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EFFECT OF DRYING METHOD ON BIOCHEMICAL COMPOSITION AND NUTRITIONAL QUALITY OF SANDFISH (*SCINCUS SCINCUS)* CONSUMED IN SOUTH-EAST ALGERIA

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ABSTRACT

Sandfish is highly consumed in South-East of Algeria for its gustative and nutritional qualities. The aim of this study was to evaluate the influence of drying methods on fatty acids and amino acids sandfish quality. Biochemical analyzes were performed using the analytical methods adopted by the Association of Official Analytical Chemists (AOAC) method. The fatty acid composition was evaluated using the gas chromatography and the high-performance liquid chromatography (HPLC) method was used for the amino acids analysis. Significant differences were found in the moisture, ash, protein and fat content. Chromatogram analysis revealed the existence of nine (9) fatty acids the highest saturated fatty acid concentration was shown in the sample at 28.9 g/100 g of lipids followed by traditional method at 28.1 g/100 g. However, for monounsaturated and polyunsaturated fatty acids, the highest content was reported in batch at 68.8 g/100 g and 10.1 g/100 g, respectively. These findings indicate that experimental dried sandfish is a good source of n-3 and n-6 fatty acids. The composition of fresh and dried sandfish in amino acids shows the richness of sandfish in essential amino acids especially lysine (1.576 g / 100 g) and threonine (0.876 g / 100 g). Important variations in amino acid content ($P < 0.05$) were observed according to the drying process. The best method of preserving sandfish from a nutritional quality standpoint was to dry in the oven.

Keywords: Sandfish, drying process, meat product conservation, nutritional value.

INTRODUCTION

Sandfish, *Scincus scincus*, is a species of the Scincidae family that lives in the sandy deserts of North Africa and the Middle East. Its climate is characterized by extreme aridity, strong oscillations in temperatures, and particularly high daytime temperatures (Anna et al., 2016). In the southeast of Algeria (Souf region) the use of Sandfish is anchored in the eating habits of the natives. This reptile has always been ubiquitous in their homes, and in search of protein sources to replace meat and fish, the Souafa is highly regarded for its gustative and nutritional qualities (Toumi et al., 2017 a). Therefore, It is distinguished by its high moisture content (Toumi et al., 2017 b) It could be the main reason for its degradation; as well, temperature, water activity, pH, and chemical environment catalyze lipid oxidation in biological food systems, which harms nutritional quality (Ashie et al., 1996).

Animal products, when not consumed fresh, are usually processed by a wide variety of conventional methods, including drying. This method is one of

the oldest methods of preserving and storing food. Therefore, extracting water from foodstuffs can prevent or impede microorganism growth (Grahame, 1996). In the Souf region, climatic and environmental conditions rapidly favor the degradation of sandfish, where it lacks adequate structures for its cool storage. The sandfish isis traditionally dried by placing them in palm leaves for a month away from sunlight and in a ventilated area after filling their body cavities with salt (Toumi et al., 2017 b).

To minimize the number of loss-related issues, especially in terms of sensory properties and experimental drying with controlled settings was examined. The purpose of this research was to assess the impact of drying methods on biochemical, sandfish quality, and changes in fatty acids and amino acids found.

MATERIALS AND METHODS

Biologic Material

The sandfish, the subject of our study were purchased from the market in Oued Souf (South-East of Algeria). Sandfish slaughter was carried out in the Natural Sciences and Life Laboratory. The eviscerated and washed samples were divided into three lots. The first was used as a fresh lot (FS), the sandfish was ground for 1 minute in liquid nitrogen. This process makes it possible to obtain a perfectly homogeneous powder that has been stored at -20° C. until analyses are carried out. The second was dried according to the traditional method (TDS), we replenished the body cavity of the samples with salt and then arranged them in the palm leaves for about a month to dry. The third batch was dried using an oven (ODS), and the temperature and relative humidity were maintained at 65°C and 15.02 % respectively.

The experiments on animals have been approved by our institution's ethics committee (n °: BCM 030/2020). All the experimental procedures were carried out following the National Institute of Animal Care Health Guidelines.

Biochemical Analysis

i. Moisture, Ash, and Protein Content

The moisture of the sandfish samples was determined by drying them in an oven at 105° C using the AOAC (1990) method. According to the AOAC (1995) process, ash content was determined by burning the sample for 12 h in a 525° C furnace. Kjeldahl method (AOAC, 1990) was used to assess total protein content. Results were expressed as a wet weight percentage.

ii. Lipids extraction and Fatty acid analysis

The lipids are cold-extracted with a mixture of organic solvents (chloroform/methanol 2/1, v / v) using the Folch et al., (1957) method. The preparation of the methyl esters of fatty acids was done according to the method proposed by Metcalfe et al., (1966). Approximately 150 mg of the lipid extract was blended with 4 ml NaOH in 0.5 moles of methanol and heated in a bath at 100 ° C until the fat globules were dissolved (about 5 min). Then 5 ml of BF3 (12%) was added to methanol and the mixture was heated for another 2 min. After cooling, 5 ml of a saturated sodium chloride solution is added. With 20 mL of petroleum ether, the mixture was poured into a separatory funnel. The funnel was rapidly agitated for 1 minute before being set aside to allow phase separation. The aqueous phase was removed and the ethereal phase was filtered with filter paper in a flask. The solvent was evaporated in a bath at 60 ° C, and the remaining solvent was removed using a nitrogen stream at ambient temperature. Before injection into the GC gas chromatograph, the methyl esters were dissolved in n-heptane. The

separation of FAs was carried out by GC using the HP 6890 chromatograph equipped with an automatic changer/injector and a flame ionization detector on a capillary column of the CP-Sil 88 type of 100 m long, 0.25 mm internal diameter and 0.20 µm stationary phase thickness. The furnace was kept at 185 ° C, and the injector and detector were both set at 250 degrees Celsius. With a flow rate of 1 ml / min, helium is used as a carrier gas.

iii. Amino Acid Analysis

The amino acids are released by hydrolysis in hydrochloric acid, at 110 ° C, by the reflux method NF EN ISO 13903 (2005). 3 different hydrolyses are needed to determine the complete amino acid composition. After each type of hydrolysis, the amino acids are separated by ion-exchange column chromatography (Moore et al., 1958), and quantified after reaction with ninhydrin. The weight of the hydrolyzed sample, the weight and exact concentration of the norleucine solution added, and the weight of hydrolyzate recovered after rinsing the hydrolysis tubes are used to calculate the amino acid concentrations in the sample. The weight of the hydrolyzed sample, the weight and exact concentration of the norleucine solution added, and the weight of hydrolyzate recovered after rinsing the hydrolysis tubes are used to calculate the concentrations of amino acids in the sample.

Statistical Analysis

Statistical analysis was performed using Minitab18 software. The comparison of different biochemical parameters in the drying process was tested using ANOVA (95 % confidence interval).

RESULTS AND DISCUSSION

Biochemical Composition

The evolution of the biochemical composition of sandfish according to experimental and traditional drying methods is shown in Table 1. Significant variations ($P < 0.001$) between the three samples analyzed were observed in water, ash, protein, and fat content. Analysis shows that the water content in the two samples decreases after drying. In items with high protein content, as temperature increases the water content decreases (Singh et al., 2006). During the dehydration process, the water content is the most important factor to monitor. Reduced as quickly as possible, it prevents drug degradation by micro-organisms and thus increases their lifespan (Ahmad and Srivastava, 2007). Thus, the water content in the (ODS) batch showed a significant decrease from that observed in the batch (TDS). The processing techniques (drying, frying, smoking), the preparation conditions and the salt levels, and all the spices have added a condition to the finished product's water content (Aktas and Gürses, 2005).

The ash content showed a significant increase in the TDS and ODS batch respectively compared to the fresh batch. The high amount of ash can be attributed to the drying process (adding salt) or to the skeleton composition (bone). This value is higher than that observed in other species (Manzano et al., 2000). The fairly high mineral content in sandfish could be an advantage. The minerals serve as activators or inhibitors of important enzymatic reactions in muscle contraction. (El rammouz, 2005).

An essential index for determining the nutritional value of meat products is the determination of protein content. Oven-dried sandfish contains a high protein content of 53.5% that can replace other protein sources. This content is higher than the protein content found in

Khliaa Ezir at 43.75 % and pork kitoza (salted and dried meat) at 40.7 % (Boudchicha, 2014).

Lipids are a major energy source, which the body easily stores. Table 1 reveals that oven-dried sandfish and traditionally dried sandfish are much higher in fat than fresh sandfish respectively. The fat content obtained through the drying of the oven is within the tolerance level for the products' conservation Frontie et al., (2004) record similar findings on the white muscle flour of the fish *Caranx ignobilis* (8.83 %.). The high increase in lipid, protein and ash levels was due especially to the water evaporation.

Table 1: Biochemical composition (% on a wet weight basis) of sandfish (*Scincus scincus*) during the traditional and experimental drying process

Parameters	Fresh sandfish (FS)	Traditional dried sandfish (TDS)	Experimental dried sandfish (EDS)
Moisture (%)	63.9 ± 0.82	6.03 ± 0.06	6.71 ±0.07*
Ash (%)	15.9±0.56	38.5±0.15	27.1±0.6***
Protein (%)	16.2±0.19	48±0.10	53.5±0.50**
Lipids (%)	1.14±0.08	7.5±0.30	12.2±0.36**

Fatty Acid Composition

The fatty acid composition of the fat extracted from the three skink samples is shown in Table 2. The chromatogram analysis revealed the presence of nine (9) fatty acids, including four saturated fatty acids (SFA), the contents of which are expressed respectively for FS, TDS, and ODS (28.9 %, 28.1 %, and 27.8 %), and are essentially represented by: palmitic acid (20.6 %, 18.4 %, and 17.9 %). The palmitic acid content in sandfish is lower than that reported by Souci (2000) for entrecote (29 %) and beef fillet (28.2 %) this content is lower than that found in red meats, 38 to 52 % (Duchene and Gandemer, 2016). Palmitic acid is an excellent energy food (129 ATP), but its high consumption can increase the risk of cardiovascular disease and promote thrombosis formation (FAO / WHO 1993).

Monounsaturated fatty acids (MIFA) are mainly expressed by oleic acid with increased content after drying in TDS and ODS respectively (57.3 %, 65.5 %, and 65.8 %). The oleic acid seems to have no adverse effect. Encouraging the increase in "healthy" cholesterol, it has a positive effect on well-being and is fairly resistant to oxidation (FAO / WHO, 1993). The variations in the composition of fatty acids found between the samples may be attributed to differences in the lipid extract amounts of neutral lipids and polar lipids. Compared to the findings of Sahraoui et al., (2014), which recorded 35.0 percent monounsaturated fatty acids for camel meat, the MUFA concentrations found in redfish are very high.

Polyunsaturated fatty acids (PUFA) showed a decrease after traditional drying, on the other hand, their value showed no significant difference in oven drying. The (PUFA) is mainly represented by linoleic acid. AFSSA (2005) reported that a 3 to 4 % intake of linoleic acid is needed to prevent any manifestation of deficiency. α-linolenic acid is also an important fatty acid, especially for blood pressure control, vessel elasticity, platelet aggregation (Woodman et al., 2003, Breslow 2006), immune reactions, and inflammatory (Alessandri et al., 2009). PUFA levels are higher than those of beef (1.5 %) (Duchene and Gandemer 2016) and lower than camel

meat (10.4 %) (Sahraoui et al., 2014, Ashie, 2014) The variation in sample proportions of polyunsaturated fatty acids is, in some cases, a lipid oxidation marker (Gray and Monahan 1992).

Therefore, the drying temperature affects the unsaturated fatty acid content significantly (Roche et al., 2004). The polyunsaturated/saturated ratio in fresh sandfish was found to be equal to 0.34 and that of ω6 / ω3 equal to 7.58 'AFSSA recommends a ratio C18: 2 n-6 / C18: 3 n-3 equal to 5 (Martin, 2001). Important variations in fatty acid content were noticed after both drying processes. Nevertheless, the fatty acid groups of MUFA and PUFA increased in the oven drying. These findings show that experimental dried sandfish is a strong source of fatty acids such as n-3 and n-6.

Table 2: Fatty acid profile (expressed as g fatty acid /100 g of total sandfish lipids)

Fatty acid		Fresh sandfish (FS)		Traditional dried sandfish (TDS)	Experimental dried sandfish (ODS)	Signification
Meristic C14:0	A	0,76 0.03	±	1.15 ± 0.04	1.02 ± 0.02	*
Palmitic C16:0	A	20,6 0.34	±	18.4 ± 0.07	17.9 ± 0.12	*
Stearic C18:0	A	7.17 0.04	±	8.51 ± 0.32	8.42± 0.02	*
Arachidic C20:0	A	0.36 0.07	±	0.51 ± 0.12	0.43± 0.03	*
SFA		28.9		28.1	27.8	*
Palmitoleic C16:1	A	4.03 0.14	±	3.06 ± 0.34	3.02 ± 0.02	*
Oleic C18:1 n-9	A	57.3 0.31	±	65.5 ± 0.39	65.8± 0.04	*
MUFA		61.4		68.5	68.8	*
Linoleic C18:2 n-6	A	7.67 0.39	±	1.92 ± 0.19	7.83± 0.34	***
α- Linolenic C18:3 n-3	A	1.14 0.11	±	0.43 ± 0.08	1.21 ± 0.01	***
Arachidonic C20:4 n-6	A	0.97 0.32	±	0.33 ± 0.11	1.02± 0.02	***
PUFA		9.78		2.68	10.1	***
PUFA /SFA		0.34		0.01	0.37	***
ω6/ω3		7.58		5.23	7.32	***

*SFA: saturated fatty acid, MUFA: monounsaturated fatty acid, PUFA: polyunsaturated fatty acid Significance at: *0.05; **0.01; ***0.001.*

Amino Acids Composition

The results obtained may not indicate any important difference in the drying methods. The amino acid composition of fresh and dried sandfish is represented in Table 3. The table analysis shows the sandfish's richness in essential amino acids, particularly lysine and threonine. These two amino acids are similar to the reference protein (Egg) value; lysine is important for bone production, collagen formation, and immune defense. This guarantees sufficient calcium absorption and

preserves an adult nitrogen balance. The skink proteins are very abundant in phenylalanine -tyrosine and valine, they have a high content of histidine and methionine -cysteine, and a notified amount of leucine and isoleucine. Relative to the reference protein, these levels of content and the demands for daily amino acids are reasonably well balanced. The consistency of a food source of protein will be measured first of all according to its capacity to satisfy these needs quantitatively and qualitatively, which depends on its essential amino acid composition and digestibility. (Remond and Duchene, 2014). According to Pion (1970), sandfish proteins are of good nutritional quality; a food protein is said to be of good nutritional quality if and only if it contains the eight essential amino acids in proportions, which are adapted to the body's needs. Sandfish proteins have a high digestibility index (68.27 %), close to that of red meat (70 %). the chemical index of digestibility is the content of the amino acid "limiting"; (IAA which has the lowest percentage) in the protein concerned about the content of this amino acid in the reference protein. FAO/WHO (1991).

Table 3: Amino acids compositions of fresh and dried sandfish (expressed in g / 100g of protein)

Amino acids	Fresh sandfish (FS)	Traditional dried sandfish (TDS)	Experimental dried sandfish (EDS)	ANC	Reference protein *
Aspartic A	4.73	4.98	5.19		
Glutamic A	1.76	1.62	1.68		
Serine- Glutamine	0.65	0.52	0.61		
Arginine-Glycine	3.6	1.68	2.01		
Alanine	2.23	1.33	1.98		
Essential amino acids					
Histidine	1.58	1.49	1.50		1.6
Valine	1.44	1.29	1.49	0.28	1.3
Threonine	0.88	0.79	1.01	2.24	0.9
Methionine-Cysteine	1.47	1.39	1.45	2.45	1.7
Lysine	1.57	1.45	1.58	2.40	1.6
Phenylalanine - Tyrosine	2.08	2.07	2.22	1.40	1.9
Isoleucine	0.98	0.88	1.30	0.84	1.3
Leucine	1.27	0.98	1.24	1.40	1.9
ID %	68.3	60.7	69.1		

ANC: Daily recommendations for adult men, 70 kg male (Martin et al., 2001).
** : (FAO/ WHO / 1991)*

CONCLUSION

Our research aims at characterizing the sandfish eaten in the Souf area and following changes in biochemical composition after a drying phase. The findings obtained indicate significant biochemical composition variations. Thus, monounsaturated fatty acids and polyunsaturated fatty acids increased within the experimental drying process. The findings show the sandfish's richness in essential amino acids.

CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest regarding the publication and dissemination of the information provided herein.

AUTHOR'S CONTRIBUTION:

Ikram Toumi conceived and designed research. Material preparation, data collection and analysis were performed by Ifriqya Medila and Hamdi Bendif. All the authors have read and approved the manuscript.

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