Transoceanic Shipment of Chilled Beef Variety Meats

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ABSTRACT

Ninety each of beef livers, hearts, tongues and kidneys were transported in a refrigerated van from Palestine, Texas to Rungis, France. Product arrived at destination 21 d after departure (24 d after removal from the animal) and was evaluated for color and odor by a four-member experienced USA panel and by variety meat buyers at the Rungis market. Vacuum packaging most successfully protected color and odor of tongues and hearts, kidneys had acceptable color and odor if not wrapped, and livers were most desirable in color and most acceptable in odor if wrapped with polyvinyl chloride film. Buyers on the Rungis, France market paid a premium for those variety meats which were vacuum packaged in relation to comparable USA product that was transported in the frozen state. Beef variety meats can be successfully transported to European markets without freezing.

In 1979, 168,418 metric tons of variety meats worth 248.6 million dollars were exported from the USA (4). The primary importer of such product was the European Economic Community (EEC); the USA supplied 31% of all beef and pork variety meats that were imported by the EEC in that year. In 1980, 200,417 metric tons of variety meats worth 300.8 million dollars were exported from the USA; the large increase, compared to that of 1979, was largely a result of dramatic increases in sales of variety meats to Japan and Mexico (4).

Essentially all of the variety meats presently exported from the USA are frozen. Some chilled (not frozen) product is presently shipped from Ireland to the EEC, but Patterson and Gibbs (13) reported that such chilled beef variety meats that are distributed to the retail trade are relatively perishable, having perhaps only 1-2 d of shelf-life even in a refrigerated display cabinet. According to Lennon (10), demand for chilled variety meats in France is quite large; if it were available, demand for chilled offal would be twice that for frozen offal; Paris alone presently experiences a chilled offal deficit of 20 metric tons per week, and very attractive premiums also are presently paid for chilled, as opposed to frozen, beef variety meats.

The greatest present deterrent to shipment of chilled variety meats to Europe and other markets is their perishability. The present study investigated possibilities for transoceanic shipment of chilled beef variety meats to the European market by use of selected means of packaging and use of a modified gaseous atmosphere in the container used to transport the product.

MATERIALS AND METHODS

Beef livers (n = 90), hearts (n = 90), kidneys (n = 90) and tongues (n = 90) were selected on the slaughter-dressing floor of a commercial packing plant in Palestine, Texas. Immediately following inspection for wholesomeness by personnel of Meat and Poultry Inspection, USDA, variety meats were assigned (at random within type of variety meat) to one of three treatments. Thirty of each type of variety meat were individually wrapped with polyvinyl chloride (PVC) film (OTR = 10,800 cc/m²/24 h/23.9°C/50%RH; MVTR = 380 g/m²/24 h/37.7°C/70%RH), 30 were vacuum packaged in a chamber-type packaging machine using bags with an OTR = 32 cc/m²/24 h/23.9°C/50%RH and MVTR = 1.5 g/m²/24 h/37.7°C/70%RH and 30 were neither film-wrapped nor vacuum packaged (not wrapped). Variety meats that were vacuum packaged, wrapped with PVC film and those that were not were placed in boxes equipped with polyethylene box liners.

Variety meats were packed--2 to the box for livers, 10 to the box for hearts, 30 to the box for kidneys and 10 to the box for tongues--in one of two folded, full telescoping single-walled, corrugated fiberboard boxes constructed with either 90 or 125 kg test material and stored in a 2°C cooler for 24 h. The larger of the two boxes was 52 1 x 39 w x 14 d cm while the smaller one was 52 1 x 31 w x 10 d cm. Each box was strapped, girthwise, with two wires. Boxes (n = 60) were stacked 4 or 5 high on wooden pallets during storage, transport and distribution.

At 24-30 h following their removal from the animal body on the slaughter-dressing floor, the boxed-palletized product was transferred to a refrigerated Sea-Land van container. Continuous recording thermometers were placed on the walls of the van container and inside certain boxes before palletizing and remained there throughout the test. After loading, the van container was pulled overland to the Houston, Texas port where it was charged with a gaseous atmosphere of 60% carbon dioxide, 25% oxygen and 15% nitrogen (Transfresh-Technol) and then was loaded on a U.S. Lines, ocean-going vessel; product was never frozen.

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The U.S. Lines vessel docked at Le Havre, France, the van container was off-loaded and product was transported overland in a small delivery van to the Rungis, France meat market. The van was then opened and product was transferred to a 2°C cooler. Each box was opened, all packaging material was removed and each of the variety meats was assigned color and odor scores by four members of an experienced USA evaluation panel. Color scores were based on an 8-point scale (8 = extremely desirable; 1 = extremely undesirable) and odor scores were assigned using a 4-point scale (4 = no off-odor; 1 = intense off-odor). Six buyers on the Rungis market also evaluated the product and made verbal comments regarding condition and appearance of each kind. The variety meats were sold, in single-box units, at the same time as was other chilled offal from Ireland and frozen offal from Australia and the United States (from other shipments); prices of product were recorded.

Data for color scores and odor scores were subjected to analysis of variance (16) and mean separation analysis (3) using procedures of Barr et al. (2).

**RESULTS AND DISCUSSION**

Evaluation of tapes from temperature recorders inside meat boxes and on the walls of the container revealed that temperatures were within 1°C of that desired (1°C) in the cooler at Palestine, rose about 2°C during loading into the van container, dropped to the desired temperature in the cooler at Rungis, France, and returned to the desired temperature in air temperature--inside the van--was sustained for 11 h; this increase in temperature resulted from a lack of power to the refrigeration unit while it was in the shipyard and during the time the van was being loaded onto the ship. After the van container was secured on the ship, power was restored and the temperature returned to 1°C for the remainder of the shipment on the ocean-going vessel. Temperature in the small delivery van, between Le Havre and Rungis was 2°C; temperature in the cooler at Rungis was 1°C. Hanna et al. (6) reported that, after storage for 1 or 3 d at 2°C, aerobic plate counts from beef, pork and lamb livers, kidneys and hearts were not different (P > 0.05) from those at day 0. This suggests that rather long periods of temperature abuse--from about 24 h at 22-28°C in the study of Oblinger et al. (12) to about 5 d for beef variety meats in the Hanna et al. (6) study—are required to affect materially microbiological quality of such product. Had product in the present study been frozen, it is possible that the external surfaces of the products may have thawed enough to have allowed blood and/or meat fluids to accumulate and be soaked-up by the box during the 11-h period while the refrigeration unit was not operational. There have been recent incidents of refusal to accept USA variety meats at European ports of entry because of blood-stained boxes (11); there were no problems with blood-stained boxes in the present study.

Color and odor scores for beef variety meats at Rungis, France are presented in Table 1. Color of variety meats would be of importance only if such product is to be displayed at retail; in the present study the variety meats were sold chilled in one-box units to meat wholesalers. Use of particular variety meats varies among countries to which USA products are exported; for example, beef tongues are sold fresh--in retail markets--in France, canned in Great Britain and used in comminuted products in Japan (10). Color scores were highest for hearts and tongues that were vacuum packaged, for livers that were PVC film wrapped, and for kidneys that were not wrapped (Table 1). Color was least desirable at shipment termination for livers that were vacuum packaged, for hearts and tongues that were PVC film wrapped or not wrapped and for kidneys that were vacuum packaged; these data suggest that very dark cuts (i.e., liver and kidney) should be removed from vacuum packages and allowed to brighten, before display at retail, to develop an acceptable bright color.

Off-odor incidence is important regardless of whether variety meats are to be sold at retail or to be used in manufactured products. Off-odor in variety meats results from growth of microbes on the product. Gardner (5) used polyethylene film to delay spoilage and prolong storage-life (by removing most but not all residual air from within the package of pork livers). Patterson and Gibbs (13) used vacuum packaging to delay spoilage of beef livers, hearts, kidneys and tongues, prolonging storage-life by as much as two weeks. Hanna et al. (7) reported that aerobic plate counts of vacuum-packaged beef livers, beef kidneys and pork livers during storage was nearly always much lower than those of comparable samples stored in polyvinyl chloride (PVC) film. Off-odor occurred (Table 1) least often if variety meats were vacuum packaged and most often if variety meats were not wrapped; of methods of packaging in the present study, use of vacuum packaging produced livers, hearts and tongues that were characterized as having no off-odor. Patterson and Gibbs (13) concluded that bovine edible variety meats should not be stored in vacuum packages for more than 3 weeks to assure that they would still have a reasonable shelf-life (about 3 d in the retail case) when exposed for sale; that conclusion was based on their observation that off-odors were present on opening of variety meats that had been vacuum packaged and stored for 3 weeks.

### TABLE 1. Mean color and odor scores for beef variety meats in Rungis, France.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Variety meat</th>
<th>Vacuum packaged</th>
<th>PVC film wrapped</th>
<th>Not wrapped</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Liver</td>
<td>3.0e</td>
<td>7.0e</td>
<td>5.5d</td>
</tr>
<tr>
<td></td>
<td>Heart</td>
<td>6.2c</td>
<td>2.4d</td>
<td>2.7d</td>
</tr>
<tr>
<td></td>
<td>Tongue</td>
<td>4.5c</td>
<td>2.7e</td>
<td>2.2d</td>
</tr>
<tr>
<td></td>
<td>Kidney</td>
<td>2.0d</td>
<td>3.7d</td>
<td>5.3c</td>
</tr>
<tr>
<td>Odor</td>
<td>Liver</td>
<td>3.0e</td>
<td>3.0e</td>
<td>2.0d</td>
</tr>
<tr>
<td></td>
<td>Heart</td>
<td>3.5e</td>
<td>2.4d</td>
<td>2.3d</td>
</tr>
<tr>
<td></td>
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<td>3.8c</td>
<td>2.8e</td>
<td>2.6e</td>
</tr>
<tr>
<td></td>
<td>Kidney</td>
<td>2.7c</td>
<td>2.0d</td>
<td>2.7c</td>
</tr>
</tbody>
</table>

*8 = extremely desirable, 7 = desirable, 6 = moderately desirable, 5 = slightly desirable, 4 = slightly undesirable, 3 = moderately undesirable, 2 = undesirable, 1 = extremely undesirable.

*4 = no off-odor, 3 = slight off-odor, 2 = moderate off-odor, 1 = intense off-odor.

*Means in the same row and for the same trait bearing a common superscript letter are not different (P > 0.05).
for 4 weeks. Data of the present study (Table 1) reveal that off-odor would not likely be a shelf-life limiting characteristic of vacuum packaged beef variety meats transported in the manner involved in this test shipment.

The most logical explanation of the generally acceptable color and odor of variety meats that were not wrapped and those that were wrapped in PVC film after a total of 24 d of storage-transportation involves use of the atmosphere containing 60% CO₂ during 21 d of the test shipment. The inhibitory effect of CO₂ on aerobic spoilage bacteria is well-documented (1,8,9). Seideman et al. (14) recently reported that the primary advantage for storage of meat in a CO₂-modified atmosphere is its tremendous inhibitory effect on the growth of psychrotrophic bacteria.

It was not possible to measure weight loss in the present study, but another test shipment that TAES scientists conducted (15) revealed that beef variety meats (hearts and livers) that were vacuum packaged or wrapped in soft film would lose about 1.6 to 7.3% of their weight during a transport-storage period of 15 to 16 d. Wholesale buyers on the Rungis market paid premiums of $.20 to $.33 per kg for chilled, as compared to frozen, variety meats including those from Ireland and those from this test shipment. Buyers interviewed were complimentary of the appearance and quality of the variety meats and each said they would purchase 2 to 3 containers of such product each month above their present requirements for frozen variety meats. If there was a 15% price premium for chilled over frozen product, the weight loss of variety meats could be as high as 13% and still be at a break-even price level. However, if purge loss in vacuum packaged variety meats does not become visibly excessive, such product can be sold in the package with no weight adjustment.

In conclusion: (a) vacuum packaging most successfully protected color and odor of beef tongues and hearts, (b) beef kidneys had acceptable color and odor if they were not wrapped, (c) beef livers were most desirable in color and most acceptable in odor if they were wrapped in polyvinyl chloride film and (d) buyers on the Rungis, France market paid a premium of $.20 to $.33 per kg for chilled (not frozen) variety meats (with the highest premium paid for variety meats which were vacuum packaged) in relation to comparable product from the USA that was transported in the frozen state.

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REFERENCES