STUDIES ON THE STORAGE BEHAVIOUR OF LAMINATED AND COMMERCIAL BOMBAY DUCK

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A modified method for the preparation of laminated Bombay duck is presented. Investigation was carried out to find out an effective chemical to control the discolouration of dried laminated Bombay duck. Among various chemicals tried, NDGA and BHT were found to have considerably retarded the discolouration and extended the storage life of the product. Attempt was also made to suggest the optimum humidity level for the proper storage of the commercially dried fish. It was found that a level of about 65% R. H. provided maximum storage life to commercial product.

INTRODUCTION

Bombay duck *(Harpodon Nehereus)* has wide and discontinuous distribution along the coasts of India, East Africa, Malaysia, Indonesia and China. In India Bombay duck is fished in large quantities from the south and south east coasts of Saurashtra in Gujarat and the Konkan coast of Maharashtra. It is also fished in fairly good quantities from Andhra - Orissa coasts and from the estuaries of Bengal. An average of about 85,000 tonnes of Bombay duck is landed every year in India constituting 12% of the total catch. Statistical records show that this is the third largest single fishery in India. (C. M. F. R. I, 1966). Such a large and important fishery has not received the attention which it deserves, in spite of the innumerable possibilities for the utilization of this fishery. Almost the entire quantity of Bombay duck is sun-dried at present by the age old method. Some quantity of this crude dried product is exported to foreign countries such as Mauritius, Ceylon, Burma, Singapore and Indonesia. A small quantity is converted into dried laminated Bombay duck which has got a good market in foreign countries like United Kingdom. This industry can be developed tremendously due to the growing demand for the dried laminated Bombay duck by the developed countries. In the case of dried laminated Bombay duck discolouration (yellowish brown) followed by general spoilage is a thorny problem faced by the industry. One of

the major problems in the storage of commercially dried Bombay duck, is the tendency of the dried product to pick up moisture or dry up due to humidity changes of the atmosphere. This susceptibility of the product to variations in the atmospheric humidity considerably affects its storage characteristics. The commercial dried product undergoes very early spoilage, when the atmospheric humidity exceeds 80%. Attention was confined in this study to control the discolouration of laminated Bombay duck and also to work out the optimum humidity level at which the commercially dried fish would have maximum shelf life.

Materials and methods

Laminated Bombay duck was prepared according to ISI (1964) procedure with some modifications. Commercial Bombay duck was prepared as is usually done in commerce.

Absolutely fresh Bombay duck, iced immediately after hauling were brought in special insulated containers to the shore and used for these investigations. The fresh fish was well washed in clear slightly saline water, guts removed, washed further and suspended on galvanized iron rods in a tunnel dryer (designed at this Substation) for two hours at 40°C for surface drying of the fish. By this the moisture content (in muscle) was brought down from the original level of 89-90% to about 85%. Tails and fins were removed by a sharp knife or scissors and fish were split longitudinally on the ventral side. The laminated fish was then dipped in 1% brine (refined salt used) at the rate of 500 ml brine for 1 kg fish containing various antioxidants and other preservative chemicals such as Butylated Hydroxy Toluene (BHT) and Butylated Hydroxy Anisole (BHA) (0.10, 0.20 and 0.30%), Nor-dehydro Guaretic Acid (NDGA) (0.10, 0.25 and 0.50%), (all in fine suspension), Ascorbic Acid (0.25, 0.5 and 1.0%), Sodium Pyro-phosphate (0.50, 1.0 and 2.0%), Acetic Acid (1, 2 and 3%) and Citric Acid (0.5, 1.0 and 2.0%) for 20 minutes. The brined fish was drained, spread on trays, dried in tunnel dryer at 40°C for 14 hours, by which time the moisture content was brought down to 16 to 17%. It was then flattened by means of the roller press, the sides were trimmed to get pieces of uniform size and further dried for 1–2 hours to bring the final moisture content to about 14%, at which the best appearance was obtained. This product was made into bundles of 25 or 50 numbers followed by packing in polythene bag and stored at room temperature for periodic observation and analysis. As the main object of this study was to control the discolouration and retain the original colour and flavour of the product over extended period, emphasis was given to the organoleptic observations. Chemical analysis was carried out, only in the case of effective preservative and control samples for moisture, salt, TBA value and fat.

Commercial samples of Bombay duck were prepared by sun drying of whole Bombay duck from a scaffold. The dried fish of moisture content 13.1% were kept in petri dishes and left in dessicators containg various standard salt solutions of known humidity levels. In another series of experiments sulphuric acid solutions were used which would maintain constant relative humidity in the range of 40 to 100%. In view of the observations made by Laesecke (1955) that the rate of change of moisture content with temperature is quite small, which agrees with Cooper's (1938) observations, the above study was carried out at room temperature. Apart from the continuous observation for the organoleptic conditions of the products, loss or gain in weight of the samples under various humidity levels was recorded at known intervals. Moisture

was also estimated in all the samples occasionally. However other chemical analyses were not carried out as the physical observations themselves showed distinct changes in the samples under different humidity levels. Moisture, salt, fat and TBA were estimated by methods of AOAC (1960).

Results and discussion

From the organoleptic observations (Table I) it was found that the samples, except BHT and NDGA treated ones were discoloured, off odoured and the characteristic taste lost after the storage period of 2–3 months. Samples treated seperately with BHT and NDGA in different concentrations were found to have retained the original colour, appearance and taste upto about 9 months of storage. Rancid and other off odours were proportionate to the intensity of discolouration of the stored product. BHA treated samples were found to have given slightly better appearance than control in the initial stages of storage. There was no significant difference in appearance of either BHT or NDGA even though TBA values (Tables II & III) showed slight difference for different concentrations. In the case of BHA treated samples, TBA values were slightly less than control. The rancid taste was significant in the control while in BHT and NDGA treated samples this defect could not be noted. In all the samples moisture and salt contents were in a limited range of variation. It was also observed that two dips could be given in the same brine, without affecting much the quality of the stored products. A weaker concentration gave equally satisfactory results, with slight reduction in shelf life.

As the incorporation of both BHT and NDGA gave identical results, use of BHT appeared to be economic. The total cost of production of 100 pieces of laminated Bombay duck was Rs. 4.50 while the current selling price is Rs. 8/-. By the incorporation of BHT at the level of 0.10% in the dipping brine with two dips, the extra cost of production for 100 pieces was only 30–40 paise.

In the case of untreated samples, the market price is at times reduced considerably due to the discolouration and off odor in the product, developed within 2 to 3 months of storage. But in antioxidant treated samples slightly better returns can be expected due to their better quality and shelf life.

In the case of commercial Bombay duck the physical observations periodically made are furnished in Table IV. This shows that a maximum shelf life of dried Bombay duck can be ensured at a level round about 65% R. H. The samples kept at levels below 60% R. H. were found to have lost some moisture, acquired brown discolouration and rancid odour and became very hard and brittle. In levels of 70% R.H. and above the samples picked up moisture and got discoloration and off odor very early. Fungus attack was noted at R. H. 100% and 90% within 20 and 25 days respectively. It was however noted that the intensity of growth was more in 90% R. H. Product at 65% R. H. appeared to have neither lost nor gained moisture significantly during storage. Considerable off odor developed in the sample at 65% R. H. only after 100 days of storage while in all other cases it was noted very early as shown in the Table IV. The figure I shows the curve obtained by plotting equilibrium moisture contents against R.H. It was found that the equilibrium moisture content at 65% R. H. almost coincided with the original moisture level of the sample. Hence it could be suggested that the optimum level for the storage of commercial Bombay duck should be round about 65% R H.

TABLE I ORGANOLEPTIC OBSERVATIONS OF LAMINATED AND DRIED BOMBAY DUCK DURING STORAGE

Storage period	Characteristics	Control	BHT treated	NDGA treated	BHA treated	Ascorbic acid treated	Citric acid treated	Acetic acid treated	Sod. pyrophosphate treated
Initial	Colour and appearance	GW	GW	GW	GW	GW	FSY	FSY	FSY
	Odor	SDF	PA	PA	SDF	SDF	SS	SS	SDF
1 month	Colour and appearance	FSY	GW	GW	GW	FSY	FSY	SY	FSY
	Odor	SDF	PA	PA	SDF	SDF	SS	SR	SDF
2 months	Colour and appearance	SY	GW	GW	GW	SY	SY	SY	SY
	Odor	DF	VSDF	VSDF	SDF	DF	SS	R	DF
3 months	Colour and appearance	Y	GW	GW	SY	Y	Y	YB	Y
	Odor	SS	VSDF	VSDF	DF	SS	SS	R	SS
7 months	Colour and appearance	B	FSY	FSY	B	B	B	DB	B
	Odor	SSU	DF	DF	SSS	SSU	RSU	RSU	SSU
9 months	Colour and appearance	DB	FSY	FSY	DB	DB	DB	DB	DB
	Odor	SSU	DF	DF	SSU	SSU	RSU	SRSU	SSU

GW = Greyish White
FSY = Faint Straw Yellow
SDF = Slight Dry Fishy
PA = Practically Absent
SS = Slightly Stronger
SY = Straw Yellow
SR = Slightly Rancid
DF = Dry Fishy
VSDF = Very Slight Dry Fisy
R = Rancid
Y = Yellow
YB = Yellowish Brown
SSU = Strong Stale Unpleasant
DB = Deep Brown
SRSU = Strong Rancid Stale Unpleasant
SSS = Stronger slightly Stale
RSU = Rancid Stale Unpleasant

TABLE II ANALYSIS OF BHA AND BHT TREATED SAMPLES DURING STORAGE

Period of storage	Factors	Control	BHA Treated 0.10%	BHA Treated 0.2%	BHA Treated 0.3%	BHT Treated 0.10%	BHT Treated 0.2%	BHT Treated 0.3%
Initial	Moisture %	14.040	13.950	14.321	14.270	13.950	15.024	14.503
	Salt %	5.430	5.082	5.324	5.148	5.382	4.914	5.210
	Fat %	8.200	8.872	8.801	8.430	8.430	8.057	8.640
	TBA value * O.D/gm	0 020	0.020	0.021	0.018	0.018	0.023	0.020
3 months	Moisture %	14.950	14.073	14.574	14.340	15.210	15.020	14.725
	Salt %	4.975	5.154	5.314	5.557	4.987	5.014	5.137
	TBA Value O.D/gm.	0.046	0.044	0.028	0.022	0.041	0.033	0.038
5 months	Moisture %	14.560	13.980	14.874	15.045	14.907	13.908	15.214
	Salt %	5.210	6.493	5.642	4.937	5.135	5.081	4.900
	TBA value O.D/gm.	0.208	0.192	0.189	0.174	0.148	0.064	0.060
7 months	Moisture %	15.210	14.257	14.950	14.805	13.980	13.743	15.042
	Salt %	4.895	5.043	5.384	5.137	5.585	5.214	4.958
	TBA value O.D/gm.	0.216	0.212	0.204	0.192	0.176	0.080	0.136
9 months	Moisture %	13.950	15.054	16.00	14.984	14.750	14.432	14.900
	Salt %	5.432	4.975	4.923	5.216	5.075	5.213	5.001
	TBA value O.D/gm.	0.248	0.240	0.244	0.216	0.212	0.112	0.120

* TBA value is expressed in terms of Optical Density.

TABLE III ANALYSIS OF NDGA TREATED SAMPLES DURING STORAGE

Period of storage	Factors	Control	NDGA		
			0.10%	0.25%	0.5%
Initial	Moisture %	13.89	14.407	13.894	13.503
	Salt %	5.048	4.949	5.021	5.432
	Fat %	6.940	7.123	7.54	7.583
	TBA value O.D/gm.	0.018	0.012	0.010	0.013
3 months	Moisture %	13.63	13.924	14.357	13.924
	Salt %	5.33	5.401	5.170	5.094
	TBA value O.D/gm.	0.129	0.027	0.020	0.027
5 months	Moisture %	14.870	14.430	13.800	13 637
	Salt %	4.980	5.009	5.408	5.430
	TBA value O.D/gm	0.158	0.074	0.036	0.036
7 months	Moisture %	14.543	13.970	13.803	14.600
	Salt %	5.185	5.304	5.195	5.040
	TBA value O.D/gm.	0.180	0.092	0.058	0.054
9 months	Moisture %	14.835	13.893	14.000	13.799
	Salt %	4.980	5.190	5.072	5.230
	TBA value O D/gm.	0.200	0 012	0.074	0.068

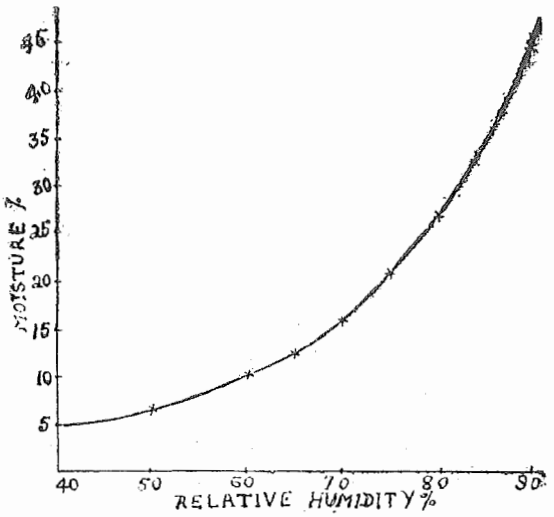

Fig. 1 Equilibrium moisture v/s R. H.

Cooper *(loc. cit)* reported that the equilibrium moisture level at 65% R. H. was about 12% for heavy salted fish. In the present study on dried Bombay duck the equilibrium moisture content at 65% R. H. is found to be 12 – 13%. Part played by the species of fish, the nature of their proteins and the initial levels of moisture, fat and salt of the product used for the study have to be considered as the probable reasons for this variation in equilibrium moisture level of different fishery products processed under different conditions.

Summary

A modified method for the preparation of laminated Bombay duck was worked out. Investigations were carried out to find out an effective chemical to control the discolouration of dried laminated Bombay duck. Among various chemical preservatives tried only BHT and NDGA in concentrations of 0.10% in the dipping brine were found to have considerably retarded the discolouration and extended the storage life of laminated Bombay duck. It was found that the level of about 65% R. H. provided maximum shelf life to the commercial Bombay duck during storage.

TABLE IV STORAGE STUDIES OF COMMERCIAL BOMBAY DUCK.

INITIAL OBSERVATION: GREYISH WHITE, FRESH ODOR OF DRY FISH, HARD AND FIRM

Storage period	Characteristics	40% R. H.	50% R. H.	60% R. H.	65% R. H.	70% R. H.	75% R. H.	80% R. H.	90% R. H.	100% R. H.
20 days	Color and appearance	GW	GW	GW	GW	GW	GW	SYB	YB	YBF
	odor	FDF	FDF	FDF	FDF	SO	SO	O	CO	Sp
	Texture	HF	HF	HF	HF	HF	LHF	LHF	LHF	St
40 days	Color and appearance	SYB	SYB	SYB	GW	AFA	AFAM	DAM	MF	F
	odor	SR	SR	VSR	FDF	CO	CO	Sp	Sp	Sp
	Texture	VHF	VHF	HF	HF	LHF	LHF	St	St	St
60 days	Color and appearance	YB	YB	SYB	GW	SYBM	SYB	SYBM	IFM	YBM
	odor	R	R	SR	AFDF	Sp	Sp	Sp	Sp	stale
	Texture	VH	VH	HF	HF	SS	St	St	St	St
80 days	Color and appearance	YB	YB	SYB	GW	YM	BM	YBM	IFM	sample was discarded as it was completely spoiled
	odor	IR	IR	R	VSO	Sp	Sp	Sp	Sp	
	Texture	VH	VH	HF	HF	St	St	St	St	
100 days	Color and appearance	YB	YB	SYB	SYB	YBM	BM	BM	BMF	
	odor	IR	IR	R	CO	Sp	Sp	Sp	Sp	
	Texture	VH	VH	HF	HF	St	St	St	St	

GW=Greyish White
FDF=Fresh Dry Fishy
SO=Slightly off
HF=Hard and Firm
LHF=Less Hard and firm
SYB=Slight Yellowish Brown
AFA=Absence of Fresh Appearance
SR=Slight Rancid
VSR=Very Slight Rancid
CO=Considerably Off
VHF=Very Harp and Firm

YB=Yellowish Brown
SYBM=Slight Yellowish Brown-Moist
R=Rancid
AFDF=Absence of Fresh Dry Fishy
SS=Slightly Soft
Sp=Spoiled
YM=Yellowish-Moist
IR=Intence Rancid
VSO=Very Slight Off
VH=Very Hard
St=Soft

YBM=Yellowish Brown Moist
YBF=Yellowish Brown-Fungus
O=Off
AFAM=Absence of Fresh Appearance-Moist
DAM=Dull Appearance-Moist
ME=Moist-Fungus
F=Fungus
IFM=Intense Fungus-Moist
BM=Brown-Moist
BMF=Brown-Moist-Fungus

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