

Process Standardization for the Preparation of Smoked Cubes and Fillet Steaks from a Marine Perch, *Lethrinus lentjan* (Lacepede 1802)

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A study was undertaken for the preparation of smoked cubes and fillet steaks from a marine perch King emperor *Lethrinus lentjan* (Lacepede) and the conditions for preparation were standardized. The parameters standardized were conditions for brining, draining, pre-drying, smoking temperature and smoking time. Brining conditions comprised brine concentrations of 10, 15 and 20% and brining periods of 15, 30 and 45 min each. Draining at room temperature and at 10°C for 10, 20 and 30 min were studied. The pre-drying conditions selected were pre-drying in a mechanical drier and smoking kiln at 50°C for 15, 30, 45 and 60 min. Smoking conditions such as smoking at 80, 90 and 100°C for 1, 2 and 3 h each were considered. Salt, moisture and phenol content of the samples were analysed in addition to sensory analysis. Based on the test results, brining at a concentration of 10%, for 15 min, draining under refrigerated condition for 30 min, pre-drying in a mechanical drier for 30 min at 50°C and smoking at 80°C for a period of 3 h were found to be ideal. Smoked cubes and fillet steaks prepared using the standardised procedure had superior quality on sensory evaluation.

Key words: Cubes, fillet steaks, standardization, smoking, *Lethrinus lentjan*

Smoking is one of the oldest methods of food preservation and is still widely used in fish processing. Smoking provides a comparatively easy method of value addition (Venugopal, 1995) for which good market exists in places like Manipur, Nagaland and Meghalaya in India (Das *et al.*, 2003). Poor quality of smoked seafood is a major factor holding back the rapid market expansion and development of innovative items (Pigott & Tucker, 1990). Standardization of the process parameters is required for improving the quality of cured and smoked fish as well as for development of new and innovative products. This paper deals with process standardization of two cured and smoked products from a marine perch, *Lethrinus lentjan* (Lacepede 1802) which has not been much utilized hitherto for smoked product. The process parameters standardized for the preparation of smoked cubes and fillet steaks include conditions for brining, draining, pre-drying and smoking.

Materials and Methods

Marine perch, *Lethrinus lentjan* (Lacepede) weighing 400-600 g obtained from local fish markets were used for the preparation of cured and smoked cubes and fillet steaks of dimensions 2.54 x 2.54 x 2.54 cm and 5.08 x 2.54 x 1.27 cm respectively.

The procedures for preparation of cured and smoked products *viz.*, fish cubes and fillet steaks; brining, draining, pre-drying and smoking, were standardized separately (Table 1). All the experimental variables were standardized in randomised block design with four replications (Snedecor & Cochran, 1968). The experimental variables most acceptable to the taste panel were selected. Each time when a parameter was standardized, that alone was kept as the variable, while other parameters were taken as per the standard method of Chandrasekhar & Manisseri (1976). Every sample of both

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product styles that was standardized for each variable separately was further smoked at 80°C for 2 h. The salt content and moisture of the smoked samples were analysed as per standard methods (AOAC, 1970; 1975). Phenol content of the smoked samples was analysed as described by Foster & Simpson (1961).

Smoked fillet steaks and cubes were prepared as described by Chandrasekhar & Manisseri (1976) using the standardized procedure. Washed cubes and fillet steaks were brined in 10% brine for 15 min followed by draining in refrigerated condition for 30 min, pre-dried in mechanical drier at 50°C for 30 min and smoked in a mechanical smoker at 80°C for 3 h. Samples after smoking were fan dried and packed.

A taste panel consisting of ten judges carried out the sensory evaluation of smoked cubes and fillet steaks. The quality attributes assessed were colour, odour, taste, texture, rancidity and overall score of the product on the basis of a 10 point hedonic scale (Kazimerz *et al.*, 1999). Sensory evaluation was carried out separately for standardizing each parameter. Smoked samples prepared after each standardization trial for the respective variable, were subjected to sensory evaluation and respective average scores were taken to determine the standard parameter and acceptability of that product. Sensory evaluation results were analysed using Friedman test (Sprent, 1989).

Results and Discussion

The present study was aimed at standardization of a process for preparation of smoked products from the marine perch, *Lethrinus lentjan*. Based on the organoleptic evaluation and statistical analysis, 10% brine concentration and brining period of 15 min were found to give best acceptability for smoked cubes and smoked fillet steaks (Table 2, 4). Higher weight yield and quality of final product is obtained by using lower salt concentrations than by using a fully saturated brine solution (Thorarinsdottir *et al.*, 2004). The concentration of brine is important to ensure a uniform and standard product (Devadasan *et al.*, 1975). Sensory scores were kept as the prime criteria for the desired saltiness in the smoked cubes and fillet steaks in the present study as previously reported by Adrian (1957). The salt and moisture content of smoked cubes were dependant on the brine concentration and brining time ($p < 0.05$) while brine concentration alone had an effect on these parameters on smoked fillet steaks ($p < 0.05$). That might be due to a marginally higher moisture content of smoked fillet steaks compared to cubes thereby resulting in a low salt content in fillet steaks. Some of the fillet steaks had embedded side bones, which resulted in low moisture removal during drying. The final concentration of salt in smoked cubes and fillet steaks brined in 10% brine for 15 min ranged from 11.8 to 12.6%. After brining at higher salt concentration of 15 and 20%, products were too salty to taste, matty in surface, slightly tougher in texture and of

Table 1. Parameters selected for standardization

Process		Parameters under each process			
Brining	Brine concentration (%)	10	15	20	
	Brining time (min)	15	30	45	
Draining	Draining time at 10°C and Room temperature (min)	10	20	30	
Pre-drying	Pre-drying time at 50°C in mechanical drier and smoking kiln (min)	15	30	45	60
Smoking	Smoking temperature (°C)	80	90	100	
	Smoking time (h)	1	2	3	

Table 2. ANOVA table for standardization of smoked cubes

I Brining			
I _a - Salt content	Sources of Variation	F value	Critical difference
	Brine concentration	436.290*	0.480
	Brining time	8.112*	
	Interaction	0.555	
I _b - Moisture content	Brine concentration	3.464*	1.320
	Brining time	6.659*	
	Interaction	0.229	
II Draining			
	Between Treatments	0.409	ND
III Pre-drying			
III _a Salt content	Between treatments	37.738*	0.525
III _b Moisture content	Between treatments	49.248*	2.256
IV Smoking			
IV _a Phenol content	Smoking temperature	65.061*	0.270
	Smoking time	2.156	
	Interaction	4.818*	
IV _b Salt content	Smoking temperature	226.631*	0.284
	Smoking time	29.398*	
	Interaction	9.496*	

* Significant at 5 % level

poor gloss due to more protein denaturation which resulted in changes in texture and reduced water holding capacity (Offer & Trinick, 1983) and unattractive white patches as salt crystallized on the surface of the final product. Brining of fish fillets improves palatability and water holding capacity (Esaïassen *et al.*, 2004; 2005). However, soluble components within the fillets, such as free amino acids (FAA), vitamins and proteins, leach out during brining (Larsen & Elvevoll, 2008). Thus, brining has both nutritional and economical implications. It may increase both yield and palatability, but

with loss of nutritional components during the process.

Draining is an important process that helps in developing the gloss to the final cured product. Based on organoleptic scores obtained, draining for 30 min under refrigerated conditions (+10°C) was selected for the preparation of standard smoked cubes and fillet steaks (Table 3, 5). It is important to drain the fish immediately after brining before the gloss begins to set as proper draining before smoking produces a typical glossy appearance on the cut surface which

Table 3. Sensory scores for treatments selected, during standardisation for smoked cubes

Quality characteristic	Brining 10% brine, 15 min	Draining Refrigerated 30 min	Pre-drying 30 min in mechanical drier	Smoking 80°C, 3 h
Colour	8.15	8.24	8.57	8.61
Odour	7.70	7.94	8.36	8.57
Taste	8.25	8.00	8.3	8.09
Texture	7.93	ND	8.1	8.07
Overall score	7.8	8.1	8.21	8.4

Scores in each column are the data related to standardization of four variables done separately

Table 4. ANOVA table for standardization of smoked fillet steaks

I Brining			
I _a - Salt content	Sources of Variation	F value	Critical difference
	Brine concentration	531.741*	0.461
	Brining time	2.652	
I _b - Moisture content	Interaction	1.590	
	Brine concentration	6.300*	1.306
	Brining time	1.751	
	Interaction	0.906	
II Draining			
	Between Treatments	1.592	ND
III Pre-drying			
III _a Salt content	Between treatments	27.117*	0.404
III _b Moisture content	Between treatments	47.861*	1.575
IV Smoking			
IV _a Phenol content	Smoking temperature	422.860*	0.105
	Smoking time	20.812*	
	Interaction	6.714*	
IV _b Salt content	Smoking temperature	448.364*	0.189
	Smoking time	121.695*	
	Interaction	30.270*	

* Significant at 5 % level

is one of the commercial criteria of quality. Draining of brine at room temperature for long periods may affect the quality of fish (Dublely *et al.*, 1973). However, under refrigerated conditions, some amount of dehydration occurs and this might have resulted in an 'appropriate wetness' of the product necessary for better smoke absorption and overall quality of the product. Draining time of 30 min was found to give the best acceptability with typical glossy appearance noted in the treatment selected,

which is evident from the comparatively higher scores obtained.

Cubes and fillet steaks pre-dried for 30 min in a mechanical drier at 50°C was found to be the most suitable condition among the different conditions tried for pre-drying. Pre-drying is an important step in hot smoking that prepares the product for adequate smoke absorption. It provides good colour and smooth sheen, avoids case hardening and subsequent spoilage (Woody & Flick, 1990). Statistical analysis of moisture content

Table 5. Sensory scores for treatments selected, for standardization of smoked fillet steaks

Quality characteristic	Brining	Draining	Pre-drying	Smoking
	10% brine, 15 min	Refrigerated 30 min	30 min in mechanical dryer	80°C, 3 h
Colour	8.3	8.28	8.43	8.51
Odour	8.05	8.36	8.44	8.45
Taste	8.14	8.25	8.38	8.13
Texture	7.82	ND	8.31	7.91
Overall score	7.91	8.34	8.57	8.36

Scores in each column are the data related to standardization of four variables done separately

and salt content of smoked cubes and fillet steaks showed significant difference ($p < 0.05$) between different periods selected for pre-drying treatments (Table 2, 4). When the product was dried for less than 30 min, the fillets appeared to be insufficiently dried. It also increased the humidity level inside the smoke kiln, which eventually lowered the rate of drying during smoking.

The Relative Humidity (RH) inside the smoker was 37% after 30 min as against 45% in the mechanical drier. The lower RH and efficient air circulation will result in faster rate of moisture removal from the smoker compared to the drier resulting in excessive hardening of the products, pre-dried in smoker compared to the dryer. The products pre-dried in smoker also had an unattractive dark brown and charred surface for the final product with low smoke odour while products smoked after pre-drying in the mechanical drier gave an yellowish brown colour typical of smoke cured products. The dark brown colour of the product could be due to the oxidation of fat, as oxidation proceeds more rapidly and changes in fatty acid composition might occur at lower RH (Koizumi *et al.*, 1980).

Temperature of 80°C was selected for smoking of cubes and fillet steaks based on organoleptic scores obtained (Table 3, 5). Smoking at higher temperature of 90°C and 100°C resulted in products with very hard texture which were rejected by the panel (Table 2, 4). Statistical analyses showed that phenol content of the smoked fillet steaks had significant difference ($p < 0.05$) with smoking temperature and time, while cubes had a slightly different pattern showing no significant difference with time (Table 2, 4).

A temperature of 80°C – 120°C is used in hot smoking in order to cook the fish flesh (Joyce, 1985). Different species tolerate heat differently. The process must be tailored to the species, processing equipment used, market demand, distribution considerations and regulatory requirements. Hot smoking process results in partial sterilization of the product (Kandoran, 2002).

Smoked products with moisture content around 50% and above were easily attacked by moulds and spoiled within 3 to 4 days of storage at room temperature and those having 37 to 40% moisture had a storage life of 2 to 4 months (Solanki *et al.*, 1970). Cubes and fillet steaks smoked at 80°C for 2 h had a moisture content of around 46 to 48% and got spoiled within seven days by mould growth. Hence for further reduction of moisture and enhancement of shelf life, smoking time of 3 h was selected.

The deposition of phenols was found to be very low in the products, which could be due to high temperature employed for smoking. According to Kingston *et al.*, (1999) smoke deposition increases with increase in temperature upto 71°C.

In the present study, conditions for preparation of smoked cubes and fillet steaks from a marine perch were standardized. The conditions of pre-smoking treatments such as brining, draining and pre-drying were standardized for each product style. Cubes and fillet steaks smoked by the standardized method had excellent acceptability.

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