Packaging and Storage Studies of Dried Lizard Fish

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Packaging and storage studies of salted and dried lizard fish (*Saurida* sp.) have been conducted using different synthetic films like low density polyethylene (LDPE) of different gauges, high density polyethylene (HDPE) of 200 gauge, polyvinylidene chloride (PVDC) coated 400 MXXT cellophane, 100 gauge polypropylene (PP) and paper laminate of 100 gauge polythene. The films found most effective in the preliminary studies were subsequently used for packaging and storage of dried fish at atmospheric and lower temperature and humidity conditions for confirming their suitability under these conditions. Polyethylene films of higher gauges showed better results under both sets of conditions. PVDC coated cellophane film also performed satisfactorily under the latter conditions which under the former condition got easily attacked by insects. Lower temperature and humidity conditions in general enhanced the storage life of the dried product.

Lizard fish (*Saurida* sp.) is a lean fish caught by trawlers in large quantities almost throughout the fishing season in the south west coast of India. The demand for the raw fish is low. If it is salted, dried, packed and stored properly, it can easily be marketed in hinterland and the tribal areas. With mechanised drying using tunnel dryer and proper scientific and hygienic packaging, it can easily capture even the sophisticated foreign markets.

Dried fishery products are very sensitive to humidity changes and absorb or lose moisture depending on the prevailing atmospheric conditions. Initial moisture content and quality of the common salt used for curing are important factors affecting the ultimate quality and storage life of dried fish. Fungal attacks, oxidative rancidity, browning and insect ifestation are some of the problems encountered in dried fish during storage and marketing. Dealwood boxes, plywood boxes, tarpolyethylene gunny bags, palmirah palm leaf mats, gunny bags, card board boxes, split bamboo baskets and coconut palm leaf mat with an inner lining of polyethylene are advocated for bulk packaging of dried fish (Srinivasa Gopal *et al.*, 1980). Packaging of dried mackerel has been reported by Sen *et al.* (1961) who observed that packed dried fish developed mold growth in 62 days, when stored at 78°F and 75% R.H. and in 82–100 days in packages at 92% RH and 100°F, when the initial moisture content was 39.68%. According to them the shelf life of dried and packed fish is limited not by bacterial decomposition but by fungal attack, off odour and bitter taste. It was also reported by Venkataraman & Vasavan (1954–55) that dried mackerel packed in teak wood boxes lined with butter paper turned moldy in 30 to 90 days.

Materials and Methods

Freshly landed lizard fish were collected, dressed, split ventrally, viscea and gills removed and thoroughly cleaned. They were salted in the ratio of 1:5 (salt to fish) for 24 h, rinsed in fresh water to remove adhering salt and dried in a tunnel drier. Moisture, fat, acid insolubles and sodium chloride were estimated by AOAC (1975) methods and total volatile nitrogen (TVN) by the method of Pillai & Nair (1957).

Preliminary screening was done using the following films and laminates which were indigenously available. (1) 100 gauge LDPE, (2) 200 gauge LDPE, (3) 300 gauge LDPE, (4) 400 gauge LDPE, (5) 700 gauge LDPE, (6) 100 gauge PP, (7) 200 gauge HDPE, (8) 60 GSM paper/100 gauge LDPE and (9) PVDC coated 400 MXXT cellophane. Bags

Table 1. *Physical properties of the packaging films*

Packaging material	WVTR/g/m²/ 24 h at 38°C and 90% R.H.	Xylene extractives %	Hexane extractives %
100 gauge LDPE	17	14	2
200 gauge LDPE	8.3	3.4	1.6
300 gauge LDPE	3.5	4.8	0.8
400 gauge LDPE	2.7	3.8	1.2
700 gauge LDPE	1.66	3.8	1.4
200 gauge HDPE	2.4	1.2	0.2
100 gauge PP	8.16	—	—
400 MXXT cellophane	8.8	—	—
60 GSM paper/100 gauge LDPE	18.8	—	—

of the above films having dimensions of 30 cm x 18 cm were prepared, 250 g of dried fish sealed in each and stored at atmospheric condition. (RH: 65% to 95% and temperature: 26 to 34°C). Samples were withdrawn every month and tested for moisture content, TVN and organoleptic qualities. Variations in total weight during storage were also noted by weighing the pouches.

Further studies based on the above observations were carried out with some of the films which had shown better results like 200, 300 and 400 gauge LDPE and PVDC coated 400 MXXT cellophane in the atmospheric conditions and 100, 200 and 300 gauge LDPE, 400 MXXT cellophane and 100 gauge PP at the lower temperature and humidity conditions (temperature: 21 to 24°C and R.H. 55 to 75%). Results obtained under the two conditions were compared.

The water vapour transmission rate (WVTR) of the films were determined in accordance with IS: 1060 (1960) at 38°C, 90% RH. Xylene and hexane extractives were estimated for LDPE and HDPE (IS: 7227, 1974) to find out their safety as a food contact medium.

Results and Discussion

Physical properties of the films used in the study are presented in Table 1. Results of analysis of samples (both first and second series) immediately after drying are given in Table 2. The changes in moisture, TVN and organoleptic qualities of the stored samples of the first series are given in Tables

Table 2. *Initial analysis of the fish immediately after drying*

	First series	Second series
Moisture %	29.75	25.46
Fat (DWB) %	4.3	3.48
Acid insolubles (DWB) %	0.85	0.52
NaCl (DWB) %	28.08	24.43
TVN (OWB) mg/100 g	29.21	35.00

3, 4 and 5 respectively. Results of biochemical and organoleptic analysis in second series of experiments are given in Tables 6, 7 and 8. Results of the biochemical and organoleptic evaluations of the salted and dried saurida sealed in different types of packages and stored under low humidity and temperature conditions are given in Tables 9, 10 and 11.

Packaging plays a very significant role as a barrier against deteriorative changes of dried fish. Absorption cf moisture and consequent growth of fungus, development of rancidity, off odour, colour changes and attack by insects are the problems generally encountered during storage of dried fish. Therefore packaging materials have to be selected with a view to controlling the above deteriorative changes *vis-a-vis* economy as well as their ready availability.

The values in Table 1 reveal that the WVTR of polythene decreased with increasing

Table 3. *Changes in the moisture percentage of dried and packed Saurida stored at atmospheric conditions in the first series (Initial value:* 29.75%*)*

Packaging materials	30 days	60 days	90 days	120 days	150 days
Control	23.47	19.23	28.65	35.53	—
100 gauge LDPE	26.10	28.17	28.67	31.25	—
200 gauge LDPE	28.50	26.90	25.56	30.33	—
300 gauge LDPE	30.60	27.25	28.47	27.51	28.50
400 gauge LDPE	29.75	29.80	26.87	28.06	29.60
700 gauge LDPE	29.30	27.14	28.17	29.43	29.52
100 gauge PP	27.80	26.16	29.39	31.57	—
200 gauge HDPE	27.96	29.29	27.29	28.54	—
60 GSM paper/ 100 gauge LDPE	26.60	27.92	27.92	28.80	—

Table 4. *Changes in volatile basic nitrogen of salted, dried, and packed Saudria in the first series (Initial value:* 29.21 *mg*/100 g)

Packaging materials	30 days	60 days	90 days	120 days	150 days
Control	42.44	45.62	62.07	109.42	—
100 gauge LDPE	49.23	59.27	77.00	83.30	—
200 gauge LDPE	56.61	60.77	76.82	81.16	—
300 gauge LDPE	49.71	56.68	69.38	98.01	102.32
400 gauge LDPE	56.11	63.37	66.23	86.88	112.21
700 gauge LDPE	35.27	56.83	70.90	98.02	109.75
100 gauge PP	45.91	66.87	105.85	—	—
200 gauge HDPE	42.91	59.00	70.60	—	—
60 GSM paper/100 gauge LDPE	30.80	60.42	77.06	—	—

thickness. The WVTR of 200 gauge HDPE is almost equivalent to that of 400 gauge LDPE. It was also observed that the paper lamination of 100 gauge LDPE film did not improve its WVTR. Xylene and hexane extractive values showed that they are well below the permissible limits as per ISI specifications, except in the case of 100 gauge LDPE which showed high xylene extractive value of 14.4%. This may be attributed to the difference in the properties of the raw material used in its manufacture, since this was obtained from a different dealer while all the other LDPE films were procured from the same source.

The moisture contents in the sealed samples did not show any appreciable changes but that of control sample fell sharply from the initial 29.75% to 19.23% during summer months and further increased to 35.53% during the rainy season. Good correlation is observed between the WVTR of the films and the fluctuations in the moisture contents of the fish packed in them. The control samples also showed sharp changes in TVN values from the initial 29.21 to 109.42 mg% in 120 days. In the matter of retention of overall quality 300, 400 and 700 gauge LDPE films showed better results. This observation is amply supported by organoleptic and culinary properties of the products. Even in the above packages tiny fungal spots appeared in 90 days. Insects appeared in control sample and those in the thinner packages by 120 days spoiling the appearance. Even though 200 gauge HDPE film possessed good barrier properties, it

Table 5. *Changes in physical and organoleptic characteristics of salted, dried and packed Saurida during storage in the first series*

Packaging materials	Initial	30 days	60 days	90 days	120 days	150 days
Control	Very good, whitish	Good	Good to fair, light white to brown	Fair to poor, brown, soft, light off odour, slight fungus, bitter	Poor, stale off smell, insect attack	
100 gauge LDPE	–do–	–do–	–do–	–do–	–do–	
200 gauge LDPE	–do–	–do–	–do–	–do–	–do–	
300 gauge LDPE	–do–	–do–	–do–	Good to fair, light white to brown, slight fungus	Fair to poor bitter taste, fungus, brown	Poor, heavy fungal growth, off smell, brown
400 gauge LDPE	–do–	–do–	–do–	–do–	–do–	–do–
700 gauge LDPE	–do–	–do–	–do–	–do–	–do–	–do–
100 gauge PP	–do–	–do–	Fair	Poor, off smell, brown, fungal growth, bitter		
200 gauge HDPE	–do–	–do–	Fair	–do–		
60 GSM paper/ 100 gauge LDPE	–do–	–do–	Fair	Fair, brown, fungal growth, light brown	Poor, off smell, insects entered, brown	

Table 6. *Changes in moisture percentage of dried and packed Saurida on storage in atmospheric conditions in the second series of studies (Initial value:* 25.46%*)*

Packaging materials	30 days	50 days	90 days	120 days	150 days	180 days
Control	21.96	20.12	29.78	36.95	—	—
200 gauge LDPE	24.75	23.17	25.23	27.62	25.43	—
300 gauge LDPE	25.31	25.04	24.88	28.70	25.81	25.80
400 gauge LDPE	27.12	26.72	25.27	24.80	25.17	25.83
400 MXXT cellophane	25.17	24.42	25.12	24.83	25.91	—

Table 7. *Changes in volatile basic nitrogen in dried and packed Saurida in atmospheric conditions in the second set of studies (Initial value: 35 mg/100 g)*

Packaging materials	30 days	60 days	90 days	120 days	150 days	180 days
Control	42.41	50.83	60.23	102.00	—	—
200 gauge LDPE	52.34	56.00	67.23	73.26	98.29	—
300 gauge LDPE	56.73	62.84	65.54	89.78	93.35	111.35
400 gauge LDPE	42.32	53.04	73.30	72.20	85.34	105.76
400 MXXT cellophane	47.04	56.59	66.21	79.88	102.24	—

Table 8. *Changes in physical and organoleptic characteristics of dried and packed Saurida during storage in atmospheric conditions in the second series of studies*

Packaging materials	Initial	30 days	60 days	90 days	120 days	150 days	180 days
Control	Very good, whitish	Good, white to slight brown	Good to fair, white to brown	Fair, light fungus, whitish to brown	Poor, off smell, insect attack, heavy fungus, brown		
200 gauge LDPE	-do-	-do-	Good, whitish to slight brown	Good, white to brown	Fair, slight fungal spots, light brown	Poor, heavy fungus, insects entered brown	
300 gauge LDPE	-do-	-do-	-do-	-do-	Good, whitish to brown	Fair, slight fungal spots, whitish to brown	Poor, heavy fungal growth, brown
400 gauge LDPE	-do-	-do-	-do-	-do-	Good, whitish to brown	-do-	-do-
400 MXXT cellophane	-do-	-do-	-do-	-do-	Good, insects entered, whitish to brown	Poor, insect attack, brown fungal spots	

Table 9. *Changes in moisture percentage of dried and packed Saurida under low humidity and temperature (Initial value: 25.46%)*

Packaging materials	60 days	120 days	180 days	240 days	300 days	360 days
Control	20.94	18.22	16.57	20.39	21.22	20.42
100 gauge LDPE	24.01	22.32	22.29	21.93	21.75	—
200 gauge LDPE	24.96	23.91	25.26	23.42	24.31	23.21
300 gauge LDPE	25.76	25.42	25.42	24.13	25.26	24.92
400 MXXT cellophane	25.03	26.48	24.88	24.85	24.81	24.52
100 gauge PP	24.92	23.8	23.08	22.90	22.13	—

Table 10. *Changes in volatile basic nitrogen in dried and packed Saurida under low humidity and temperature conditions in the second series of studies (Initial value: 35.05 mg/100 g)*

Packaging materials	60 days	120 days	180 days	240 days	300 days	360 days
Control	42.45	48.74	67.24	69.00	82.60	101.15
100 gauge LDPE	38.54	42.34	64.25	61.82	85.65	—
200 gauge LDPE	39.05	46.65	56.32	64.84	70.00	78.82
300 gauge LDPE	39.42	46.85	51.62	68.43	64.00	79.53
400 MXXT cellophane	43.24	53.23	65.86	71.46	70.65	92.23
100 gauge PP	49.00	46.94	78.45	90.2	115.5	—

did not give satisfactory performance which may be attributed to the pin holes developed during heat sealing.

In the second set of studies in atmospheric conditions, the moisture content of the salted and dried saurida is brought down to around 25%, as it has been reported by Suryanarayana Rao *et al.* (1962) that excessive drying of salted fish to 25% moisture level would be necessary to prevent attacks by molds while employing the latest packaging materials. Under these conditions of storage, the control samples showed wide variations in moisture content between 21.96 and 36.95%. No appreciable fluctuation was observed in the case of the sealed fish samples. The changes in TVN content also were similar to the previous set of studies. Fungus appeared in the control sample in 90 days due to heavy absorption of moisture in the rainy season. 200 gauge LDPE film could keep the material in acceptable condition only for 120 days in spite of bringing down the moisture content to 25% level. Even though PVDC coated 400 MXXT cellophane could preserve the dried material without fungus for 120 days, the appearance of the dried fish inside the package was marred by excessive entry and growth of insects which may be attributed to the poor sealing strength of the material, since insects were found to enter through the seal and not by boring the film. Both 300 gauge and 400 gauge LDPE films could preserve the material to a period of 150 days in a fair condition. However, fungal spots appeared in these packages in 115 days.

As in the other experiments, in the low humidity and temperature conditions also, the control sample showed some fluctuations in moisture contents. The humidity varied from 55 to 75% and the moisture content came down to 16.57% in the lower ranges of humidity and again increased to about 21% at the higher ranges in the case of control sample. Samples packed in thinner films like 100 gauge, 200 gauge LDPE and 100 gauge PP showed some variations in the moisture contents; but the thicker films were able to act as better barriers against fluctuations in moisture contents. The changes in TVN contents were almost similar in all

Table 11. *Changes in physical and organoleptic properties of dried and packed Saurida during storage under low humidity and temperature conditions in the second series of studies*

Packaging materials	Initial	60 days	120 days	180 days	240 days	300 days	360 days
Control	Very Good, whitish	Very good	Good	Good	Good to fair, whitish to light brown	Fair, whitish to brown	Poor, brown
100 gauge LDPE	-do-	-do-	-do-	Good to fair, whitish to light brown	Fair to poor, whitish to brown	Poor, brown, discon-tinued	—
200 gauge LDPE	-do-	-do-	-do-	Good, whitish to light brown	Fair, whitish to brown	Fair to poor, whitish to brown	
300 gauge LDPE	-do-	-do-	-do-	-do-	Good to fair, whitish to light brown	Good to fair, whitish to brown	Poor, brown
400 MXXT cellophane	-do-	-do-	-do-	-do-	-do-	-do-	-do-
100 Gange P.P.	-do-	-do-	Good to fair	Fair, whitish light brown	Fair to poor, whitish to brown	Poor, brown	—

cases, except in the material sealed in PP film which showed higher values. This may be attributed to the low gas transmission rate of the film which causes higher retention of the volatile gases, but far slower than those samples stored at ambient conditions. Fungus, red halophiles or insects never appeared in any of the samples. The biochemical changes were also corroborated by organoleptic changes. Both the control and the packed samples did not show significant changes in quality aspects. The thicker packages provided good barriers against moisture loss, but control sample and those in thinner films became hard in texture. The limiting factors in shelf life were the colour changes and development of bitter taste during storage, probably due to rancidity.

The control sample kept well up to 300th day, but became very fibrous, hard and brown. Alterations in colour became apparent from 240th day. Gradual changes in taste was noted from 180th day. 300 gauge LDPE and PVDC coated 400 MXXT cellophane films also behaved in a similar way providing protection upto 300th day. In general a trebling of the shelf life was achieved by storage at lower humidity and temperature conditions in contrast to the findings of Sen *et al.* (1961) who observed a reverse trend.

Salted and dried lizard fish sealed in pouches of low density polyethylene of thicker gauges (300 and 400) and 400 MXXT cellophane film kept in good condition at ambient condition for 3 to 4 months. However the

400 MXXT cellophane was found to be prone to easy attack by insects which found entry into the product in the 4th month. The shelf life almost trebled by storage at lower controlled temperature and humidity conditions in all the films used.

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