.3391
LSD	0.905	1.015	0.974	0.5111
CV	4.7	5.7	6	3.4
Grand mean	12.67	11.82	10.83	10.1

Mean with same letter within column do not differ significantly at p=0.05.Bio agent (ripe apple, ripe banana, asuro), SEM=standard error of mean, LSD=least significance difference, CV = coefficient of variation,*significant at 5 % and **significant at 1% level of significance, NS= Non-significant.

In table 4.5. The firmness values were in the narrow range of 9.511^{b} to 10.70^{a} in all the treatments of 6th day and differences were not statistically significant. In T5 (750 ppm ethephone), the value of firmness was observed about 12.75 and 9.5111 at 0 and 6th day respectively decreasing from first to last and similar results was seen for other treatments too. The decreased in firmness during ripening may be due to break down of insoluble proto-pectin into soluble pectin or by cellular disintegration leading to membrane permeability (Brinston, et all., 1988).

4. CONCLUSION

This study was conducted to determine the ripening behavior and post-harvest life of bananas fruit by using different ripening agents. The objective o was to study ripening of bananas artificially and to determine the different quality parameters of bananas as the effect of different ripening agents. In our research, five treatments were set. Among them first one was kept as control, second one was kept with biological ripening agents (Ripe banana, apple and asuro) and other three samples were kept with viz. 250 ppm, 500 ppm and 750 ppm of ethephon.

From this study we found that bananas kept with ethephon treatment ripen faster than other treatments and also deteriorate faster. The TSS was observed highest in 250 ppm ethepon treatment (27^{0} Brix) and lowest in control (13^{0}Brix). The highest physiological loss in weight was observed in 750 ppm ethepon treatment (32.53%) and lowest in treatment of biological ripening agents. The titrable acidity was observed highest in treatment of 250 ppm of ethepon (0.936%) at 6th day then towards decreasing in order also in other ethepon treatments, but in control and bio-agent treatment it gone increasing in order up to 10th day.

In the ethephon treatment pH is decreased upto day 6 and thereafter goes on increasing upto day 12th day. The tritrable acidity percentage goes on increasing on the fruit progress towards ripening. It means that, pH value goes on decreasing in the fruit during ripening. The firmness were began decrease with increasing in days and recorded lowest in 750 ppm ethephon treatment (9.511)

From this study, it can be concluded that the ethephon treatment helps to ripe faster than biological ripening agents and control, and lower post-harvest physiological loss in weight occurred in treatment of biological ripening agents.

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