Improved packaging design for long distance transportation of high value horticultural crops

Nikunj Abhay Rathod[1], Nanki Nath[1] and Pritom Borathakur[2]
Department of Design, Indian Institute of Technology Guwahati[1]
Department of Horticulture, Assam Agricultural University, Jorhat[2]
Email Id: a.rathod@iitg.ernet.in, nanki.nath@iitg.ernet.in, pritomborthakur@yahoo.co.in

Abstract

Long Distance transportation of high value horticultural crops is an area of extensive research and practice. In context of North-East this area requires more in-depth investigations in context of risk-free, cost-effective, innovative and sustainable structural packaging designs of the existing Corrugated Fiber Boards (CFBs) that carry these horticultural crops over a minimum distance of a 1000 km. within India and also across Indo-Myanmar border.

Within these variables of study as part of our project, the project also aims to design and implement an a "improved packaging" (Design and Mechanical aspects) for long distance transportation of high value crops. We are also in the process of find the economics of using the developed packaging material(s) along with finding alternative material options (equivalent to eco-friendly materials in existing designs made of CFB- different grades and make).Treatments inside the structural package would be explored and new recommendations would be proposed accordingly.

Keywords: Material Science Of CFBs, Structural Packaging Principles, Sustainable Packaging, Contextual Inquiry, Packaging Graphics, Innovative Packaging Design, Large-scale Field testing, Colour and Type, Active Packaging Concepts

Introduction and Background

Long distance transport assumes a great importance. Packaging fresh fruits and vegetables is one of the more important steps in the long and complicated journey from grower to consumer. Bags, crates, hampers, baskets, cartons, bulk bins, and palletized containers are convenient containers for handling, transporting, and marketing fresh produce.

Improving the packaging techniques and prolonging the storage life of fruits leading to good marketing of fruit to long distant places. The damage to the fruits depends upon several factors such as type of packaging boxes, type of cushioning materials, level of forced vibration from road and the moisture loss from the fruits.

For reference to above points please refer Fig. 1 and Fig. 2.

Fig. 1.

Fig. 2.

Aims & Objectives

1. To develop a "improved packaging" (Design and Mechanical aspects) for long distance transportation of high value crops. The highlight feature would be an innovative package design for risk-free export packaging for long distances (keeping in mind the import and export of the fruits/crops to nearby countries across the Indo-Myanmar border).

2. Find the economics of using the developed packaging material(s) along with finding alternative material options (equivalent to eco-friendly materials in existing designs made of CFB- different grades and make).

3. Treatments inside the structural package would be explored and new recommendations would be proposed.

Other Points of Care

1. The CFB boxes shall be taken / a mix materials approach to be applied.

2. The separators of the box shall be fitted both inside and outside with foams.

3. The foams shall be wetted with Silver nitrate(Agno3)or potassium permanganate(Kmno4) solution (ethylene absorbent), Fig. 3 and Fig. 4

4. The high value crops shall be fitted in each of the slots so as to provide protection against injury due to compression, vibration and bruising.

5. The boxes shall be moved to a distance of 1000km.

6. The shelf- life, physical and biochemical chemical changes during storage shall be studied.

7. Economics of using the developed packaging shall be determined.

Fig. 3.

Green mature stage(the stage at which transportation was done)

Fig. 4.

Fruits after three days of transportation

Problems with current packages

1. About 25 to 30 % of fruit and vegetables are lost annually due to inadequate post harvest handling.
2. Lion share to this loss is contributed by inadequate packaging and transportation.
3. Due to several useful qualities CFB boxes has gained popularity as a packaging material.
4. CFB boxes have good stacking strength and cushioning effect.
5. Most of the wastage in CFB boxes occurs because of compression and vibration of the produce inside the box.
6. The injury developed due to compression or vibration may not be visible immediately but damage is manifested during subsequent storage.

Idea I with Wooden Crates

Features of the box:

- Matter & energy exchange between box and environment.
- Respiration rate of food is increased
- Absorption rate of ethylene is increased
- Physiological Loss in Weight(PLW) is increased
- Texture Loss is increased.
- For cushioning, shredded newspaper or straws are used.

Fig. 5.

So, in traditional structures, the impact of fruit/veg to the surface of structure is more, which leads to distortion of fruit surface which ultimately leads to enzyme activity. Whenever enzyme activity is increased, it leads to absorption of O_2 from the environment and generation of heat and CO_2. Within OH around the fruit such that the respiration rate is increased which leads to loss in fruit/veg quality.

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Ides II with Corrugated Boxes

Corrugated Fibre Board are made from the craft paper which can easily be manufactured from Bamboo, grasses and various types of agricultural residues as well as by recycling the used Card Boards or Papers, Fig. 6.

Advantages of Corrugated Fibre Board Boxes:

1.They are light in weight.
2.They cause much less damage to fruits.
3.They are easy to handle and print.
4.They improve the product image.
5.They reduce the fright cost.

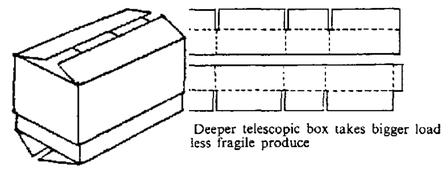

Fig. 6.

Features of the box:

- No matter exchange between environment and box
- Air exchange is there between environment and box so temperature is maintained but not moisture
- Less respiration rate due to reduction in temperature and oxygen content.

Fig. 7.

Fig. 8.

Ethylene Generation & other parameters for product development

Ethylene Generation

1) Fruits type related to ethylene generation
   - Climatic – Fruit generates of ethylene even after the fruit is harvested immaturely from the mother plant and fruit ripening begins.
   - Non-climatic – Fruit does not generate ethylene, once it's harvested immaturely from mother plant and fruit ripening does not take place.

2) A minimal amount of O_2 is required for fruit/veg so that the minimal life processes are sustained. Above a certain level O_2 is deteriorating for the fruit as it increases the ripening rate.

3) Certain parameters necessary for product development:
   - Respiration rate
   - Absorption of Ethylene
   - PLW
   - Texture of fruit
   - Physical damage to fruit.
   - Probe into use of $KMnO_4$ and $AgNO_3$.

Select Bibliography

Al-Mashari, M. and M. Zairi (2000). "Supply-Chain Re-Engineering using Enterprise Resource Planning (ERD) Systems: An Analysis of a SAP R/3 Implementation Case." International Journal of Physical Distribution and Logistics Management, Vol. 30, No. 3-4: 296-313.

Alderson, W. (1950). "Survival and Adjustment in Organized Behavioral Systems." R. Cox and W. Alderson (eds.) Theory in Marketing, Chicago IL: Richard D. Irwin.

Alderson, W. (1957). "Marketing Behaviour and Executive Action." Homewood IL: Richard D. Irwin.

Caixeta-Filho, J.V. (1999). "Losses in the Transportation of Fruits and Vegetables: A Brazilian Case Study." International Journal of Logistics: Research and Applications. Vol. 2, No. 3: 325-341.

Dreyer, H.C., R.Wahl, J. Storøy, E. Forås, and P. Olsen (2004). "Traceability Standards and Supply Chain Relationships." Proceedings of NOFOMA (the Nordic Logistics Research Network Conference), Linköping: Sweden: 155-170.

DoD Department of Design
Indian Institute of Technology Guwahati
Guwahati, Assam