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Assessment of Vibration Damage to Banana Bunches Simulated by Vibration Tester

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***ABSTRACT**: The research was conducted to evaluate the effect of vibration frequency and packaging methods on mechanical injury to banana bunch during road transport. Banana bunches were packed in different packaging materials such as corrugated fiberboard box with foam sheet, plastic crate with foam sheet, corrugated fiberboard box with banana leaves, plastic crate with banana leaves, corrugated fiberboard container, plastic crate. Packed banana bunch were stored at ambient condition for the assessment of mechanical injury. Parameters such as bruise area (cm^2/fruit), percent weight loss and percent of injured bananas were used to assess the mechanical damage to banana bunch. The highest and lowest bruise area was recorded for treatment T (banana bunch packed without any packaging and cushioning materials) and for treatment TB_1 (banana bunch packed in corrugated fiber box with foam sheet) i.e. 8.34 cm^2/fruit and 3.15 cm^2/fruit respectively, on the seventh day storage period. Minimum and maximum percent of weight loss were found as 18.34% and 32.12% in treatment TB_1 and control respectively. The corrugated fiberboard boxes with foam sheet was found to be best suitable packaging methods with respect to minimum bruise area, weight loss and percent injured bananas.*

***Keywords**: banana bunch, mechanical damage, packaging methods.*

Banana is the queen of all tropical fruits. It is one of the major starchy staple in the local food of tropical region in Maharashtra and all over the country. Consequently, bananas can be a very cheap food to buy and are, hence, an important food for low-income families. It is a rich source of carbohydrate, vitamin B, potassium, phosphorus, calcium and magnesium. In 2012-2014 area under cultivation was 776 thousand ha and productivity i.e.34.2MT/ha. Maharashtra contributed 82 thousand ha of area under cultivation with production of 3600 thousand metric tons [2].

Bananas are transported from localities of production to far off places for marketing and consumption. Banana being succulent are liable to damage and deterioration during harvesting, transportation, marketing, storage and consumption, if not properly handled. Vibration generated by vehicles during road transport has an important effect on the banana fruits. Their damage and deterioration may result due to physical injuries, enzymatic action by the attack of microorganisms or combination of both these factors. Injuries and damage to fruits may in turn result in loss of moisture due to faster surface evaporation. Injured fruits are attacked by microorganisms (fungi, bacteria) and become diseased. The diseased fruits respire at much faster rates than intact healthy fruits.

The main advantage resulting from the improvement of packaging is reducing losses due to mechanical damage. Modern packaging techniques are useful to lengthen the storage duration of fruits and keep the quality of nutrition as well as their interesting external appearance. In Marathwada region, the bananas are transported as bunches without any packaging material. There is no practice of using any special type of packaging methods for banana hands and bunches.

Different packaging materials viz; CFB Boxes, Plastic crates and cushioning material such as fresh, clean banana leaves and foam sheet are easily available in the market with minimum cost which is affordable to farmer. All these packaging methods were effective to reduce damage of fruits during transport. The packaging requirements for fresh produce can be summarized as: protection against bruising, physical injury, microbial contamination, deterioration, weight loss and increase storage life in the package. Hence, the present work was done to

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assess different packaging methods on mechanical damage to banana bunch due to road transport and to determine most suitable packaging and cushioning material for transportation of banana.

MATERIALS AND METHOD

Procedure for packaging of banana bunches

Well matured unripe banana bunches were procured from commercial plantation located near Parbhani city. Banana bunches were checked for incidences of dirt, spider webs and cleaned with water. Individual banana bunch was placed in different containers such as CFB boxes and plastic crates of dimensions (55x45x25cm) and (50x45x30cm). These containers were cushioned with by using foam sheet and fresh, clean banana leaves. Banana bunches were packed in different packaging methods with or without cushioning materials as per treatments. Vibration test was conducted for control by placing banana bunch on vibration table without any packaging and cushioning materials

Assessment of mechanical injury

Various parameters such as bruise area (cm^2/ fruit), percent weight loss, and percentage of injured bananas were observed on alternate day in order to assess the mechanical injury to banana hands during the storage period of seven days.

Bruise area

Bruise area was determined by tracing the brown dark surface area of banana on paper, which was then determined by graphical method by counting number of square [1].

Weight loss

Weight loss was determined by weighing the banana bunch every one day interval for seven day storage period. The initial weight (W_1) of the banana bunch at o day and the weight of the same bunch (W_2) at every one day interval were noted [5].

Percent weight loss was then calculated as

$$\% \text{ of weight loss} = (W_1 - W_2)/ W_1 \times 100$$

Where,

W_1- Initial weight of the banana bunch at 0 day,

W_2- Weight of the same bunch on the day of observation.

Percentage of injured bananas

After vibration test, bananas were categorized based on bruise area into three different categories for the determination of percent of injured bananas during the storage period.

Category I: Bruise area less than 2 cm^2/fruit,

Category II: Bruise area in between 2-5 cm^2/fruit &

Category III: Bruise area greater than 5 cm^2/fruit.

RESULT AND DISCUSSION

Characteristics of banana bunches

From Table 1, it was observed that average weight of bunch ranged from 10.93 to 13.80 kg. Maximum average weight of bunch was found in treatment TB_5 i.e. 13.80 kg, while the minimum weight was found in treatment TB_4 i.e. 10.93 kg. Finger length ranged from 50.4 to 58.5 cm, girth of banana ranged from 4.4 to 5.3 cm and highest number of fingers in two treatments TB_2 and TB_3 i.e. 105, while the lowest number was found in treatment TB_1 i.e. 71.

Table 1
Characteristics of banana bunch
Banana bunch Parameters

Treatments	*Weight of bunch (kg)*	*Length of bunch (cm)*	*Girth of banana (cm)*	*Number of hands*	*Number of bananas*
TB_1	12.34	54.2	5.3	7	71
TB_2	11.62	55.6	5.2	8	105
TB_3	12.95	58.5	4.8	8	105
TB_4	10.93	50.4	4.6	7	86
TB_5	13.80	55.8	4.4	8	97
TB_6	11.57	52.3	4.7	7	80
T	11.48	51.4	4.5	7	76
Average Value	12.10	54.03	4.8	7.43	88.57

Where,

TB_1 - Bunch packed in corrugated fiberboard box with foam sheet;

TB_2 - Bunch packed in plastic crate with foam sheet;

TB_3 - Bunch packed in corrugated fiberboard box with banana leaves;

TB_4 - Bunch packed in plastic crate with banana leaves;

TB_5 - Bunch packed in corrugated fiberboard container;

TB_6 - Bunch packed in plastic crate &

T-Control-without any packaging and cushioning materials.

Effect of packaging methods on bruise area for banana bunch

Table 2 revealed that bruise area (cm^2/fruit) differed significantly at 5 per cent level of significance among the treatments. It was observed that the bruise area (cm^2/fruit) for banana bunches was increased with increase in storage period of seven days. It was also revealed that the highest bruise area was found in control treatment from 2.18 to 8.34 cm^2/fruit, whereas,

lowest bruise area was observed for TB_1 treatment i.e from 0.63 to 3.15 cm^2/fruit followed by TB_2 treatment from 1st to 7th day of storage.

Table 2
Bruise area (cm^2/fruit) for banana bunch packed in different packaging methods

Treatments	Storage Period (Days) 0	1	3	5	7
TB_1	0.00	0.63	1.15	1.85	3.15
TB_2	0.00	0.79	1.34	2.14	3.76
TB_3	0.00	0.96	2.06	3.57	4.63
TB_4	0.00	1.22	2.67	4.42	5.57
TB_5	0.00	1.47	3.34	5.12	6.16
TB_6	0.00	1.74	4.10	6.16	7.26
T	0.00	2.18	5.30	7.48	8.34
S.E.±	-	0.020	0.113	0.070	0.087
C.D. at 5%	-	0.062	0.351	0.217	0.270
F	-	735.988*	175.220*	853.509*	452.764*

* 5% of significant

Comparing the values of bruise area for bunch packed in CFB box and plastic crate using either foam sheet or banana leaves as cushioning material, it was found that CFB box showed less bruise area than plastic crate for both the cushioning materials and without any cushioning materials. Costa [1] found that the increasing bruise area may be due to contact forces produced between bunches and contacting surface. Similar results were also observed by Mario [4].

Effect of packaging methods on per cent weight loss

It was observed from Table 3 that, all treatments were significantly differed at 5 per cent level of significance. Control treatment not only displayed rapid increase in weight loss (%) but also showed the highest weight loss percentage on the seventh day of storage period. It was also observed that banana bunch packed with different cushioning material found lower weight loss than bananas packed without any cushioning material. Weight loss in banana bunch packed in CFB box and plastic crate with foam sheet was found lower than bananas packed in same container with banana leaves as cushioning materials.

At the end of storage period, percent of weight loss in different packaging methods i.e. TB_1, TB_2, TB_3, TB_4, TB_5, TB_6 and control were found as 18.34%, 20.40%, 23.20%, 25.00%, 29.38%, 31.37% and 33.67% respectively. Maia [3] reported that there was also intense dehydration in the affected region of the fruits damaged by abrasion and cutting over time. Injury by cutting and abrasion were more susceptible to fresh weight loss. It was also observed that mechanical injuries increased weight loss.

Table 3
Percent weight loss for banana bunches packed in different packaging methods

Treatments	Storage period (days) 0	1	3	5	7
TB_1	0.00	4.16	8.64	14.50	18.34
TB_2	0.00	4.91	9.43	15.46	20.40
TB_3	0.00	5.64	10.23	16.65	23.20
TB_4	0.00	6.25	11.67	17.88	25.00
TB_5	0.00	7.62	13.49	20.14	29.38
TB_6	0.00	8.56	14.85	22.15	31.37
T	0.00	10.22	17.18	25.43	33.67
S.E.±	-	0.091	0.090	0.093	0.099
C.D. at 5%	-	0.282	0.279	0.289	0.306
F	-	548.039*	1149.100*	1743.113*	3343.169*

Per cent of injured bananas for banana bunch

Category-I: It was observed that injured bananas in TB_1 treatment was increased from 8.45% to 16.90%; whereas percent of injured bananas in control treatment increased from 18.42% to 35.32% during seven days storage period. For the cushioning materials such as banana leaves and foam sheet, maximum percent of injured bananas were found for banana leaves as compared to foam sheet. Therefore it can be revealed that foam sheet gives better result than banana leaves for both plastic crate and CFB box as packaging container.

Table 4
Percentage of injured bananas in category-I

Storage Period (Days)	Treatments TB_1	TB_2	TB_3	TB_4	TB_5	TB_6	T
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	8.45	9.52	10.47	11.62	13.40	15.00	18.42
3	12.67	14.28	15.24	17.44	19.58	22.50	26.45
5	14.08	15.24	17.14	20.93	22.68	26.25	31.57
7	16.90	18.09	20.95	23.27	25.77	28.75	35.52

Category-II: Table 5 showed that there was no percentage of injured bananas in category-II for the treatment TB_1 and TB_2 up to 3 days of storage period. The highest percent of injured bananas i.e. 22.36% was found in control treatment. It was also observed that treatment TB_1 showed the minimum percent of injured bananas for 5th and 7th day of storage period followed by the treatment TB_2.

Table 5
Percentage of injured bananas in category-II

Storage Period (Days)	*Treatments*						
	TB_1	TB_2	TB_3	TB_4	TB_5	TB_6	*T*
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	2.06	2.50	3.95
3	0.00	0.00	1.96	3.48	6.18	8.75	13.16
5	1.40	1.90	3.81	5.81	11.34	15.00	19.37
7	2.82	3.81	5.71	9.30	16.49	21.25	22.36

Category-III: It was observed from Table 6 that, banana bunch packed in CFB box and plastic crate with foam sheet as cushioning material did not show any percent of injured banana up to seven days of storage, whereas treatment TB_3 showed minimum percent of injured bananas i.e. 1% on the seventh day of storage. Highest percent of injured bananas i.e. 7.89% was found in control treatment followed by TB_6 treatment i.e. 6.25%.

Table 6
Percent of injured bananas in category-III

Storage Period (Days)	*Treatments*						
	TB_1	TB_2	TB_3	TB_4	TB_5	TB_6	*T*
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	1.32
3	0.00	0.00	0.00	0.00	1.03	1.25	3.95
5	0.00	0.00	0.00	1.16	2.06	3.15	6.58
7	0.00	0.00	1.00	2.32	4.12	6.25	7.89

From the data, it revealed that foam sheet proved better cushioning material than banana leaves for both CFB box and plastic crate.

CONCLUSIONS

Banana bunches packed in corrugated fiberboard box showed minimum bruise area, weight loss and percent injured bananas than plastic crate.. Foam sheet showed better result as cushioning material than banana leaves. A corrugated fiberboard box with foam sheet was found best suitable packaging methods with respect to minimum mechanical injury during transportation.

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