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Influences of Drying Methods on Nutritional Properties of Tilapia Fish (*Oreochromis nilotieus*)

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Abstract: The effects of two different drying methods (smoking kiln and electric oven) on nutritional properties of tilapia fish (*Oreochromis nilotieus*) were determined. Purchased quantities of tilapia fish were shared into two parts: one part was used to determine the nutritional properties of the raw fish and the other part was sub-divided into two; a part was dried using smoking kiln at a temperature range of 70-85°C for 20 hours and the remaining one was dried using electric oven at a temperature range of 110°C for 45 minutes. The nutritional properties of the dried samples were determined. Mean moisture, protein, lipids, ash, fibre, carbohydrate, vitamin A, potassium and phosphorus contents of raw fish were 70.15±0.04, 23.06±0.04, 12.85±0.05, 28.16±0.02, 1.91±0.01, 3.67±0.04, $2.5 \times 10^{-4} \pm 4 \times 10^{-5}$, $1.2 \times 10^{-4} \pm 10^{-5}$ and $1.2 \times 10^{-4} \pm 10^{-5}$%, respectively while the energy value was 5.94±0.03 J/100g and vitamin C content was $2.3 \times 10^{-3} \pm 4 \times 10^{-4}$ mg/ml. The changes in moisture, lipids, energy value and vitamin A contents were found to be significant ($P < 0.05$) for the two drying methods. Protein, ash, fibre, carbohydrate, vitamin C, potassium and phosphorus contents showed no significant differences ($P < 0.05$) for the two drying methods studied. The results indicate that drying methods have effects on the nutritional properties of tilapia fish. Electric oven drying is recommended for healthy eating if reduced lipids content and increased vitamin A content are desired and also for longer shelf-life of dried fish.

Key words: Drying methods · Electric oven · Nutritional properties · Smoking kiln · Tilapia fish

INTRODUCTION

Fish is a very important source of animal protein in the diets of man. Smoked or dried fish is a traditional part of the diet of a large section of the world's population. However, the gap between the demand and supply of fish is widening due to increase in population, poor postharvest handling, lack of processing and storage facilities and utilization of unconventional fish species. For instance, the estimated fish demand in Nigeria in 1994 was put at 1,139,833 tonnes based on the population figure of 94,986,044 and per capita consumption of 12.0kg which was considered globally adequate for normal and healthy growth. However, only 280,307 tonnes were produced, indicating a deficit of 94,705,737 [1].

Methods of drying and smoking fish vary between different countries and within the same country depending on the species of fish used and the type of product desired. The fish may be dehydrated to various degrees with moisture levels in the final product ranging from about 10% to 60%. Processing temperatures may range from less than 5°C to up to 120°C and processing times from half an hour to several months. The fish may be dried only or smoked only or there may be a combination of smoking and drying. In some countries the fish is boiled before being smoked and/or dried. Adding to this complexity, the fish species used as raw material may be freshwater or marine species and may range from very lean to fatty fishes and its condition from fresh to stale. This variation makes it difficult to arrive at general conclusions regarding processing effects of smoking and drying on nutritional compositions of the final products.

The effects of different processing and cooking methods on nutritional compositions of different species of fish have been studied. Nutritive and organoleptic changes of Nigerian traditionally-processed freshwater fish species were studied by Afolabi *et al.* [2]. The effect of traditional drying processes on the nutritional values

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of fish was studied by Eves and Brown [3]. Changes in chemical composition and nutritional quality of fried sardine (*Clupea pilchardus*) produced by frozen storage and microwave reheating were reported by Castrillon *et al*. [4]. Proximate and mineral compositions of dried salted roes of hake (*Merluccius merluccius*, L.) and ling (*Molva molva*, L.) were reported by Rodrigo *et al.* [5]. Proximate compositions of raw and cooked Thai freshwater and marine fish were studied by Puwastien *et al.* [6]. Experimental investigation on solar drying of fish using solar tunnel dryer was carried out by Bala and Mondol [7]. Effects of cooking methods on the proximate compositions and mineral contents of rainbow trout (*Oncorhynchus mykiss*) were studied by Gokoglu *et al.* [8]. Tao and Linchun [9] reported influences of hot air drying and microwave drying on nutritional and odorous properties of grass carp (*Ctenopharyngodon idellus*) while Turkkan *et al.* [10] studied effects of cooking methods on the proximate and fatty acid compositions of seabass (*Dicentrarchus labrax*, L. 1758).

It has been observed that different processing and drying methods have different effects on nutritional compositions of fish. This is because heating, freezing and exposure to high concentration of salt lead to chemical and physical changes and therefore digestibility is increased, due to protein denaturation, but the content of thermolabile compounds and polyunsaturated fatty acids is often reduced [3, 9, 11]. Therefore, the qualities of fish dried using different methods cannot be the same. Also the shelf life of fish dried in an electrically-operated oven varies from that of fish dried using a smoking kiln. The objective of this study is to determine the nutritional properties of raw tilapia fish and tilapia fish dried using smoking kiln and electric oven so as to ascertain the effects of drying methods on nutritional properties of the fish.

MATERIALS AND METHODS

Thirty-two freshly harvested tilapia fish (*Oreochromis nilotieus*) were obtained from Fish Market at Seeb in Muscat, Oman. The mean weight and length of the fish were respectively 320.12±1.65g and 28. 45±1.22 cm. The thirty-two fish were shared into two equal parts: sixteen were used to determine the nutritional properties of the raw fish and the other sixteen were divided into two, each part being eight fish. Eight fish were prepared (eviscerated, beheaded and washed) and dried using smoking kiln at a temperature range of 70°C-85°C for 20 hours and the remaining eight were prepared and dried using electric oven at a temperature of 110°C for 45 minutes. After drying using the two methods, all fish for each drying method were homogenized using a kitchen blender.

Nutritional Analysis: The nutritional compositions were assayed as described by AOAC [12]. All chemicals used were of analytical grade and supplied by Sigma Co. (St. Louis, USA). Each analysis was carried out in triplicates.

Statistical Analysis: The design was completely randomized. Nutritional composition analysis was replicated three times (n = 3). Results presented are mean values of each determination±standard deviation (SD). Analysis of variance was performed by one-way ANOVA procedures (SPSS 12.0 for Windows). Differences between the mean values of the treatments were determined by the least significant difference (LSD) test and the significance was defined at $P < 0.05$.

RESULTS AND DISCUSSION

The nutritional properties of raw and dried tilapia fish are presented in Table 1. Each value is the mean±standard deviation of triplicate determinations. Raw samples presented low protein, lipids, vitamin A, potassium and

Table 1: Nutritional Properties of Raw and Dried Tilapia Fish (*Oreochromis nilotieus*)

Nutritional Properties	Raw	Kiln-dried	Electric-dried
Moisture (%)	70.15±0.04^{a}	20.12±0.03^{b}	17.13±0.04^{c}
Protein (%)	23.06±0.04^{a}	63.64±0.14^{b}	64.10±0.14^{c}
Lipids (%)	12.85±0.05^{a}	28.03±0.01^{b}	20.25±0.07^{c}
Ash (%)	28.16±0.02^{a}	15.76±0.06^{b}	15.46±0.06^{b}
Fibre (%)	1.91±0.01^{a}	1.06±0.03^{b}	1.45±0.04^{b}
Carbohydrate (%)	3.67±0.04^{a}	2.57±0.04^{b}	3.64±0.06^{b}
Energy value (J/kg)	5.94±0.03^{a}	4.27±0.04^{b}	7.34±0.06^{c}
Vitamin A (%)	0.00025±0.00004^{a}	0.00046±0.00002^{b}	0.00084±0.00003^{c}
Vitamin C (mg/ml)	0.0023±0.0004^{a}	0.0040±0.0001^{a}	0.0023±0.0001^{a}
Potassium (%)	0.00012±0.00001^{a}	0.00058±0.00002^{b}	0.00052±0.00002^{b}
Phosphorus (%)	0.00012±0.00001^{a}	0.00042±0.00001^{b}	0.00042±0.00001^{c}

Values in the same row followed by different letters are significantly different ($P < 0.05$).

phosphorus; intermediate energy value; high moisture and ash contents, similar findings reported by Eyo [11, 13]. Decrease of moisture and increase of protein, lipids, vitamin A, potassium and phosphorus contents were the most prominent changes in tilapia fish after drying. Moisture, protein, lipids and vitamin A contents increased significantly in processed samples ($P<0.05$). This trend is in agreement with those obtained by Tao and Linchun [9]. The significant increase in protein levels ($P<0.05$) in dried tilapia fish, when compared with the raw fish, suggests that protein nitrogen was not lost during drying. This is in accordance with the findings of Puwastien *et al.* [6], Gokoglu *et al.* [8] and Tao and Linchun [9]. However, there was no significant difference between smoking kiln drying and electric oven drying for protein, ash, fibre, carbohydrate, potassium and phosphorus contents.

After drying, there was a significant increase in lipids content. Smoking kiln-dried samples retained higher lipids content than electric oven-dried samples ($P<0.05$). This result indicates that the fat loss phenomenon was more intensive in the electric oven-dried fish than in smoking kiln-dried samples. Fat may exude with the moisture evaporation during electric oven drying and that seems to enhance the phenomenon of lipids loss.

CONCLUSIONS

In general, there were significant influences of drying on nutritional properties of tilapia fish. Lack of negative influence of the drying processes on the protein, lipids, vitamin A and mineral contents of tilapia fish is of great practical importance, although drying resulted in a significant loss of ash, fibre, carbohydrate and energy value. These results show that different nutritional components of fish undergo different changes at elevated temperatures. However, electric oven drying could improve the protein quality in tilapia fish, as compared with the conventional smoking kiln drying. The electric oven-dried samples showed higher lipids loss and slightly higher protein content than smoking kiln-dried samples. This research provides basic nutritional information on freshwater tilapia fish, both raw and dried. The present study also provides a possible application of electric oven drying as an efficient drying process for fish in Oman and elsewhere.

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