INTRODUCTION
India is the second largest producer of food worldwide after the China (Mahish, 2015) contributing only 1.5% of export for processed food in world market (Singh et al. 2012). The insufficiency of resources, low crops yield and continuous increase in food demand might lead to food crisis. Hence, there is an urgent need to trap other food resources and promote the advanced food processing industries as well as traditional methodology of food processing. In this light, processed fish is an important alternative, that offer good nutrition and also meets the need of consumers. Fish and fish products are the major animal source of protein (Tidwell and Allan, 2001) providing significant contribution in the eradication of malnutrition in the world and widely accepted as good protein source for the maintenance of healthy body (Ravichandran et al. 2012). However, fish is an extremely perishable commodity where quality loss can occur very rapidly after catch (Khan and Khan, 2001; Musa et al. 2010; Dewi et al. 2011). Therefore, immediate after the harvesting, fish must be processed or preserved because no processing or preservation methods can enhance the quality of spoiled fish (Lliyasu et al. 2011).

Curing is a traditional method of fish preservation that reduces the rate of spoilage and extends the shelf life of fish and fish products. Curing methods includes salting, drying and smoking (Sanjeev and Surendran, 1996; Anonymous, 2001). Traditionally, cured fish products are low cost of high quality protein for poor population. In Chhattisgarh, nearly 35% of total catch is spoiled or become inferior quality due to lack of storage facilities and cold chain. The local fisher folk of Chhattisgarh have developed some traditional fish curing methods like sun drying, salting and smoking to avoid the post harvest loss. Bastar and Kurud are the most dominant region of Chhattisgarh in production of dried and smoked fish (Jakhar et al. 2015). Dried fish is a good source of inexpensive, high-quality protein to the poor population (Petrus and Suprayitno, 2013 ). Drying is a simple, cheap and an ancient fish preservation method in which moisture content is reduced to 10% or less early as possible to slow down or stop the microbial and biochemical spoilage (Ruiter, 1995). For additional preservation, drying is often combined with salting. Traditionally, in salting process, 3 kg salt and 10 kg dressed fish salt are used, and the ratio varies with country to country and species to species. The salted dried fish processed with low level of salt and turmeric powder are best for human consumption, particularly for the patients of blood pressure and diabetes. Therefore, preparation of dried products from low-cost fish will help in increasing the employment opportunities and also reduce post-harvest losses.

Key words: Aerobic plate count, Carcass recovery, Drying, Mystus tengara, Salting.

ABSTRACT
Fresh tengra fish (Mystus tengara) samples were collected from fish market, Kawardha and different levels of salt and turmeric powder were added (0% salt & 0% turmeric powder, T0; 2% salt with 0.2% turmeric, T1; 4% salt with 0.2% turmeric, T2; 8% salt with 0% turmeric powder, T3 and 12% salt with 0% turmeric powder, T4). The processed and salted fish were dried in hot air oven at 60°C for 20 hours. Carcass yield (%), salt content (%), pH and moisture content of cured fish were respectively 39.06 - 43.87%, 3.15 - 4.59%, 6.52 - 6.90 and 4.91 – 6.84 %. The sensory assessment showed that treatment T2 had the highest score for texture 5.70; appearance 8.30, odor 8.02 and taste 8.05 while T0 and T1 had least sensory scores. Aerobic plate count of various treatments were found significantly different (p <0.05) with the lowest in treatment T4 (3.3 x 103 cfu/g) followed by treatment T2 (3.7 x 103 cfu/g) and highest in treatment T0 (5.4 x 103 cfu/g). Tengra fish cured with 4% salt and 0.2% turmeric powder (T2) found to be the best in yield, microbial load and sensory attributes. The dry salted fish processed with low level of salt and turmeric powder are best for human consumption, particularly for the patients of blood pressure and diabetes. Therefore, preparation of dried products from low-cost fish will help in increasing the employment opportunities and also reduce post-harvest losses.
a risk of cardiovascular and renal diseases (Nuwanthi et al. 2016). The patient of hypertension and diabetes are advised to substitute the part of salt content with other substances like potassium lactate, potassium chloride and spices (Osheba, 2013). In modern trends, consumers prefer the foodstuff with natural preservatives like spices and avoid the food stuff with chemical preservatives. These natural spices have chemical effect as well as antimicrobial properties (Prasad and Seenayya, 2000). Therefore, production of dried fish with an optimum level of salt and spices may give better results from nutritional and public health security point of view. The objective of this study was to determine the optimum level of salt with turmeric powder to prepare low salted dried fish.

MATERIALS AND METHODS

Fresh tengra (*Mystus tengara*) fish were collected from fish market of Kawardha (Chhattisgarh), India. Fish were hygienically handled and transported in chilled condition to the laboratory of Fish Harvest and Post Harvest Technology Department, College of Fisheries, Kawardha.

**Sample preparation:** Fresh tengra fish were dressed and washed in tap water and treated in different ways with 0% salt and 0% turmeric powder (T0), 2% salt with 0.2% turmeric powder (T1), and 4% salt with 0.2% turmeric powder (T2), 8% salt and 0% turmeric powder (T3) and 12% salt and 0% turmeric powder (T4). Dry salting was done as per the method of the Bureau of Indian Standard (IS, 1970). The processed samples were kept overnight for curing. After curing, fish drying was carried out at 60°C in hot air dehydrator for 20 hours. Biochemical, microbiological and sensory attributes were determined to evaluate the effect of salt and turmeric concentrations on the quality of processed fish.

**Biochemical analysis:** Moisture and ash content of different treatment samples were determined by standard methods (AOAC, 2005). The salt content (NaCl) of processed fish samples was determined titrimetrically using silver nitrate solution (Kirk and Sawyer, 1991) and expressed as the percentage of salt. The pH analysis of the samples was done with microprocessor pH meter (Goulas and Kontaminas, 2005).

**Carcass recovery (\%):** The carcass recovery was assessed using the following formula:

\[
\text{Carcass recovery (\%)} = \left( \frac{\text{weight of fish after drying}}{\text{weight of fresh fish}} \right) \times 100
\]

**Microbiological analysis:** Aerobic Plate Count (APC) was done following the SLS 516: Part 1: 1991 microbial test method. In this process, 25 grams of fish samples were taken and homogenized with 225 ml of sterile physiological saline. Serial dilutions were carried out with the same diluents. The diluted suspensions of different treatments were spread plated on the plate count agar (Hi-media, India). The plates were incubated for 48 hours at 37 °C. The number of colonies developed were counted as total bacterial count and expressed as CFU/g.

**Sensory evaluation:** The samples of salted dry fish for different treatment were subjected to sensory evaluation following method of Akankwasa, 1998 (Table 2). The appearance, color, odor, texture, and taste were checked by the taste panel using the 9 points hedonic scale, 9= like extremely, 7= like moderately, 5= neither like nor dislike, 3= dislike moderately and 1= dislike extremely (Meilgaard et al. 1990). Acceptance test was conducted by 15 fish eaters as a sensory panel.

**Statistical analysis:** One way analysis of variance (ANOVA) was used to analysis the data. The significant difference between the treatments was determined by Duncan’s Multiple Range Test (DMRT) using SPSS (Version 16.0) (SPSS Michigan Avenue, Chicago, IL, USA), Graph Pad Prism 5 and MS excel 2007 were used for graphical interpretation. The level of significance employed was 0.05. Data are expressed as mean ± SD of three replicate groups.

**RESULTS AND DISCUSSION**

Carcass recovery (%), biochemical parameters and aerobic plate count of different fish samples have been shown in Table 1. Carcass recovery (%) of salted dried fish from different treatment groups were found significantly (P<0.05) different. The carcass recovery (%) was highest in the treatment T1 (43.33 % ±0.25) followed by almost similar in the treatment T3 (42.94 % ±0.36). Sugathapala et al. (2012) reported 33% carcass recovery from salt based dry fish processing.

In dried fish, a general increment in salt content was found in fish muscle with increasing the salting rate. The salt content in dried fish was significantly higher (P<0.05) in treatment T4 (4.59% ±0.30) than the treatment T1 (3.15 % ±0.88). The dried salted fish of treatment T3 and T4 had 3.33% ± 0.75 and 4.59% ± 0.30 salt respectively. These results were in conformity with that of Hwang et al. 2012 where 5% and 10% salted dried fish had 5.47% ±0.75 and 8.57% ±0.76 salt respectively. In another study, Nuwanthi
Table 1: Biochemical properties of salted dried tengra fish (*Mystus tengara*) under various treatments.

| Parameter            | To      | T1     | T2     | T3     | T4     | P value |
|----------------------|---------|--------|--------|--------|--------|---------|
| Carcass yield (%)    | 39.06±0.13 | 43.33±0.25 | 41.77±0.64 | 42.94±0.36 | 43.87±0.51 | 0.000   |
| APC                  | 5.4±0.6 | 5.0±0.5 | 3.7±0.37 | 4.5±0.37 | 3.3±0.10 |         |
| Moisture (%)         | 6.43±0.15 | 6.84±0.66 | 5.87±0.95 | 4.91±0.52 | 4.96±0.71 | 0.045   |
| pH                   | 6.75±0.02 | 6.90±0.01 | 6.68±0.05 | 6.50±0.31 | 6.52±0.18 | 0.055   |
| Salt content (%)     | 0.0±0.05 | 3.15±0.08 | 4.18±0.20 | 3.33±0.75 | 4.59±0.30 | 0.000   |
| Ash (%)              | 1.16±0.03 | 1.04±0.07 | 0.93±0.02 | 0.83±0.01 | 0.79±0.01 | 0.000   |

Data are presented as Mean± SD and same letter in the same row are not significantly different.

Table 2: Sensory scores of salted dried tengra fish (*Mystus tengara*) under different treatments.

| Parameter        | To     | T1     | T2     | T3     | T4     | P value |
|------------------|--------|--------|--------|--------|--------|---------|
| Appearance       | 6.27±0.20 | 5.31±0.17 | 8.30±0.26 | 6.73±0.43 | 6.42±0.16 | 0.00    |
| Color            | 5.57±0.37 | 5.71±0.33 | 7.55±0.18 | 7.49±0.07 | 7.02±0.10 | 0.00    |
| Fishy smell      | 5.47±0.01 | 5.92±0.15 | 8.02±0.10 | 6.90±0.04 | 6.10±0.10 | 0.00    |
| Texture          | 5.70±0.21 | 5.67±0.20 | 7.42±0.07 | 7.57±0.11 | 6.05±0.11 | 0.00    |
| Taste            | 4.28±0.12 | 5.68±0.18 | 8.05±0.12 | 7.79±0.10 | 6.28±0.12 | 0.00    |

Data are presented as Mean± SD and same letter in the same row are not significantly different.

et al. (2016) however, reported that 12.43 % and 17.72 % salt in the salted dried fish cured with 5% and 10% salt. The difference in salt content of dried fish might be because of the fish species, size, dressing methods, the basis of determination (Dry and wet basis) and drying temperature. The percentage of moisture content and salt in muscle showed the reverse pattern because salting process removes water from the fish muscle during the drying. Moisture content in salted dried fish of treatment T0, T1 and T2 found significantly (P<0.05) higher than treatment T3 and T4. The salted dried fish of treatment T1 showed highest (6.84 % ±0.66) moisture content and statistically similar moisture content was found in treatment T0 (6.43% ±0.15). The pH of the salted dried fish samples were not found significantly (P>0.05) different and ranged from 6.50 to 6.90. Ash content varied significantly (P<0.05) among the treatments (0.79 to 1.16%).

Fish are extremely susceptible for microbial spoilage because of their soft tissues and aquatic environment. The potential sites for spoilers in live fish are intestine, gills and slime or skin. Data presented in Table 1 and fig 1 showed the aerobic plate count (APC) of cured fish for different treatments. Aerobic plate count (APC) was found significantly (P<0.05) different among the treatments ranging from 3.3 x 10³ to 5.4 x 10⁵ cfu/gm. The APC was found higher (5.4 x 10⁵ cfu/gm) in the fish processed without salt and turmeric powder (T0) than the fish treated with salt or combination of salt and turmeric powder. The fish processed with 12% salt (T4) showed the lowest (3.3 x 10³ cfu/gm) APC followed by the salted fish of treatment T2. Salt and turmeric added sample had a lower number of APC than the fish treatment without or less percentage of salt. The antimicrobial properties and preservative effect of salt and turmeric powder might be the possible reason for low number of APC in salted and turmeric processed fish sample (Prasad and Seenayya, 2000). For the fresh fish, the acceptable limit of aerobic plate count is 1 x 10⁵ cfu/gm at 37°C while the acceptable limit for cooked fish and dried fish is 1 x 10⁵ cfu/gm (Suliman et al. 2014). Although, results of APC were found under the permissible limit for all treatments.

Sensory analysis: Likeness score of sensory attributes (appearance, color, fishy smell, texture, and taste) for various treatments are shown in Table 2. Sensory scores were found significantly (P<0.05) different among the treatments. The treatment T0 obtained the significantly (P<0.05) lowest sensory score among the treatments. Treatment T2 (4% Salt+ 0.2% Turmeric) has obtained more preference than other fish samples for all sensory attributes. This might be because of spicy taste (Turmeric) and appropriate low salt content in the treatment T2.

CONCLUSION

As per the results, fish processed with 4% salt and 0.2% turmeric powder (T2) showed the best yield, preferable microbial load and sensory attributes. The microbial load of all treatments was found at considerable safe level. However, result of the present study clearly indicates that the dry salted
fish processed with low level of salt and turmeric powder are best for human consumption, particularly for the patients of blood pressure and diabetes. Further, using the simple drying equipments such as artificial and solar dryers would help to increase the hygienicity of dried fish and fish products.

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