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Effect of Vibration Frequency and Packaging Methods on Mechanical Injury to Banana Hands

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ABSTRACT: *Vibration tester was used to study the effect of the different packaging methods and vibration frequency on mechanical damage to banana hands during road transport. Banana hands were packed in corrugated fiberboard box and plastic crate with and without cushioning. Foam sheet and banana leaves were used as cushioning material. Packed banana hands 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 hands. The highest and lowest bruise area was recorded 3.54 cm^2/fruit for T_6 treatment and 1.91 cm^2/fruit for T_1 treatment respectively during storage period from 1^{st} to 7^{th} day. Weight loss was recorded 12.43% and 18.64% in T_1 and T_6 respectively. The highest percentages of injured bananas were found in control treatment and T_6 treatment and lowest percentages of injured bananas were found in T_1 treatment for categories of percentage of injured bananas. The result concluded that the corrugated fiberboard boxes with foam sheet was found best suitable packaging methods with respect to minimum bruise area, weight loss and percent injured bananas.*

Key words*: banana hands, cushioning material, mechanical damage, packaging material*

Banana (Musa sp.) is the most widely grown fruit for fresh consumption in the world and a very popular fruit due to its low price and high nutritive value. It is a rich source of carbohydrate, vitamins particularly vitamin B and a good source of potassium, phosphorus, calcium and magnesium. Banana is the most important fruit crop of India having great socio-economic significance. India contributed 25.6 % of the total banana production in world. In 2013, India leads the world in banana production with an annual output of about 26509.96 thousand tonnes for domestic consumption followed by china, Philippines, Ecuador, Brazil and Indonesia [3].

Fresh fruits and vegetables with high moisture content ranging from 75 to 95% in some cases are susceptible to mechanical damage especially during transportation and handling [8].Different injuries may cause different effect on agricultural fruits, mainly changes in color and appearance, fast ripening, increase in loss of water and in deterioration of fruit by microorganisms, thus directly affecting fruit quality and market price [2].

In Marathwada region, bananas are transported as bunches without any packaging material. Bananas are much more susceptible to mechanical injury because of their soft texture. Post harvest mishandling, vibration, impacts, compression and superficial bruises during transportation are the basic causes for banana injuries leading to fruit deterioration. De-mark able contribution to the development of mechanical damage can be due to transportation from farms to packing houses and from packing houses to retail outlets. The vibration is mainly associated with transportation. One important property of fresh fruits, which directly influences the damages, is the natural frequency of vibration of the fruit itself [7].

In order to improve and maintain the quality of fresh banana fruit, it is necessary to study the role of different types of packing method on quality, intensity of bruising and total weight loss of banana. The packaging of fresh fruits is one of the most important steps in the long-term transportation. Thus keeping in view the postharvest losses and mechanical injury of banana due to transportation, different packaging methods are used to minimize mechanical

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damage to assess the effect of vibration frequency and packaging methods on mechanical injury to banana hands.

MATERIAL AND METHODS

Vibration test for banana hands

Fully matured unripe bananas of variety "Ardhapuri" were procured from local farmer nearby Parbhani. Banana hands were separated from bunches with the help of knife and packed in different packaging containers such as CFB boxes and plastic crates. These containers were properly cushioned with foam sheet and banana leaves for four contacting sides along with bottom for all the treatments i.e. T_1, T_2, T_3 and T_4. Packed banana hands were vibrated in the laboratory using vibration tester after packaging. Vibration test was conducted for each treatment by subjecting boxes to constant vibration frequency of 20 Hz for 10 minutes time duration. Banana hands were taken out of boxes after vibration test. For the evaluation of mechanical injury, vibrated banana hands were stored at room condition for the period of seven days.

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

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

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.

RESULTS AND DISCUSSION

Effect of different packaging methods on bruise area of banana hand

Statistical analysis of bruise area (cm^2/fruit) differed significantly among all the treatments. Highest bruise area was found in T_6 treatment i.e. 3.54 cm^2/fruit and lowest for T_1 treatment on seventh day of the storage period. Bruise area (cm^2/fruit) for banana hands increased during storage period for all treatments. The damaged or bruised area might be increased due to exposure time of fruit to contact forces produced between bunches and contacting surface during handling. CFB box showed less bruise area than plastic crate for banana leave and foam sheet.

Similar results were reported by Kajuna[4]. Treatment T_6 showed higher increase in bruise area with storage period than other treatments. Minimum bruising was found in banana packed in corrugated fiberboard box with foam sheet packaging methods. Similar results were reported by Costa[1].

Table 1
Bruise area (cm^2/fruit) for banana hand packed in different packaging methods

Sr. No.	*Treatments*	*Storage Period (Days)*				
		0	*1*	*3*	*5*	*7*
1	T_1	0.00	0.50	0.78	1.35	1.91
2	T_2	0.00	0.56	0.90	1.44	2.19
3	T_3	0.00	0.66	1.04	1.57	2.56
4	T_4	0.00	0.80	1.24	1.90	2.73
5	T_5	0.00	0.90	1.46	2.30	3.20
6	T_6	0.00	1.11	1.65	2.52	3.54
7	S.E.±	-	0.067	0.106	0.096	0.110
8	C.D. at 5%	-	0.211	0.335	0.303	0.348
9	F	-	11.600*	9.887*	24.839*	30.536*

Where, *significant

T_1 - Hands packed in corrugated fiberboard box with foam sheet;

T_2 - Hands packed in plastic crate with foam sheet;

T_3 - Hands packed in corrugated fiberboard box with banana leaves;

T_4 - Hands packed in plastic crate with banana leaves;

T_5 - Hands packed in corrugated fiberboard container;

T_6 - Hands packed in plastic crate.

Effect of percent weight loss for banana hands packed in different packaging methods

There was significant difference on percent weight loss among the various packaging methods used for banana hands. Weight loss for banana hands packed in CFB box and plastic crate with foam sheet was found lower than packed with banana leaves. It was also observed that banana hands packed with different cushioning material found lower weight loss than hands packed without any cushioning material.

Table 2
Weight loss (%) in banana hands packed in different packaging materials

Treatments	*Storage period (days)*				
	0	*1*	*3*	*5*	*7*
T_1	0.00	3.82	6.04	9.20	12.34
T_2	0.00	4.40	7.31	10.15	13.18
T_3	0.00	5.24	7.93	10.42	13.56
T_4	0.00	6.04	8.76	11.58	14.04
T_5	0.00	7.13	9.86	13.24	16.43
T_6	0.00	8.14	11.34	15.12	18.64
S.E.±	-	0.042	0.107	0.106	0.072
C.D. at 5%	-	0.133	0.338	0.337	0227
F	-	1511.683*	309.719*	425.530*	1077.377*

*significant

Percent of injured bananas for banana hands in category-I

Banana hands packed in CFB box with foam sheet showed the lowest percent of injured bananas i.e. 12.35% followed by treatment T_2 i.e. 15.85% on the seventh day of storage period. The highest percent of injured bananas i.e. 21.17% was recorded in T_6 treatment followed by TH_5 treatment i.e. 19.18%.

Table 3
Percent of injured bananas in category-I

Storage Period (Days)	*Treatments*					
	T_1	T_2	T_3	T_4	T_5	T_6
0	0.00	0.00	0.00	0.00	0.00	0.00
1	6.74	7.32	9.21	10.76	10.95	11.76
3	7.86	8.53	10.53	12.30	13.69	14.12
5	10.11	12.19	13.15	15.38	16.43	18.82
7	12.35	15.85	17.10	18.46	19.18	21.17

From the data, it was revealed that banana hands packed in both the cushioning material i.e. foam sheet and banana leaves showed lower percent of injured bananas than banana hands packed without any cushioning material for CFB box as well as plastic crates. Percent of injured bananas was lower for CFB box with foam sheet as a cushioning material. Similar results were recorded for foam sheet and banana leaves, when banana hands packed in plastic crate.

Percent of injured bananas for banana hands in category-II

The highest percent of injured bananas was found 2.35% to 10.58% in T_6 treatment. From the data, it was observed that for treatment T_1 & T_2, no percent of injured bananas was observed up to third days of storage of period. Whereas treatments T_3 & T_4 did not show any percent of injured bananas up to two days of storage. In category-II, treatment T_1 and T_2 showed lower percent of injured bananas than banana hands packed in CFB box and plastic crates with banana leaves as a cushioning material.

Table 4
Percent of injured bananas in category-II

Storage Period (Days)	*Treatments*					
	T_1	T_2	T_3	T_4	T_5	T_6
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	1.37	2.35
3	0.00	0.00	1.32	3.07	4.11	5.88
5	0.89	2.44	2.63	4.62	6.85	7.00
7	2.25	3.66	5.26	7.69	8.22	10.58

Percent of injured bananas for banana hands in category-III

In the category-III, there was no percent of injured bananas found in treatments T_1, T_2 and T_3 during seven days. However, treatment T_4 showed lower percent of injured bananas which was 1.54%.

Table 5
Percent of injured bananas in category-III

Storage Period (Days)	*Treatments*					
	T_1	T_2	T_3	T_4	T_5	T_6
0	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
3	0.00	0.00	0.00	0.00	0.00	1.20
5	0.00	0.00	0.00	0.00	1.37	2.35
7	0.00	0.00	0.00	1.54	2.74	3.53

From the result, it was observed that banana hands packed in CFB box and plastic crates without any cushioning material showed higher percent of injured bananas than hands packed in same packaging container with foam sheet and banana leaves as cushioning materials.

CONCLUSIONS

Banana hands packed in corrugated fiberboard box showed minimum bruise area, weight loss and percent injured bananas than plastic crate for both cushioning material. A corrugated fiberboard box with foam sheet was found best suitable packaging methods with respect to minimum mechanical injury during transportation. Foam sheet was found to be better cushioning material than banana leaves for transport of banana when packed in plastic crates and corrugated fiberboard boxes.

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