

Thermal Treatment for the Prevention of Insect Infestation in Dried Fish - Use of a Tunnel Drier/Solar Tent Drier

**P. Ravindranathan Nair, T.S. Unnikrishnan Nair, Cyriac Mathen*
and K. George Joseph**

*Research Centre of Central Institute of
Fisheries Technology, West Hill
Calicut - 673 005, India*

A thermal treatment for the prevention of insect infestation in dry fish is described. The treatment was carried out in a tunnel drier/solar tent drier maintained between 55-65°C. The optimum time of exposure for thin varieties of dry fish was 60 min and 90 min for thick fish. The thermally treated products were packed in polythene bags after cooling. Untreated control had an insect-free shelf life of 1-2 months, whereas the heat-treated controls remained insect-free for 4 months. Refined and preservative treated fish remained insect-free for more than 6 months, while heat treatment further extended the shelf life to more than 12 months.

Dry fish are prone to infestation by certain types of insects and mites which can cause considerable loss. The multitude of insects and mites infesting dried fish and causing storage losses described by various workers have been recently summarised by Nair *et al.* (1994).

It has been reported that all stages of insects from eggs to adults are destroyed by temperatures of above 50°C (Blatchford, 1962). Szabo (1968) demonstrated the heat treatment process in Mali with the help of a solar tent drier for disinfecting of infested dry fish. The temperature inside the tent rose to 80°C within 30 min forcing the insects either to escape or killing them. Toye (1970) suggested heating dry fish in a simple charcoal fired oven for 30 min at four day intervals during the storage period to control infestation. The hot smoking technique (45-60°C) for 4-7 h for

large fish described by Watanabe & Cabrita (1971) is also probably a good method for the prevention of insect attack. Valsan (1968) has reported that thermal treatment at 125°C for 15 min prevents infestation in masmin, the traditional smoked, hard dried product from Lakshadweep. He later extended this process to dried Bombay duck also (Valsan, 1985).

The present work describes two means for the thermal treatment of dry cured fish to prevent infestation, by heating either in a tunnel or solar drier.

Materials and Methods

Commercial samples of dried silver belly and shark were procured from the local market. The tunnel drier used was a pilot model tunnel drier described elsewhere (Swaminathan, 1964).

* Present address : Central Institute of Fisheries Technology, Cochin - 682 029, India

A mini solar tent drier was made by covering a bamboo frame (2x1x1 m) with polythene sheet in tent fashion and lining the base of the tent with black polythene sheet. A maximum temperature of $65 \pm 2^\circ\text{C}$ could be attained inside the drier at noon. The dry fish procured were divided into two batches, one was kept as such (control) and the other was subjected to the refining and preservative treatment described by Mathen *et al.* (1990). Silver belly and shark were dipped for 2 and 5 min respectively, in the preservative following which they were dried to the same moisture level as controls. The control and treated samples were exposed to a temperature $55 \pm 1^\circ\text{C}$ in

the tunnel drier and $65 \pm 2^\circ\text{C}$ in the solar drier for periods varying from 30 to 120 min. Following the heat treatment, samples were cooled and packed in 150 gauge LDPE bags along with similarly packed non heat-treated samples for comparison. Moisture, salt and fat were determined as per AOAC (1980). Total volatile nitrogen (TVN) was determined as per the method of Conway (1962). Samples stored under ambient conditions were observed visually at regular intervals for incidence of insect infestation and also analysed for moisture and TVN. Only adult mites were taken into account, while for insects larval, pupal and adult stages of all insects were considered.

Table 1. Incidence of insect infestation in dry cured silver belly exposed to $55 \pm 1^\circ\text{C}$ in a tunnel drier for 60 min

Storage in months	Non-heat treated			Heat treated		
	Moisture, %	TVN, mg 100g ⁻¹	Organoleptic observations	Moisture, %	TVN, mg 100g ⁻¹	Organoleptic observations
0	26.0	57.0	Good in all respects	24.0	50.0	Good in all respects
1	28.0	140.0	Slight red attack. A few insects seen	24.0	90.0	Good, slight yellowing. No insects seen
2	28.0	200.0	Red attack intense. Many insects seen. Discarded	22.0	109.0	More yellowing. No insects seen
3	-	-	-	22.0	125.0	Slight reddening and off odour. No insects seen
4	-	-	-	24.0	265.0	More reddening. Spoiled smell. A few insects seen.
5	-	-	-	27.0	476.0	Intense reddening. Spoiled odour. Many insects seen. Discarded

Table 2. *Incidence of insect infestation in dry cured silver belly treated with preservatives and exposed to $55 \pm 1^\circ\text{C}$ in a tunnel drier for 60 min*

Storage in months	Non-heat treated			Heat treated		
	Moisture, %	TVN, mg 100g ⁻¹	Organoleptic observations	Moisture, %	TVN, mg 100g ⁻¹	Organoleptic observations
0	27.0	45.0	Good in all respects	24.0	48.0	Good in all respects
1	27.0	68.0	Good in all respects. No insects seen	22.0	72.0	Good in all respects. No insects seen
2	26.0	98.0	"	22.0	89.0	"
3	26.0	85.0	"	22.0	107.0	"
4	26.0	120.0	No reddening No foul smell. No insects	23.0	125.0	No reddening. No foul smell. No insects
5	28.0	160.0	"	25.0	156.0	"
6	28.0	156.0	"	24.0	164.0	"
7	29.0	160.0	"	24.0	169.0	"
8	28.0	178.0	"	26.0	172.0	"
9	28.0	190.0	No reddening No spoiled odour. No insects. Slight powdering.	25.0	187.0	No reddening. No foul odour. No insects seen. Slight powdering
10	29.0	210.0	No reddening. No spoiled odour. Powdering. A few insects seen	27.0	223.0	" Still acceptable
11	30.0	225.0	"	26.0	230.0	"
12	30.0	240.0	A few insects seen. Observations discontinued	26.0	245.0	Sample acceptable, but observations discontinued

Results and Discussion

The dried silver belly had an initial fat content of 8.1% and salt content of 28.55%

while for the dried sharks the fat content was 3.78% and salt 35.65% (all on dry weight basis).

Table 3. Incidence of insect infestation in dried cured shark heat treated in a tunnel drier at $55 \pm 1^\circ\text{C}$ for 90 min

Storage in months	Moisture, %	Non-heat treated TVN, $\text{mg } 100\text{g}^{-1}$	Organoleptic observations	Moisture, %	Heat treated TVN, $\text{mg } 100\text{g}^{-1}$	Organoleptic observations
0	34.0	98.0	Good in all respects	31.0	98.0	Good in all respects
1	31.0	162.0	"	31.0	101.0	"
2	32.0	248.0	Ammoniacal smell. Slight reddening. No insects seen	31.0	161.0	"
3	31.0	263.0	Ammonical smell. Reddening. Insects seen. Discarded	29.0	197.0	Slight ammonia-cal smell. Slight reddening. No insects seen
4	-	-	-	27.0	227.0	More ammonia-cal smell and more reddening. No insects seen
5	-	-	-	29.0	243.0	Intense reddening. Fungus present. A few insects seen
6	-	-	-	30.0	254.0	Intense reddening Foul smell. Many insects seen. Discarded

In the preliminary investigations, the optimum time for thermal treatment in both the tunnel drier and solar drier was determined to be 60 min for silver bellies and 90 min for sharks.

The observations and analytical data collected during the storage of fish thermally treated in the tunnel drier are presented in Table 1 to 4. From the data it is clear that the control samples (without heat treatment or preservative treatment)

deteriorated by 'red' attack and insect infestation within a period of 1-3 months and had to be discarded. The heat treated samples without preservative treatment were free from insect infestation for 4 months; but were subject to 'red' halophilic attacks by 3 months. Insect attack was observed to be facilitated by the spoilage of fish. On the contrary, preservative treated fish were free from insect attack for not less than 9 months apart from being free of the 'red' and fungal attack. Preservative treat-

Table 4. Incidence of insect infestation in dried and cured shark treated with preservatives and heat treated in a tunnel drier at $55 \pm 1^\circ\text{C}$ for 90 min

Storage in months	Moisture, %	Non-heat treated TVN, mg 100g ⁻¹	Organoleptic observations	Moisture, %	Heat treated TVN, mg 100g ⁻¹	Organoleptic observations
0	35.0	90.0	Good in all respects	31.0	90.0	Good in all respects
1	35.0	92.0	"	30.0	99.0	"
2	34.0	125.0	"	28.0	136.0	"
3	36.0	144.0	"	30.0	159.0	"
4	34.0	175.0	"	26.0	189.0	"
5	34.0	200.0	"	27.0	210.0	"
6	35.0	210.0	"	26.0	218.0	"
7	35.0	220.0	"	27.0	231.0	"
8	35.0	230.0	"	28.0	223.0	"
9	34.0	244.0	No reddening No spoiled odour. No insects seen	30.0	254.0	"
10	34.0	270.0	"	30.0	280.0	"
11	35.0	285.0	No reddening No spoilage. A few insects seen	31.0	300.0	"
12	35.0	305.0	More number of insects seen. No other type of spoilage. Observations discontinued	30.0	320.0	Sample still acceptable. Observations discontinued

ment followed by heat treatment gave ample protection from 'red' halophiles and insect attack and samples were found to be free from visible spoilage for more than 12 months. This was also supported by lower TVN values.

The results of fish treated in solar tent drier are shown in Tables 5 to 8. Here also, it was seen that the insect-free shelf life for the control (untreated) samples was 1-2 months and for the heat treated sample (not treated with preservative), 4 months.

Table 5. Incidence of insect infestation in dried and cured silver belly heat treated in a solar tent drier for 60 min at $65 \pm 2^\circ\text{C}$

Storage in months	Moisture, %	Non-heat treated TVN, mg 100g ⁻¹	Organoleptic observations	Moisture, %	Heat treated TVN, mg 100g ⁻¹	Organoleptic observations
0	36.0	22.0	Good in all respects	33.0	18.0	Good in all respect
1	37.0	45.0	No reddening. No foul smell. No insects.	34.0	40.0	"
2	37.0	111.0	Reddening Slight foul smell. A few insects	34.0	85.0	Slight reddening. No insects seen
3	37.0	242.0	Intense reddening. Foul smell. Many insects seen. Discarded.	35.0	107.0	More reddening. Spoiled smell. No insects
4	-	-	-	34.0	106.0	Intense reddening. Foul smell. A few insects.
5	-	-	-	34.0	127.0	Intense reddening. Foul smell. More insects.
6	-	-	-	33.0	145.0	Intense reddening. Foul odour. Many insects and larvae. Discarded.

Although the heat treated samples were free from insect infestation for 4 months, they were subject to heavy attack of 'red' halophiles and had other manifestations of spoilage. For the preservative treated fish, the insect free shelf life was not less than 9 months. This conforms to the finding by Mathen *et al.* (1992). The TVN values

indicate the difference in quality among the two categories of fish namely, untreated and preservative treated. The preservative treated and heat treated dried fish were found to have a shelf life of not less than 12 months after which the observations were discontinued.

Table 6. Incidence of insect infestation in dried and cured silver belly treated with preservatives and heat treated in a solar drier for 60 min at $65 \pm 2^\circ\text{C}$

Storage in months	Non-heat treated			Heat treated		
	Moisture, %	TVN, mg 100g ⁻¹	Organoleptic observations	Moisture, %	TVN, mg 100g ⁻¹	Organoleptic observations
0	37.0	15.0	Good in all respects	34.0	16.0	Good in all respects
1	37.0	24.0	"	33.0	28.0	"
2	36.0	40.0	"	33.0	45.0	"
3	36.0	66.0	No reddening or foul smell. No insects	34.0	70.0	No reddening. No foul odour. No insects
4	37.0	72.0	"	33.0	85.0	"
5	37.0	98.0	"	32.0	110.0	"
6	36.0	110.0	No reddening or foul smell. No insects	32.0	120.0	No reddening or foul smell. No insects
7	36.0	128.0	"	33.0	140.0	"
8	37.0	145.0	"	33.0	156.0	"
9	37.0	155.0	"	34.0	160.0	"
10	37.0	168.0	No reddening No spoiled odour. A few insects seen	34.0	175.0	"
11	36.0	185.0	"	33.0	190.0	"
12	37.0	200.0	No reddening or foul smell. More insects seen. Obser- vations discontinued	33.0	210.0	Still acceptable. Observations discontinued.

Table 7. Incidence of insect infestation in dried & cured shark treated in a solar tent drier for 90 min at $65 \pm 2^\circ\text{C}$

Storage in months	Non-heat treated			Heat treated		
	Moisture, %	TVN, mg 100g ⁻¹	Organoleptic observations	Moisture, %	TVN, mg 100g ⁻¹	Organoleptic observations
0	32.0	72.0	Good in all respects	30.0	64.0	Good in all aspects
1	33.0	190.0	Slight ammoniacal smell. A few insects seen.	29.0	159.0	"
2	33.0	245.0	More ammoniacal smell. Reddening. Many insects seen. Discarded	30.0	168.0	"
3	-	-	-	31.0	176.0	Slight ammoniacal smell. Slight reddening. No insects.
4	-	-	-	32.0	184.0	More ammoniacal smell and reddening. No insects.
5	-	-	-	32.0	200.0	Heavy reddening and foul smell. A few insects
6	-	-	-	32.0	248.0	Heavy reddening and foul smell
7	-	-	-	33.0	286.0	Completely spoiled smell. Many insects and larvae. Discarded

Table 8. Incidence of insect infestation in dried and cured shark treated with preservatives and heat treated in a solar tent drier for 90 min at $65 \pm 2^\circ\text{C}$

Storage in months	Non-heat treated			Heat treated		
	Moisture, %	TVN, mg 100g ⁻¹	Organoleptic observations	Moisture, %	TVN, mg 100g ⁻¹	Organoleptic observations
0	34.0	56.0	Good in all respects	30.0	60.0	Good in all respects
1	34.0	88.0	"	28.0	96.0	"
2	33.0	96.0	"	30.0	100.0	"
3	34.0	156.0	"	30.0	160.0	"
4	34.0	168.0	"	30.0	169.0	"
5	34.0	168.0	"	32.0	172.0	"
6	33.0	180.0	"	32.0	176.0	"
7	33.0	190.0	"	33.0	185.0	"
8	34.0	195.0	"	33.0	200.0	"
9	34.0	205.0	"	33.0	212.0	"
10	34.0	215.0	"	33.0	224.0	"
11	33.0	230.0	A few insects seen	31.0	240.0	"
12	34.0	250.0	A few insects seen. Observations discontinued.	32.0	256.0	Still acceptable. Observations discontinued.

The insects found to infest the samples under storage were identified to be the same as those described earlier by Kalaimani *et al.* (1987), viz., beetles of the species *Dermestes ater* and *Stegobium panicum* and mites of the species *Suidesia nesbetti*.

The results indicate that refined and preservative treated dry cured fish, subjected to thermal treatment for 60-90 min in a tunnel drier or solar tent drier, will remain insect free for not less than 12 months under proper storage conditions.

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