# 3-P30

## INVESTIGATION ON SOME PHYSICAL PROPERTIES OF VACUUM AND WRAP PACKAGING MATERIALS FOR CHILLED MEAT OBTAINED FROM KOREAN MARKETS

**Keun-Taik Lee and Kook-Jong Lee**

Department of Food Science, Kangnung National University, Jibyun-Dong San 123, Kangnung, Kangwon-Do, Korea

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**Background:**

In Korea, it is estimated that approximately 90 percent of meat is distributed frozen. However, fresh chilled meat is recently being preferred by the consumer because of the convenience of preparation and superior eating quality compared to frozen meat. Thus, there are more needs to package and distribute meat in a chilled state. Physical properties such as thickness, tensile strength, transparency and permeability of film are the important factors affecting stability and quality of packaged chilled meat. Therefore, the proper selection of appropriate film for packaging of chilled meat would be necessary for storing chilled meat.

**Objectives:**

The objective of this study was to examine the various physical properties of vacuum and wrap films available in Korea in order to choose and use proper packaging films for fresh chilled meat.

**Methods:**

Water vapor permeability(WVP) was determined according to Korean Standard method 3088 using water permeability testing units (Permatran-W TWN, Mocon, U.S.A.) measured at 38±1℃ and 100% r.h. For measuring oxygen permeability (OP), an OX-TRAN 100 A system (Mocon, U.S.A.) was used, being operated at 22±2℃ in dry state according to Korean Standard method A 1027. Tensile strength was measured by an Universal testing machine (Model 4204, Instron, U.S.A.) according to Korean Standard method M 3001-96. A hand-held micrometer (Toyoseiki, Japan) was used to measure film thickness in accordance with Korean Standard B 5207. The presence of pinholes was electronically examined by using a pinhole tester (Elcometer 136, Elcometer Instruments Ltd., England). Haze was measured by a direct reading haze meter (Toyoseiki, Japan). Shrink rates of film in mechanical and transverse directions were calculated after test film was shrunk in a water bath at 80℃ for 2 sec.

**Results and discussions:**

Physical properties of vacuum packaging materials obtained from local markets are presented in Table 1. The average thicknesses of laminated polyamide/polyethylene (PA/PE) films and polyvinylidene chloride coextruded between ethylene vinyl acetate films (PVDC/EVA shrink film) were 89 and 66㎛, respectively. PVDC/EVA shrink film had a little greater variation in thickness than PA/PE films. No significant differences were found in the haze degree between PA/PE and PVDC/EVA films, whereas PVDC/EVA shrink film showed greater tensile strength values than PA/PE. Between the two types of vacuum packaging materials tested in this study, no significant differences were found in the WVP. The OP of PA/PE films was 48.8㎛, whereas that of PVDC films was 14㎛ on average. The higher humidities found in meat packages will increase the permeabilities of hydrophilic film (e.g. polyamide), but they have little effect on those of hydrophobic film (e.g. PVDC). Newton & Rigg (1979) observed that the storage life of the vacuum packaged meat was inversely related to film permeability. By use of films of lower $O_2$ permeability, the growth of Pseudomonas was reduced (Hess et al., 1980) and deterioration of meat could be delayed (Lee, 1985).

Shrinking of heat shrinkable films reduced the oxygen permeability approximately in proportion to the reduction in surface area (Eustace, 1981). Tändler (1982) reported that shrinking of the package reduced exudate loss up to one-half compared to conventional vacuum packaging. When PVDC films were shrunk unrestrained without contents, the shrink rates were from 34.9 to 48.5% in the mechanical direction and from 40.9 to 57.3% in the transverse direction (Table 2). Furthermore, the thickness was increased about threefold, and accordingly tensile strength, OP and WVP were reduced after shrinkage has occurred. The area reduction, however, no more than 20% of the original area, when a film was shrunk around a meat product in practice under tension. Also, it could be expected that film shrinkage around the meat would not be fully developed in a short time because of the low surface temperature of packaged meat.

Table 3 shows results on some physical properties obtained for wrap films available in Korea including those used in chilled meat storage. The thicknesses of PVC and linear low density polyethylene (LLDPE) wrap films investigated were in the range of 11 - 13 and 9 - 12㎛, respectively. The average WVP of PVC wrap films was 786g, which was considerably greater than that of LLDPE films, which was 99g. All wrap packaging materials examined except the two LLDPE samples from manufacturers 'S' and 'T' had a OP of more than 20,000cm³/m²·day·atm. Landrock & Wallace (1955) reported that the packaging film for fresh meat should have an oxygen permeability more than 5000cm³ at least to provide meat with oxygen necessary for the retention of a bright red color. The average values of tensile strength of PVC and LLDPE wrap films were 301 and 284kg in the mechanical direction, and 201 and 221kg in the transverse direction, respectively. Tensile strength for wrap films showed relatively great deviation depending upon the manufacturer. In general, as calculated on average, PVC wrap films showed higher haze values (1.1%), thus being more transparent, than LLDPE films (2.1%), however two LLDPE films from manufacturers 'Q' and 'S' had an equivalent haze value to PVC.

**Conclusions:**

Although physical properties of wrap films available in Korea are largely manufacturer-dependent, all vacuum and wrap packaging materials tested in this study were not principally objectionable for packaging fresh chilled meat.

**Pertinent literature:**

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**Table 1. Physical properties of various vacuum packaging materials obtained from local market*).**

| Film | | | WVP | OP | Tensile strength | Haze | Pinhole | Manufac-turer |
|---|---|---|---|---|---|---|---|---|
| Type | Composition | Thickness(μm)[1)] | (g/m²·day·atm) | (cm³/m²·day·atm) | MD/TD [2)] (kg/cm²) | (%) | | |
| Laminated Film | PA/PE | 70±1.9 | 7.1 | 89.3 | 479/419 | 8.8 | X | A |
| | PA/PE | 80±2.9 | 14.5 | 42.3 | 460/443 | 13.0 | X | A |
| | PA/PE | 100±2.5 | 5.6 | 40.9 | 457/400 | 10.7 | X | A |
| | PA/PE | 85±1.6 | 9.1 | 47.9 | 555/501 | 9.9 | X | B |
| | PA/PE | 85±1.1 | 7.3 | 42.2 | 492/405 | 12.6 | X | C |
| | PA/PE | 90±2.3 | 6.3 | 44.1 | 434/404 | 11.3 | X | D |
| | PA/PE | 90±1.0 | 14.0 | 41.2 | 428/388 | 8.2 | X | E |
| | PA/PE | 90±1.5 | 7.7 | 42.2 | 443/378 | 8.8 | X | E |
| | PA/PE | 100±1.4 | 7.0 | 46.8 | 410/394 | 13.8 | X | F |
| | PA/PE | 100±2.2 | 5.7 | 51.3 | 416/366 | 11.4 | X | G |
| | Mean | 89±1.8 | 8.4 | 48.8 | 457/410 | 10.9 | X | |
| Shrink Film (Copo-Lymer) | PVDC/EVA | 70±3.6 | 6.0 | 10.2 | 508/505 | 15.7 | X | H |
| | PVDC/EVA | 74±2.0 | 5.5 | 15.3 | 546/407 | 8.5 | X | H |
| | PVDC/EVA | 62±4.5 | 5.5 | 14.9 | 826/780 | 6.6 | X | I |
| | PVDC/EVA | 58±3.5 | 5.6 | 15.4 | 732/551 | 10.0 | X | J |
| | Mean | 66±3.4 | 5.7 | 14.0 | 653/561 | 10.2 | X | |

*) Each value represents the mean of six to ten replicates. 1) Mean±S.D. 2) Mechanical direction/transverse direction

**Table 2. Changes in various physical parameters of shrink films obtained from local market before and after shrinkage*)**

| Manufacturer / Parameter | | H | | I | | J | |
|---|---|---|---|---|---|---|---|
| | | Before[1)] | After[2)] | Before | After | Before | After |
| Thickness (μm) | | 74 | 259 | 62 | 174 | 58 | 166 |
| WVP (g/m²·day·atm) | | 5.5 | 1.2 | 5.5 | 3.9 | 5.6 | 4.8 |
| OP (cm³/m²·day·atm) | | 15.3 | 5.8 | 14.9 | 12.6 | 15.4 | 5.8 |
| Tensile strength MD/TD[3)](kg/cm³) | | 546/407 | 333/328 | 826/780 | 650/623 | 732/551 | 391/255 |
| Haze (%) | | 8.5 | 34.9 | 6.6 | 63.3 | 10.0 | 16.2 |
| Pinhole | | x | x | x | x | x | x |
| Shrink rate (%) | MD | - | 48.5 | - | 42.7 | - | 34.9 |
| | TD | - | 57.3 | - | 46.5 | - | 40.9 |

*) Each value represents the mean of six to ten replicates.
1) Not shrunk 2) Shrunk unrestrained
3) Mechanical direction / transverse direction

**Table 3. Physical properties of wrap packaging materials obtained from local markets*)**

| Film | | WVP | OP | Tensile | Haze | Pin- | Ma- |
|---|---|---|---|---|---|---|---|
| Type | Thickness[1)] (μm) | (g/m²·day·atm) | (cm³/m²·day·atm) | strength MD/TD[2)] (kg/cm²) | (%) | hole | nufac-turer |
| PVC | 11±0.8 | 980 | >20,000 | 257/191 | 1.0 | x | K |
| PVC | 11±0.5 | 760 | >20,000 | 350/186 | 0.6 | x | L |
| PVC | 12±0.5 | 710 | >20,000 | 276/198 | 1.1 | x | M |
| PVC | 12±0.4 | 870 | >20,000 | 268/176 | 1.1 | x | O |
| PVC | 13±0.6 | 610 | >20,000 | 356/252 | 1.5 | x | P |
| Mean | 12±0.6 | 786 | >20,000 | 301/201 | 1.1 | x | |
| LLDPE | 9±0.7 | 160 | >20,000 | 340/244 | 1.0 | x | Q |
| LLDPE/ LDPE | 10±0.5 | 76 | >20,000 | 258/219 | 1.6 | x | R |
| LLDPE | 11±0.5 | 88 | 17,000 | 277/233 | 1.1 | x | S |
| LLDPE | 12±0.6 | 110 | 15,400 | 208/180 | 3.7 | x | T |
| LLDPE | 11±1.0 | 63 | >20,000 | 336/230 | 3.3 | x | U |
| Mean | 11±0.7 | 99 | >20,000 | 284/221 | 2.1 | x | |
| Total mean | 11±0.6 | 443 | | 293/211 | 1.6 | x | |

*) Each value represents the mean of six to ten replicates.
1) Mean±S.D 2) Mechanical direction / transverse direction