International Journal of Biochemistry Research & Review

31(9): 10-16, 2022; Article no.IJBCRR.93014
ISSN: 2231-086X, NLM ID: 101654445

Influence of Microwave and Traditional Smoked Drying Method on the Protein and Moisture Content of *Puntius sophore*

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Authors' contributions

This work was carried out in collaboration between both authors. This article was conceptualized by authors AB and NA. Formal analysis and investigation was done by author NA and supervised by author AB. Writing and statistics done by author NA while review and editing done by author AB. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJBCRR/2022/v31i9777

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/93014

Original Research Article

Received 15 August 2022
Accepted 23 October 2022
Published 29 October 2022

ABSTRACT

Drying of fish is a traditional method for storing fishes for long periods without any significant damages. Effects of two smoking and microwave drying on moisture and protein content of fish (*Puntius sophore*) was studied to determine the benefits of preserving and retaining the protein content of fish. Collected fishes were dried in traditional smoking method for about 12 hours and using microwave drying method at different power levels of 140W, 280W and 560W for different time period. The moisture and protein content of raw fish was found to be 70.78±2.2% and 18.78±1.06 mg/g wet weight respectively. The changes in moisture and protein content in the two different drying methods was found to be significant ($p<0.05$). With increase in microwave temperature moisture content decreases and protein content increases. The results showed that microwave-drying method could be used for preservation of fish and make the product commercially available.

Keywords: Fish; traditional smoking; microwave oven drying; moisture percentage; protein content.

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1. INTRODUCTION

Fish is one of the high value nutritional foods in human diet. It is an important as well as a cheap source of high amounts of protein, unsaturated fatty acid, dietary minerals, vitamins etc. Approximately 16% of total animal protein consumed by the world's population are derived mostly from fish and over one billion people all over the world depend on fish as their main source of protein [1]. However, fresh fish contains up to 80% of water in their body and are readily susceptible to various microbial contamination mainly due to its high moisture content and soft nature of tissues [2]. Over the long period of time smoking and drying techniques have been used to increase the shelf life of fish. Drying is one of the oldest methods used for preservation of fish. During drying processes, the moisture content of the fish is reduced as most of the water are vaporised. Thus, growth of various microorganisms is inhibited and can be stored for a longer period of time without any significant damage. The quality of the dried products is affected by temperature, humidity and other drying conditions [3]. Dried fish is also one of the most transported marine products in many countries like India, China, Nepal etc.

Puntius sophore commonly called Puthi in Assam belongs to the family Cyprinidae, commonly known pool barb and easily available and a cheap source of nutrition for the indigenous people. There are about 134 species of the genus *Puntius* that originates in inland waters in Asia, it is found in Pakistan, India, Nepal, Bangladesh, Sri Lanka, Bhutan, and Myanmar. The composite analysis of *Puntius species* showed the richness of protein, fat and mineral of the fish [4,5]. Both the fresh and processed fishes are widely consumed by the people of Assam and North Eastern states of India. It is known as 'puthi' fish among the people of Assam. All over the world, various processing methods of fish preservation are used depending on the availability of fish, environmental conditions, demand of food etc. Earlier fishes were mostly preserved by freezing, smoking or sun drying method. Various experiments had been carried out for analysing the impact of different processing techniques to come up with a better method that improve the quality of dried fish and protect its nutritive properties and increase the shelf life. As an alternative to traditional method of fish preservation, modern techniques such as hot air drying, solar drying, microwave drying etc. are widely adopted. In smoked drying method, it was reported that the moisture content decreases with increasing temperature and drying time while crude protein, crude lipid, crude fibre, and ash content increases with increasing temperature and time [6]. Chukwu and Shaba [7] reported more improved protein quality and less lipid oxidation in catfish dried with electric oven as compared to the conventional smoking kiln drying. Electric oven drying is more recommendable for healthy eating, if reduced lipids content and increased vitamin A content is desired and also for longer shelf-life of dried fish [8]. Another drying technique, Solar drying resulted in faster drying, less contamination by sand dust and microorganisms [4,9,10].

Microwave drying has become one of the emerging field of techniques used for preservation of food material, especially a few hybrid methods such as, hot air- microwave drying are widely adopted [11]. Hu et al. [12] suggested freezing as a most suitable method for drying hairtail fish meat gel followed by microwave drying and hot air drying. Microwave drying was found to improve protein quality and prevent lipid oxidation in fish fillets as compared to conventional hot air drying in Grass Carp [13]. It was reported that microwave drying of a sensitive material cause more rapid removal of moisture [14]. Since microwaves heat the material simultaneously from both inside and outside, and thus provides high rate of evaporation [11], the moisture content (dry basis) and drying time of the samples was found to be significantly reduced in microwave drying as the power input of Microwave oven increases [15]. However, the microwave oven drying are not widely used by common people, but it shows advantages of less time and labour requirement and high quality of product. Microwave energy is widely used in agricultural product processing since it is less time consuming, energy efficient, safe and easy to handle [16]. The present study was undertaken in order to check the effect of microwave on soluble content of protein and moisture content as limited studies was done so far on microwave drying kinetics and energy consumption on fish. In addition, it is important to understand the controlling parameters of drying so that by improving the drying process and by reducing the time and energy consumption, better technology with improved nutritive quality could be achieved.

2. MATERIALS AND METHODS

2.1 Sample Collection and Preparation

40 fishes (*Puntius sophore)* were collected from local fish market of Hatigaon, Guwahati, Assam. Fishes were washed and degutted.

2.2 Drying Experiment

2.2.1 Traditional smoking

In the traditional smoked drying method (Fig. 1) fishes were dried in a smoking kiln, after cleaning without any pre-treatment such as salting or icing. Fishes were spread on a metal grill and directly exposed to smoke and heat that was produced below. The fishes were smoked for about 12 hours. Following smoking, sun-drying was carried out for 24 hours. The dried fish samples were kept in airtight glass containers and stored in a refrigerator.

Fig. 1. Traditional smoked drying of fish (*P. sophore*)

2.2.2 Microwave oven drying

The 27 fishes were divided into total 9 sets in groups of three. Each set was dried in a microwave oven at three different powers of 140W, 280W and 560W. The first three sets were kept for about 25min at 140W. The next three sets kept at 280W for 15min and the remaining set was dried with 560W for 8min. The sample weight was recorded using a digital balance after different interval of time. The drying process was continued until the constant weight is obtained.

2.3 Moisture Content

The moisture content was determined by taking the weight of the fresh sample and keeping them in an oven until they attained the constant weight. The moisture percentage of the fish was calculated by the following formula [6].

$$Moisture\ \% = \frac{W1 - W2}{W1} \times 100$$

where, W1= Initial weight (before drying), W2= final weight (after drying).

2.4 Protein Analysis

Total soluble protein was assayed by Lowry's method [17].

2.4.1 Protein extraction

Protein was extracted by homogenizing the muscle in water followed by addition of equal volume of 10% TCA. The solution was then centrifuged for 5min at 5000 rpm. The supernatant was removed and precipitate was centrifuged again with ether: ethanol (1:3) solution for 5min at 5000 rpm. The final supernatant was separated and precipitate was dissolved in 0.1N NaOH.

2.4.2 Protein estimation

1 ml of the supernatant was taken for analysis and 5 ml of alkaline copper solution was added. The tubes were mixed well and allowed to stand for about 10 minutes, then 0.5 mL of Folin-ciocalteau reagent was added. Simultaneously blank test tube was also run without sample. The blue colour developed was measured by taking the O.D at 660 nm.

2.5 Statistical Analysis

The protein and moisture content analysis were replicated three times for oven dried sample. The results presented are the mean value of each replication ± Standard deviation. Analysis of variance was performed by ANOVA and t-test procedures (MS Excel). Differences among the mean values of the various treatments were determined by the least significant difference (LSD) test, and the significance was defined at $P< 0.05$.

3. RESULTS AND DISCUSSION

Table 1 shows the average length and weight of selected species under study. The average weight and length of the fish was 5.45±1.86 g and 7.2 ±0.5 cm. respectively. Table 2 shows the moisture and protein content of fish dried through traditional smoked and microwave at different temperature and different time interval. Fig. 2 indicated the comparative analysis of moisture and protein content of two different drying methods adopted in our study. It was observed that there was a reduction in moisture content after 12 hours of traditional smoking. Moisture percentage showed significant difference at ($p<0.05$) level. Further, it was found that increase in power level of microwave resulted in decrease in drying time required to reach the final moisture. The moisture content of sample dried at three different temperature and in different time interval showed significant difference at 95% ($p<0.05$) confidence level.

Table 1. Number, length and weight of *P. sophore*

Total No.	Particulars	Length (cm)	Weight (g)
36	Minimum	5.8	4.81
	Maximum	8.6	6.12
	Average	7.2 ± 0.5	5.45 ± 1.86

Table 2. Moisture and protein content of traditional smoked dried fish sample and fish sample dried with three different power level of microwave oven (140W, 280W, 560W). Different letters indicate significant differences between each group comparisons ($p<0.05$)

Parameter	Raw	Traditional smoked dried	Microwave oven dried		
			140W	280W	560W
TIME (min)	-	720	25	15	8
MOISTURE %	70.78 ± 2.2^{a}	33.26 ± 2.6^{b}	26.1 ± 0.34^{c}	24.6 ± 1.53^{cd}	22.6 ± 0.84^{d}
PROTEIN (mg g^{-1}) (Dry weight)	18.76 ± 1.06^{a}	34.82 ± 2.4^{b}	57.31 ± 2.36^{c}	61.63 ± 1.87^{d}	66.61 ± 3.00^{e}

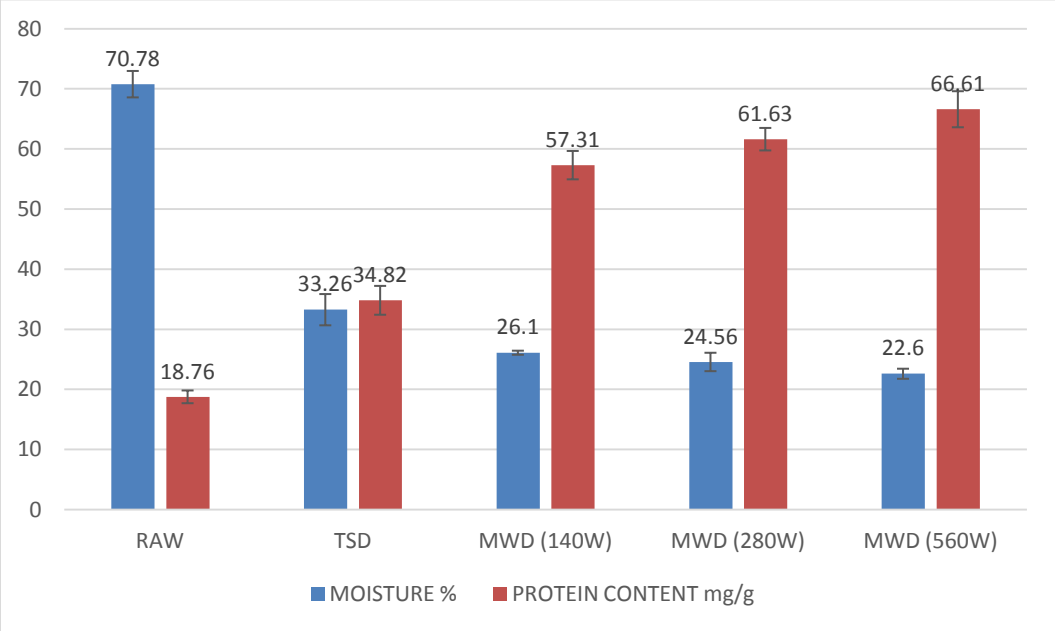

Fig. 2. Comparative moisture and protein content of Raw, Traditionally Smoked Dried (TSD) and Microwave Oven Dried at three temperature (140W, 280W, 560W) fish sample *Puntius sophore*

In case of protein content, there is a gradual increase in protein content. In raw form protein, content was found to be 18.76 mg g^{-1} (dry weight). The protein content of traditional smoked fish was found to be 34.8±2.04 mg g^{-1}(dry weight). Significant difference in protein content was observed at ($p<0.05$). Further, it was observed that with increasing temperature of microwave, the protein content increased significantly ($p<0.05$).

The raw fish showed high moisture and low protein content, i.e., 70.78% and 18.76% respectively. These values are within the range done in earlier studies [6,8,18]. A decrease in moisture content up to 35% of fish from the smoking kiln was found that is close to the observation done by Tenyang et al. [19]. The moisture content of microwave dried fish reduced up to 24.5% which is close to the values obtained by Tao and Linchun [13] in microwave drying of grass carp fillets and Tilapia fish sample in electric oven [8]. Further, it was observed that increase in power level of microwave oven resulted in decrease in drying time required to reach the final moisture [11,20]. It has been reported that if a fish is well dried, moisture content is reduced up to 25%, it will not be affected by microbes and thereby increases the shelf life [18].

The results indicated the gradual increase in protein content as drying proceeded. It may be because of dehydration of water molecule present between the protein causing aggregation of protein that resulted in increased protein in dried fish [21]. Chukwu and Shaba [7], reported that protein was not lost during drying and the protein increased with reduced moisture content in catfish. The protein content of traditional smoked-dried fish observed was 34.8±2.04 mg. g^{-1} (dry weight) which is somewhat falls near the values calculated by Idah and Nwanko [6]. Smoking/drying increase the crude protein content as reported earlier with decrease in moisture content [18,22,23,24]. The microwave dried fish sample showed average value of protein content of 61.85±4.4 mg. g^{-1} which falls near the values of protein in microwave dried grass carp calculated by Tao and Linchun [13] and in electric oven dried Tilapia fish sample [8]. As the results shows significantly higher amount of protein in microwave dried sample that stipulate the efficiency of microwave on drying as well as in improving the proteins. Further, it was observed that with increasing temperature of microwave, the protein content increased significantly ($p<0.05$) with less time requirement for drying. The amount of protein content of the fish dried at 560W (66.61 ± 3.00 mg. g^{-1}) was found significantly different from that of temperature 140W (57.31 ± 2.36 mg. g^{-1}). This implies that increasing temperature can enhance the nutritional value of the fish.

4. CONCLUSION

From the above study, it is observed that the fresh fish (*Puntius sophore*) is a good source of protein. Generally, drying experiments influence on different biochemical properties of fish. Both traditional smoke drying and microwave oven drying has shown effect on moisture and protein content of the fish. Changes are comparatively more prominent in microwave dried fish sample. Moreover, microwave oven drying could improve protein quality in fish as compared to smoke drying. It showed significantly higher amount of protein content and less moisture content in fish (*Puntius sophore*) than smoke drying. Less moisture content also indicates longer shelf life of fish. The microwave drying procedure also requires less time and effort and result in good quality and more hygienic product. Thus, this present study provides basic information on moisture and protein content of fresh water fish (*Puntius sophore*), both raw and dried with different methods and attempted on determining a more efficient and economic method for drying of fish (*Puntius sophore).* As drying play an important role in food processing. The microwave drying has several advantages that requires less time, energy efficient and improve the nutritive quality of food. The important aspect of drying is modelling of drying process that is augmented with improved quality of fish. Further drying kinetics study is required to fit the model in order to predict the suitable microwave temperature of drying.

ACKNOWLEDGEMENT

The authors are thankful to the Principal and HoD of B. Borooah College, Guwahati, Assam for providing all the necessary facilities to carry out the research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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