Survey of the Properties of the Master Cartons (Corrugated Fibreboard Boxes) Used in Frozen Shrimp Industry

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Master cartons for fishery products collected from different prawn freezing factories were evaluated for bursting strength, puncture resistance, waterproofness, combined weight of liners, basis weight of the corrugating medium, weight of the carton, dimensions of the carton, wax content and saponifiable matter and discussed in the light of the ISI standards

India has of late emerged as one of the leading fishing nations of the world, ranking sixth in the magnitude of production, the annual fish landings touching a figure of 2.4 million tonnes. In the year 1979, India exported 78,976 tonnes of frozen prawns, fish and cuttle fish together (Anon, 1980) employing 3.95 crores of waxed duplex cartons and as many as 3.95 million corrugated fibreboard boxes. This gives some idea of the magnitude of this packaging industry. Frozen blocks weighing 2 kg are first packed in waxed duplex cartons lined with 100/125 guage low density polythene sheet. Ten such waxed cartons are packed in 5 ply corrugated fibreboard boxes which serve as shipping containers. These are strapped with 12 mm wide high density polythene or polypropylene straps.

Two of the common defects reported in the master cartons exported from India are low mechanical strength and tendency to get wet. They are weakened easily by deposit of moisture caused by temperature fluctuations during loading, unloading and other handling stages. As a result the master cartons appear soggy and often give way during handling (IS:6715–1972). The gross weight of the contents packed in master cartons lies between 20 and 30 kg. Among several packaging materials used in fishery industry, ISI specifications have been formulated only for corrugated fibreboard boxes for export of frozen seafoods and froglegs.

The present study deals with an extensive survey of master cartons used in the packaging of frozen fishery products as shipping containers with respect to their mechanical and chemical properties and their conformity to ISI standards.

Materials and Methods

Master cartons used in frozen shrimp export were collected at random from 32 different factories in and around Calicut, Cochin, Quilon, Bombay, Kakinada and Veraval. They were tested for different parameters as per ISI specification (IS: 6715–1972). The samples were conditioned before testing by the method described in IS : 1060 (1966). Bursting strength and water proofness expressed in terms of Cobb 30' value were determined as per the same Indian standard. Puncture resistance, combined weight of liners and corrugating medium were determined according to IS : 4006 (1972). The wax content in the corrugated fibreboard was determined by the method of IS: 3962 (1967). This method determines the unsaponifiable matter in the carbon-tetrachloride extractable material. The difference between the total solids extracted by carbon-tetrachloride and the wax content has been reckoned as the saponifiable matter content. The type of flute was determined as specified in the IS : 2771 (1977). The weights, dimensions and the general appearance of the cartons were also taken into consideration.

Results and Discussion

The particulars of the master cartons collected from 32 different factories and studied are given in Table 1, the bursting strength in Table 2, values of puncture resistance in Table 3, water proofness in Table 4 and analysis of the cartons for combined weight of liners in Table 5. Weights of substance are presented in Table 6, total weight of each carton in Table 7 and volumes in Table 8.

Table 1. *Particulars of master cartons*

Total number of cartons	32
Number of plies in the carton	5
Number of waxed cartons	14
Number of unwaxed cartons	18
Number of cartons with 'B' flutes	31
Number of cartons with 'B' + 'C' flutes combined	1
Wax %	1.3 to 6.6
Saponifiable matter %	0.02 to 2.85

Table 2. *Bursting strength of master cartons*

Bursting strength kg/cm²	Cartons falling in each range
8.5– 9.5	11
9.6–10.5	6
10.6–11.5	5
11.6–12.5	6
12.6–13.5	1
14.0–16.5	3

Table 3. *Puncture resistance of master cartons*

Puncture resistance beach units	Cartons falling in each range
124–149	1
150–174	7
175–199	8
200–224	11
225–249	4
250–274	–
275–299	1

Table 4. *Water proofness of master cartons*

Water proofness Cobb 30′ value	Cartons falling in each range
60–120	3
121–321	17
322–522	8
523–723	1
724–924	3

Table 5. *Analysis of combined weight of liners*

Combined weight of liners g/m²	Cartons falling in each range
300–349	1
350–399	10
400–449	10
450–499	5
500–549	4
550–599	1
600–649	1

Table 6. *Weight of substance for corrugating medium in the master cartons*

Weight of substance g/m²	Cartons falling in each range
102–117	2
118–133	11
134–149	8
150–165	6
166–181	3
182–197	2

Table 7. *Total weight of master cartons*

Total weight g	Cartons falling in each range
550–600	5
601–651	11
652–702	8
703–753	1
754–804	3
805–855	4

Table 8. *Volume of master cartons.*

Volume cm³	Cartons falling in each range
23,100–25,000	1
25,100–27,000	1
27,100–29,000	2
29,100–31,000	7
31,100–33,000	14
33,100–35,000	7

It may be seen from Table 1 that no uniformity is maintained by the different manufacturers as regards waxing, quantity of wax employed wherever waxing is resorted to and in the saponifiable matter, which is usually resin, a sizing agent used in the manufacturing process of the paperboards which imparts water proofness to them. In general the flute that is being used in the corrugating medium is of the B type (40–55 corrugations/30 cm) and 2.1 to 2.9 mm flute height. Only one manufacturer has used a combination of B+C flute. 'C' flute contains 36–44 corrugations/30 cm and 3.6 to 3.8 mm flute height. It is seen from the results that only some manufacturers wax the master cartons. Waxing is necessary to reduce the water absorption and assists in the retention of various physical properties so that the strength of the carton is not reduced even while subjected to waterspray/condensation while shipping. The data shows that there is a variation in the wax content ranging from 1.3 to 6.6% and saponifiable matter from 0.02 to 2.85%. Waxing alone is not sufficient to reduce the water absorption value. Some percentage of saponifiable matter (usually rosin) and probably other sizing materials should also be present in the paper in order to keep it down. However, ISI specifications (IS: 6715–1972) do not lay down any minimum requirements for these constituents in the carton material. Probably, the requirement for water proofness stipulated in the standards takes care of this aspect indirectly, since in the absence of the required degree of glazing and probably external water proofing (by wax treatment) the former cannot be achieved.

It is observed from Table 2 that only 9.4% of the cartons studied conformed to ISI standards with respect to bursting strength, minimum value of which stipulated for cartons meant for holding 20–30 kg of material being 14 kg/cm². Bursting strength is a complex function of tensile strength and stretch. It reveals the interfibre bonding and the formation of paper, the latter meaning the uniformity with which fibres are distributed in the paper. The larger number of the cartons falling in the lower ranges of bursting strength contribute to the low mechanical strength generally reported in the commercial samples of master cartons.

Indian Standard Specification for puncture resistance of master cartons under study is 200 beach units. One half of the samples tested satisfied this condition and another 25% were within 25 units below the minimum value fixed. The puncture resistance is reflective of the paperboard quality. The resistance of paperboard to puncture is of extreme importance in the manufacture of shipping containers because of the hazards involved in transportation, handling and storing. Containers are frequently punctured by corners of other containers, lumbers, forks etc.

Cobb test is the test to measure the water absorption of the paper board. It reflects the efficiency of sizing and similar properties of paper and is particularly useful in assessing the suitability of corrugated fibreboards for the manufacture of master cartons to be used as shipping containers under conditions where they are likely to get exposed to waterspray or subjected to water vapour condensation. Cobb value must be low when the paper is used for making shipping containers which are subjected to high humidity for a prolonged period. Table 4 shows that only 9.4% of the cartons used in frozen shrimp export are conforming to the ISI standard of 120 Cobb 30′, some samples showing values as high as 6 to 7 times the maximum stipulated. It is interesting to note that lower Cobb values are generally associated with higher wax and saponifiable matter (rosin) contents. The sample which had a wax content of 6.46% and saponifiable matter of 2.85% showed the lowest Cobb value (68.25) among the samples studied. Another one with 4% wax and 2.27% saponifiable matter had a Cobb value of 91.77. However, this was not so always, for example, a sample with no wax coating and 0.43% saponifiable matter showed a Cobb value of only 11.5 and another one, also with no waxing, but with 0.82% saponifiable matter had a Cobb value of 138.3. This means that some other sizing agents used in manufacturing process of the board also influence the water resisting property. Hence the proper degree of sizing at the manufacturing stage and a superficial coating with wax help in enhancing the water proofness of corrugated fibre board.

It is seen from Tables 5 and 6 that only

18.8% of the samples studied conformed to the ISI specification of a minimum of 500 g/m² of combined weight of liners, while 34.4% satisfied the stipulation of a minimum of 150 g/m² for the corrugating medium. The basis weight is a very important property of paper and paperboards as they are customarily bought and sold on a weight basis but are used on area basis. It also affects the burst factor and other physical properties of board and the functional characteristics of the box. Besides, the basis weight can be used to a reasonable extent as an index of physical strength. Particularly in the case of shipping containers the basis weight has found a place in national and international specifications which are used as a guide by buyers in package design.

The weight of the carton is related to the grammage of paper, type of adhesives and dimensions of the box. Most of the cartons are having the weight in the range of 550–699 g (Table 7). The weight cannot be specified to the manufacturer as it may increase if the adhesive used is silicate based. This may be the reason why the ISI standards also do not stipulate any weight specifications for the corrugated fibreboard master cartons.

Table 8 shows that there are wide variations in the dimensions of the master carton. This is due to the variation in the dimensions of waxed duplex cartons (which are specified by the importers) used inside the master cartons whose dimensions have to be adjusted to exactly pack 10 numbers of the former. That may be the reason why the ISI specifications do not stipulate any restrictions on the dimensions of the master cartons. Nevertheless, dimension is an important property when exported to different countries as variation may affect the handling conditions. It is desirable to have the uniform dimensions in the duplex and master cartons for the same gross weight of the contents. In cases where automatic erection and filling of the boxes are envisaged, uniformity of dimensions has to be adhered to atleast with not more than ± 1 mm deviation. It is desirable that no single dimension exceeds 50% of the combined internal dimensions, that is, the sum of length, width and depth. A proportion of 2:1:1 is desirable to facilitate stacking and palletization.

It may be seen from the above that only 9.4% of the samples studied conformed to the ISI standard with respect to two of the most important criteria, namely, bursting strength and Cobb value, while the minimum requirement for combined weight of liners was met by only 18.8% of the samples, the latter may be the reason for the low bursting strength observed. More attention may have to be paid by the manufacturers of fibreboards/cartons for adhering to the quality parameters. It is also possible that some of the stipulations in the ISI standards may be too stringent for easy compliance. Probably, a certain amount of relaxation in these criteria is called for, paying due consideration to the safety of the material packed in the containers and the protective properties demanded of them for withstanding the rigors of transportation under normal commercial conditions obtaining in the country.

The authors are indebted to Shri G. K. Kuriyan, Director and Shri M. R. Nair, Joint Director Central Institute of Fisheries Technology, Cochin for permission to publish this paper.

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