Simulation Technique for Transport Test of Fruit and Vegetables

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Introduction

Various kinds of packing materials for fruits and vegetables are used to prevent in-transit mechanical damage receive from shock ana vibration during long distance transport. However, some packing systems currentle used lack the capability for preventing damage of the productions, or in contrast, some ones overprotect the products. Methods for designing a suitable system were not yet developed because of a lack of information about physicomechanical properties of the products as well as the present status of transporting condition.

In order to overcome a part of the problem, the simulation thechnic for transport test of fruits and vegetables has been developed which could simulate an actual transport condition in a laboratory.

In my presentation, the outline of the transport simulation technic is described.

Theory of the transport simulation technic

In-transit mechanical damage of fruits and vegetables was assumed to be fatigue failure due to an accumulation of damage caused by vibrating acceleration which acted on the products during transport. The Palmgren and Miner's hypothetical law, which is useful for the fatigue analysis of metallic materials, was applied to estimate the degree of the damage. A method to design conditions of the simulated transport test incluking vibration acceleration, vibration frequency and vibration time was in-

dicated.

Vibration characteristics for multi-stacked corrugated fiberboard boxes

multi-stacked corrugated fiberboard boxes were assumed to be a linear combination of the Voigt rheological model which has the equivalent vibrating characteristic of an individual corrugated fiberboard box. Vibrating response as a result of solving problems of a multi-degree-freedom-system of vibration was analyzed by means of a transfer matrix method. the vibration responses of resonance frequency and transmissibility showed a fairly good agreement with those of the experiment.

In-transit mechanical damage of fruits and vegetables, and improvement of the packing systems currently used

1. Vibrating characteristics of lettuce packed in corrugated fiberboard boxes stacked in seven layers were examined together with a mechanism of in-transit mechanical damages. Resonance frequency of the box at the top layer was approximately 8 Hz for a non-banded stack and approximately 13 Hz for a banded stack.

The mechanical damage was caused by a free rotation of the product in the box, particulary when excited by the resonance frequency. We found that the damage could be reduced by packing the lettuce in the box with the butt downward in order to avoid free rotation.

2. To improve the transport technics of processing tomatoes, vibration characteristics of small type plastic containers were analyzed. In a five-high stack arrangement of containers filled with tomatoes, the ordinary condition for shipment, the vibration acceleration at the top container was largest; the acceleration transmissibility at resonance frequency reached approximately 4.0 As vibration time increased, sofening of the flesh initiated, followed by breakage of the products.

3. The efficiency of the packaging system used for Japanese pear 'Nijisseiki' was evaluated using the simulated transport test. The packing system for the product was found more than necessary to pro-

tect the fruit from shock and vibration during long distance transport. We suggested that the packing system should be replaced by a simpler one.

4. The degree of damage of several kinds of fruits and vegetables which had been transported under certain condition was evaluated. Consequently, vibrating conditions for simulated transport test susch as acceleration, frequency and time were designed to reproduce similar characteristics as during actual transport.

Mechanical durability of liquid-type food containers against shocks and vibrations during long distance transport

A simulated transport test was applied to verify the mechanical durability of containers for liquid-type food.

1. Rectangular paperboard container

A simulated transport test was conducted using rectangular paperboard containers for fruit juice. The container at the top ;layer in the stack had resonance frequency of 9–15Hz and maximum transmissibility of 4 to 6, depending on the kind of containers tested. There was a general tendency that vibration practice weakened seal strength of the container. Results of the simulated transport tests were compared those of actual transport tests carried out for a distance as long as 2000km by trackhauling. It was found that the containers had safety fractor large enough to withstand vibrations during an actual long distance transport.

2. Gabletop-type of aseptic paperboard-container

The durability of gabletop-type of aseptic paperboard-container against shocks and vibrations during a long distance transport was evaluated. The degree of damage to the container subjected to vibration in a actual transport for 2,270km was evaluated on the basis of the number of accelerations recorded on a portable mechanical accelerometer. Judging from the fact that the value was 0.11 at most, results

verified the container to have enough strength to withstand vibrations during the actual long distance transport.

3. Bag-in-drum type of aseptic container

The durability of bag-in-drum type of aseptic container was examined when transported for more than 1200km; this type of container is becoming popular at present for orange juice or tomato puree. The container received many cracks and pin-holes. The damage was more serious in case of shipment by train than by truck and ferry boat because resonance frequency of the products in the aseptic bag was mostly equivaleny to the lowest vibrating frequency of transporting vibration in the train. Thd damage could be reduced by suppressing the aseptic bag in the drum with two semicircular plates of polystyrene form.

수송 시뮬레이션 기술의 개발과 농산물 수송기술개선으로의 응용 (Simulation technique for agricultural products transformation)

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유통과정에 있어서 진동 및 충격에 의한 손상을 방지하기 위해 농산물에는 각종 완충 포장처리가 행해지고 있다. 그러나 현재의 농산물 완충 포장은 성상이나 수송환경조건에 적합하게 설계되어 있다고 할 수 있으나 완충포장잉 불완전하거나 거꾸로 과중포장된 경우가 많다. 완충포장이 불완전한 경우는 손상을 받아 예기치 못한 손해가 발생하며, 거꾸로 과중포장된 경우는 포장재료비의 상승에 의한 포장경비가 증대하게 된다.

이러한 문제를 해결하기위해서 완충포장 적정화를 꾀할 필요가있다. 완충포장 적정화는 식품의 안전수송을 보증하며,완충포장의 간략화에 의한 포장 및 짐 묶음 경비를 절감하게 될 뿐만 아니라 포장자원을 유용하게 이용함에 있어서도 중요하다.

이러한 배경으로 본강연에서는 완충포장의 적정화를 꾀함에 있어 유료한 방법으로서 개발한 수송 시뮬레이션 기술과 농산물의 수송 기술개선에 관한 응용에 대해 설명하려한다.

수송 시뮬레이션 기술이란 진동 및 충격이 일어나는 실제 수송환경을 실내에서 똑같이 농산물에 재현시키는 방법을 뜻한다.