Use of Linear Low Density Polythene Film for Frozen Fish Packaging

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Physical properties of linear low density polythene film of 60 gauge thickness and its suitability as packaging material in frozen fish industry was studied in comparison with conventional 100 gauge low density polythene film. Both were comparable in water vapour transmission rate both at 38°C and-20°C, overall migration test and flexibility at low temperatures. Even though the tearing strength was inferior to the conventional one, it is of no significance in its use in frozen fish industry. The new film worked out to be more economical than the other one

Linear low density polythene (LLDPE) is characterised by its short chain branching due to low temperature and pressure of polymerisation which considerably influence the properties and the processing behaviour of the material. The presence of short chain branches in higher degrees in LLDPE film leads to a reasonably high degree of crystallinity (50–50%) compared to low density polythene (LDPE) which exhibits a crystallinity of only 40–50%. The presence of long chain branching is very low in LLDPE. Linearity improves the mechanical strength and branching provides the resin's toughness in this material.

At present an estimated 10 million square metres (247.5 tonnes) of LDPE film (100 gauge) costing Rs. 7.4 million are utilised every year by the industry. The new material, LLDPE of 60 gauge thickness has been released in the market offering potentialities of being used as substitute for LDPE film. Hence a detailed study of the physical properties of the LLDPE film introduced into the market was made with a view to explore the possibility of its being used in the frozen fish industry. Comparative cost calculation was also made, and the results of these studies are presented in this paper.

Materials and Methods

Linear low density polythene (LLDPE) film procured from an extruder in Cochin and LDPE film were subjected to the following physico-chemical tests as per IS: 1060 (part I, 1956, 1966; Part II, 1960) and IS: 2508 (1984).

1. Thickness and tearing strength
2. Tensile strength and elongation at break in machine and cross direction
3. Density
4. Yield
5. Water vapour transmission rate (WVTR) at 38°C, 90% RH
6. Water vapour transmission rate at -20°C, 85–90% RH

A pouch of known area made with the film under test was filled with anhydrous calicium chloride and carefully sealed without the slightest possibility of any leak. The sealed pouch was kept in a commercial frozen storage where the relative humidity was around 85–90%, at -20°C. The increase in weight was determined after wiping any condensed moisture on the pouch by means of a filter paper.

7. Oxygen transmission rate was determined as per ASTM D1434 (1975).

8. Suitability of the film for frozen fish packaging (food contact application) was found out by following the methods of IS 9845 (1981) and IS:10146 (1982) and FDA

Table 1. *Physical properties of LDPE and LLDPE films*

Characteristics		LDPE film	LLDPE film
Thicknes	gauge	100–110	60–66
	mm	0.025-0.0275	0.015–0.0165
Water vapour transmission rate g/sqm/90% RH/24 h			
	at 38°C	17	17.98
	at –20°C	0.50	0.82
Tearing strength g	Machine direction	120–124	25–28.8
	Transverse direction	179–184	62–65.6
Tensile strength kg/cm²	Machine direction	284–350	212–245
	Transverse direction	208–226	102–143
Elongation %	Machine direction	280–320	700–760
	Transverse direction	650–680	572–620
Flexibility at low temperatures	–20°C and –35°C	Flexible	Flexible
Brittleness at low temperature	,, ,,	Not brittle	Not brittle
Overall migration	As per IS test 40°C for 24 h	5 mg/dm²	7.77 mg/dm²
	as per FDA procedure 21°C for 24 h	2.1 mg/l	4.4 mg/litre
Oxygen transmission rate cc/sqm/24 h at 28°C		7647	11.469
Density		0.923	0.925
Yield (sqm/kg)		43.5	69.0

(1983). Low density polythene film (100 gauge) used at present in the packaging of frozen shrimp was also tested by the above methods for comparison.

Squid mantles (2 kg) were filled in waxed duplex cartons with LLDPE film and LDPE film lining inside. Glaze water was added to the level, wrapped as in conventional practice and left in frozen storage maintained at –20°C and –35°C. The film was examined after a storage period of 3 months at the above temperature. The frozen material was thawed and sensory qualities observed after cooking them for 10 min in 2% boiling brine.

Results and Discussion

Table 1 shows the comparative properties of LDPE and LLDPE films. As seen from the Table LLDPE film (60 gauge) behaves similar to 100 gauge LDPE film in properties like WVTR at 38°C and –20°C, overall migration test and flexibility characteristics at –20°C and –35°C. As regards tearing strength, LLDPE film is definitely inferior to 100 gauge LDPE film. LLDPE film exhibits higher elongation in machine direction as compared to LDPE film. Even though the tearing strength is less than those of the conventional 100 gauge LDPE film, it is suitable for frozen fish packaging since it is used only as an overwrap and as such the weight of the product does not act directly on the film. The minimum tensile strength of the film is agreeable with IS specification for LDPE film (IS: 2508, 1984). The yield/kg of LLDPE (60 gauge) is more than the conventional LDPE film (100 gauge).

Overall migration values of the LDPE and LLDPE film (water extraction test) are below the limits of 50 mg/litre (FDA, 1983) and 60 mg/litre or 10 mg/dm² (IS: 10146, 1982).

Thus when viewed from both these specifications, the film used for frozen fish

packaging has overall extractive values below the specified limits for use in the packaging of frozen fish products. The oxygen transmission rate of LLDPE film was found to be 11469 cc/sqm/24h/atm at 20°C while it was 7647 for LDPE film. In case of commercial LDPE film an oxygen transmission rate of 3900–13,000 is reported (Griggs, 1987). The oxygen transmission rate of LLDPE film is within the above range. The above results prove the suitability of the film for the packaging of frozen fish products. Non-brittleness of the film at frozen storage temperature is another favourable property in this regard. The sensory panel observed no difference between the two samples in taste, texture and appearance. No migration taste of the film could be detected in the product.

Comparative costs of LDPE film and LLDPE film are shown in Table 2. Even

Table 2. *Comparative costs of the packaging films*

Film	Cost Rs.
LDPE film/kg (100 gauge)	30.00
LLDPE film/kg (60 gauge)	33.00
LDPE film/sq. m	0.76
LLDPE film/sq. m	0.46
LDPE film/0.3021 sq. m (7.48 g)	0.23
LLDPE film/0.3021 sq. m (4.22 g)	0.14

though the cost/kg of LLDPE film is more, the number of pieces/area is more for a kilogram of the film because of its lower thickness and weight. For a 2 kg block institutional pack of frozen prawn for export, an area of 0.3021 sq m is required which cost 14 paise compared to 23 paise for the same area of LDPE film (100 gauge). Thus cost reduction can be achieved by the use of 60 gauge LLDPE film instead of 100gauge LDPE film presently used for packing frozen marine products. Taking the export figure for the year 1985 for frozen marine products a saving of Rs. 3.15 million per annum can be effected by substituting the conventional 100 gauge LDPE film with the new 60 gauge LLDPE film in the frozen fish industry.

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