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A report on the sodium levels of salted dry fish in Chennai and recommendations to comply regulation

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Abstract
Regulating the intake of sodium is in need of the hour pertaining to the established health effects of high sodium consumption. Labeled food products from organized food sectors provide information on sodium levels, while in unorganized sector the sodium content of some of the heavily salted food products such as dry fish goes unnoticed. This report is presented based on the studies from 12 commercial dry fish samples collected form Chennai, one of the major sea food export coastal region of India. The samples were tested for NaCl, sodium and moisture content. The NaCl content was found to be well above 15% in 7 samples, between 10-15% in 2 samples and below 10% in 3 samples. Consequently 9 samples had sodium content above 2000 mG/100G and it was evident that NaCl content of more than half the samples was not in compliance with the FSSAI regulations of 10-15% NaCl content by weight of salted dry fish. This situation poses a serious threat to health and calls for the awareness of the local manufacturers on the level of salting in processed dry fish. Attending to this need an experiment was conducted by processing anchovies (*Stolephorus spp.)* with 1-8% salt w/w of fresh fish and it was found that 3-5% of salting would to be sufficient to meet the FSSAI regulations.

Keywords: Sodium levels, dry fish, FSSAI regulations, salting recommendations

1. Introduction
The importance of salt in food manufacture arises from its role in preservation and contribution to flavour, texture and colour. It acts as a preservative by lowering the water activity (a_w) content to below that which is required by various bacterial species for growth [1]. Salt comprises of both sodium and chloride in which sodium consists of up to 40% of the molecule [2]. From a physiological standpoint, sodium (Na+) is absolutely essential for life and the recommended level of sodium intake by the World Health Organization (WHO) is maximum of 2 G per day for adults (≥16 years old) equivalent to 5 G of salt (NaCl) per day [3,4]. However, most people consume too much salt, on average between 9 and 12 G per day, or around twice the recommended maximum level of intake [5]. Excess sodium intake is one of the top 2 dietary risk factors contributing to the global burden of disease (Eyles *et al*., 2016). Also, high sodium intake has been associated with a high risk of non-communicable diseases (NCDs) such as hypertension, cardiovascular disease and stroke [4].
In India, hypertension is the leading NCD risk and estimated to be attributable for nearly 10% of all deaths [6]. Figures showed that India consumes 55-58 lacs tons of edible salt annually and can reduce incidence of stroke by 25% and heart attacks by 10% by cutting down on salt consumption [7]. A more specific regional study by Radhika *et al*., [8] in 2007 reported a salt intake of 8.5 G in Chennai population, which has high chances of being increased by now due to higher consumption of processed foods in recent times. Therefore minimizing salt consumption could be an important target for improving public health.
Dry fish is an important source of animal protein supplement which is preferred as a key dish or used as a flavoring agent in combination with other food items [9]. In India, consumption of dried fishes is about 32% of the marine landings and about 17% of the total catch is used for the production of dry fishes [10]. According to reports by MPEDA (2014) [11] Indian dry fish export contributed to 7.86% of all forms of fish exports and earned 819 crores during the year 2013-2014.
Salted dry fish is a product prepared from fresh wholesome fish and salt is a functional part of it wherein it serves as a preservative, more than just a flavor compound. Luck and Pager (2000) [12] stated that technically, common salt does not display antimicrobial action, but its capacity to reduce water activity values (aw) in foods, slows down or even interrupts vital

microbial processes. Therefore high salt substitution is essential to maintain the quality of the product in conjunction with proper drying. This on the other hand arise the risk of increased sodium intake per day even if consumed in small proportion.

FSSAI (2010) [13] regulations recommend salt content of 10 – 15% by weight of the salted fish which has been dried to a moisture content of not more than 16%. Since most of the dry fish product is from unorganized local manufacturing, compliance to this regulatory standard is unknown. With respect to this, the current report has been prepared to analyze the NaCl content in commercial dry fish and establish the required amount of salt substitution to meet the regulatory standards.

2. Materials and methods

2.1 Raw materials

Commercial samples of dry fish were collected from various local markets in Chennai. The samples included fish varieties such as *Stolephorus spp*., Scomberomorus spp., *Leiognathidae spp., Sillago spp., Decapterus russelli and Lates calcarifer*.

2.2 Estimation of NaCl %

Modified Mohr's method was followed for determination of NaCl %. 1 G of sample was powdered and dissolved in 30 mL of boiling Milli-Q water. 1 mL of 5% potassium chromate solution (Merck Life Sciences Pvt. Ltd. - DE7D671206) was added as indicator and titrated against 0.1 N silver nitrate solution (MP Bio chemicals - Lot No. MR31127/ Cat No: 195495). The initially yellow solution turned into white precipitate on formation of silver chloride. The end point occurred when all chloride ions precipitated and excess silver ions reacted with chromate ions of the indicator to form red-brown precipitate of silver chromate. The titer value was noted and substituted in the formula mentioned below to express NaCl content in percentage,

$$\text{NaCl \%} = \frac{\text{Titer value} \times \text{Normality of } AgNO_3 \times 58.4 \times 100}{\text{Weight of sample} \times 1000}$$

2.3 Estimation of sodium (mG/ G)

Sodium content was determined by mathematical calculation from the NaCl content (Moncada, 2013) using the below mentioned formula,

$$\text{Sodium } \left(\frac{\text{mG}}{\text{G}}\right) = \frac{\text{NaCl \%}}{100} \times \text{weight of sample used (G)} \times \text{ sodium \% in NaCl } \times 1000$$

2.4 Moisture content

Moisture content in percentage was estimated using M/s Shimadzu make MOC63u series Unibloc Moisture analyzer. 1 G of the dry fish sample was loaded and the moisture content in percentage was noted.

2.5 Processing of dry fish

Anchovies were purchased from local market and de-headed, eviscerated and cleaned. The samples were weighed and then dry salted with 1- 8% kosher salt and cured for 24 hours. Drying was carried out in Hot air oven (Model no. HIS-118 supplied by M/s. Hasthas Scientific Instruments India Pvt. Ltd.) at 70 °C for 5 ± 1 h to reach < 16% moisture content. The NaCl content of the 8 samples were then estimated by the procedure mentioned in 2.2.

2.6 Statistical analysis

The data obtained were analyzed statistically and Turkey's test was conducted using IBM SPSS® 20.0 Windows® software as per the standard procedure of Snedecor and Cochran (1994) [14].

3. Results and Discussion

3.1 NaCl and Sodium levels

In general dry fish is a heavily salted product due to traditional practices and need of salt for preservation. Doyle *et al.* (2010) [15] stated that although NaCl performs important technological functions during the production of many meat, fish, dairy, and bakery products, some of these foods probably contain more salt than is necessary for high-quality characteristics. Out of the 12 commercial samples analyzed, 7 samples (S1, S4, S6, S7, S8, S9 & S10) were found to have NaCl concentration above 15%

Table 1: Sodium chloride (%), Sodium (mG/100G) and Moisture (%) of different varieties of commercial dry fish samples

Sample No.	Dry fish samples	NaCl (%)	Sodium (mG/ 100G)	Moisture content (%)
S1	*Stolephorus spp.*	18.44±0.03^{g}	3687.67±5.04^{g}	10.25±0.03^{e}
S2	*Stolephorus spp.*	8.94±0.04^{c}	1787.33±8.35^{c}	14.38±0.04^{f}
S3	*Stolephorus spp.*	2.93±0.03^{a}	586.67±5.93^{a}	3.83±0.02^{a}
S4	*Leiognathidae spp.*	18.69±0.01^{h}	3737.20±1.74^{h}	18.58±0.01^{h}
S5	*Leiognathidae spp.*	6.47±0.05^{b}	1294.93±9.54^{b}	22.47±0.02^{i}
S6	*Sillago spp.*	15.72±0.03^{f}	3143.20±5.33^{f}	23.46±0.02^{j}
S7	*Sillago spp.*	22.13±0.08^{i}	4426.80±5.56^{i}	7.19±0.02^{c}
S8	*Sillago spp.*	26.82±0.02^{k}	5363.60±4.64^{k}	17.83±0.02^{g}
S9	Scomberomorus spp	23.41±0.03^{j}	4681.93±5.28^{j}	5.71±0.03^{b}
S10	Scomberomorus spp	18.66±0.03^{h}	3731.00±5.63^{h}	8.74±0.03^{d}
S11	*Decapterus russelli*	12.83±0.02^{d}	2565.80±4.00^{d}	29.74±0.03^{k}
S12	*Lates calcarifer*	13.47±0.03^{e}	2694.13±6.95^{e}	33.75±0.01^{l}

The data are expressed as Mean ± S.E (n=3). The values bearing different superscripts in a column represent significantly different mean values (P<0.05)

(Table 1). S8 had the highest NaCl content, contributing to around 5363.60±4.64 of sodium which is more than twice the recommended amount by WHO (2016) [5]. Salt may be added at the table or during cooking; however 60- 70% of dietary salt originates from processed foods [16]. Although it is not common to consume huge amounts of processed dry fish per serving, a minimum quantity of 10 G consumption could also contribute to a significant 16-27% of the total dietary sodium per day.

Samples 11 & S12 had NaCl concentration between 10-15% (Table 1) and this shows that only 2 samples complies regulations since the NaCl concentration recommended by

FSSAI for good quality dry fish preparation is 10-15%. These samples also contained sodium levels above 2000 mG/G but it is essential for proper preservation of the highly perishable product. Around 3 samples (S2, S3, S5) were found to have NaCl content below 10% (Table 1), which although provides lesser sodium, may induce the risk of microbial growth. Beatty and Fougere (1957) stated that the bacteria which contribute to spoilage in fresh fish cannot survive very long at salt concentrations much above 12% by weight of the green fish and hence the lesser the quantity of salt used, the more quickly the fish will spoil. Regulations such as CODEX (2013) [17] also recommend a minimum of 12% salt concentration and therefore these samples found in non-compliance with the FSSAI regulation may pose serious threat to health.

It is also evident that the concentration of salt used is most probably dependant on the manufacturer rather than the variety of fish, since the NaCl content of same variety are found to have huge variation. The 12 fish samples collected from Chennai market was found to have NaCl concentration ranging from 2.93% to 26.82%, with more than half the samples in non-compliance to Indian food standards. In a similar report by Nuwanthi *et al*. (2016) [18], the NaCl concentrations of dried fish samples from Srilankan markets ranged from 14.05% to 17.41% according to Industrial Technology Institute (ITI) findings and that it was not acceptable according to Sri Lanka standard. However this is not agreeable since the minimum salt content recommended by Sri Lanka's Food (Fish and Fish Products) Regulations (2003) [19] is 12% on dry basis.

3.2 Moisture content

Salting alone will never completely stop the spoilage of fish since there will always be a few types of bacteria that can survive and grow no matter how high a concentration of salt we use on fish [20]. Hence drying is generally used as a tool along with salting to control the moisture content in dry fish thereby decreasing microbial activity. Although the NaCl concentration may influence the moisture content in dry fish the level of drying also plays a significant role. The FSSAI regulations provide a standard of less than 16% moisture level in dried fish to maintain quality, but 6 samples (S4, S5, S6, S8, S11, S12) out of the 12 commercial dry fish samples analyzed were found to have a moisture content of more than 16% (Table 1). This condition may be detrimental to the quality of the dry fish and moreover influence the NaCl % analyzed on dry basis.

In a research conducted in dried fish with different concentrations of salt, a general increment in salt content of dried muscle was noted compared to the muscle prior to drying due to removal of water [18]. The 2 samples (S11, S12) which comply the regulations in terms of NaCl concentration were found to have high moisture content of 29.74±0.03 % and 33.75±0.01% respectively, thus it is most likely that their NaCl % would be higher than the analyzed values when moisture content is controlled below 16%. Similar condition was encountered with S5, which had NaCl % less than 10 but its moisture content analyzed to be around 22%.

3.3 Salt levels to comply regulation

The anchovies substituted with salt concentration between 3-5% by weight of the fresh fish were found to have NaCl % between 10-15% by weight of dry fish (Table 2). This shows that 3-5% dry salting would be sufficient to have sodium levels in compliance to the FSSAI standards. But most importantly this salt substitution would be effective only if the fish is dried to the moisture content below 16%. This result is closely in accordance with the report by Nuwathi *et al*., (2016) [18] where 5% and 10% salt substitution in *Sardinella gibbosa* by weight of fresh fish provided 12.436±0.157% and 17.7211a±0.157% NaCl concentration respectively in dried fish.

Table 2: NaCl % of dried anchovies with different levels of salt substitution

Concentration of salt substituted in fresh fish (%)	NaCl (%) in dry fish
0	1.74 ± 0.11^{a}
1	8.16 ± 0.10^{b}
2	10.05 ± 0.05^{c}
3	11.62 ± 0.03^{d}
4	13.82 ± 0.02^{e}
5	15.00 ± 0.06^{f}
6	16.02 ± 0.03^{g}
7	17.04 ± 0.04^{h}
8	17.87 ± 0.03^{i}

The data are expressed as Mean ± S.E (n=3). The values bearing different superscripts in a column represent significantly different mean values ($P<0.05$)

4. Conclusions

More than half the commercially available dry fish samples collected from Chennai markets were found to have NaCl concentration above 15% which is a violation of FSSAI regulations. The samples which met the standards were also at a risk of having more than the analyzed NaCl concentration due to the prevalence of high moisture content. This practice of high salt substitution is a matter of concern in a country like India where NCD's have been a major burden in the past few decades. In a bid to cope with the increased uptake of sodium from processed foods, consumers have developed the tendency to opt for low sodium food products in recent times. While this may be possible with labeled food products, traditionally prepared non labeled food products do not always offer such convenience.

Moreover in a heavily salted product like dry fish, the negligence of keeping salt concentrations under control could be a serious problem. Hence it is essential that the local manufacturers be informed of the regulations and the level of salting in order to relish the traditional product without health complications. Experimental studies conducted in *Stolephorous spp.* suggest that 3- 5% dry salting of fresh fish would be sufficient to meet the regulations. Although this range may vary with the type of fish, the data presented here would give a rough idea for the addition of salt in dry fishes.

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