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PROXIMATE COMPOSITION AND ORGANOLEPTIC PROPERTIES OF OVEN-DRIED ABA KNIFE FISH (*Gymnarchus Niloticus*)

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Abstract: This study investigates the quality composition of Aba knife fish (*Gymnarchus Niloticus*) predominant in South-eastern Nigeria. The fish sample require proper processing techniques to preserve their organoleptic qualities for a substantial period. The objective of the study was to investigate the influence of oven-drying process on the proximate and organoleptic qualities of *Gymnaruchus Niloticus*. The studied fresh fish fillets were rinsed in clean water, brined and spread in trays before taken for oven drying. An oven drier (FALC STF-F-52) was used for the oven-drying process. Analyses of proximate compositions (moisture content, crude lipid, crude protein, ash content and crude fiber) were carried out on the fresh and oven dried fish samples. The study showed that oven drying decreases the moisture content to a safe level of 38.13 ± 0.01% dry basis(d.b), and increase the crude protein content (18.23±0.01), fat content (4.34±0.01), ash content (3.40±0.01), carbohydrate content (35.96±0.01) of the investigated fish samples. There were no crude fibre contents (0.00) in the fresh fish samples. Therefore, the oven drying process had no noticeable effect on the fibre content. The oven dried fish samples were rated high in terms of taste, aroma, colour, texture and general acceptability by the panel of assessors. The significance of the obtained results as well as recommendations for further studies were offered.

Keywords*: Fish, drying process, quality composition, fillets, oven drier.*

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INTRODUCTION

Fish are major source of food for humans, providing a significant portion of protein, fats and vitamins in the meals of a vast proportion of the people and a key food commodity [1].

This is one of the world's most crucial source of animal protein preferred by most people due to the nutrients it has which are all vital for human health and growth [2,3]. Fish has nutrients such as omega-3 long chain polyunsaturated fatty acids (n-3 LC-PUFAs) calcium, iodine, vitamin D, zinc and iron [4]. It is also the cheapest source of animal protein, however, fresh fish spoil so easily and therefore requires adequate preservation and storage [5]. It is susceptible to microbial spoilage, tissue decomposition and the development of rancidity [6]. Fish oven-drying is a process of preserving fish by exposing it to high temperature in a drying chamber and this is more necessary when there is poor infrastructure in handling and processing fresh foodstuffs [7].

In Nigeria, oven-drying is a common practice in fish processing as it preserves its quality for an extended time and offers several advantages such as insignificant alterations and minimum deterioration of the product. This process is usually characterized by a combination of salting, drying and heating in an oven drying chamber [8].

Fish oven-drying is a simple method of preserving fish as it does not require highly sophisticated equipment or expertise [9]. Oven drying as a method of preservation produces acceptable products due to the desirable flavor and colour it imparts. The shelf-life of the oven-dried fish sample is usually extended basically due to the reduction in water activity. In order to ensure a short storage duration of dried fish that is safe from molds and bacteria infestation, the percentage moisture content must be less than 30 [10; 11].

Oven-drying is known to affect the weight, aroma, colour, texture, flavour and general acceptability of the finished products [12; 7]. Oven-drying results in weight loss in the final product due to both the effect of dehydration and leaching of lipids from the fish sample. The weight loss can be about 10-25% depending on the origin of the material, final product characteristics, drying method, size and shape of the fish [13]. Oven-drying affects the quality of fish in numerous ways, however, this depends mainly on the quality of the raw material used. A quality raw material will definitely yield a quality oven-dried product that ensures a good market demand and profit [14].

Aba knife fish (*Gymnarchus Niloticus*) is a fish found in swamps, rivers and lakes in the Nile, Niger, Chad and Nigeria. The fish is normally found in slow-moving streams and densely vegetated swamps [15]. In its natural habitat the fish feeds on insects, crustaceans, snails and frogs [10]. Deterioration of fish quality begins immediately after harvest, so therefore requires adequate preservation and storage.

Hence, oven-drying as a method of preservation which has been known to impart desirable proximate and organoleptic qualities of finished products was applied in this study to determine the influence of oven drying on the proximate and organoleptic qualities of the fish sample [16].

Gymnaruchus Niloticus is rich in protein which makes it command a high price in Nigerian market. It has an average price of $10 per fish which is due to its high value and usually relished when dried [1].

Various researches has been carried out on the breeding, life cycle, feeding, nutritive value and storage of *Gymnarchus Niloticus* species but there's limited information on the oven-drying process and the influence of oven-drying on the proximate values and organoleptic properties.

This research therefore, aims to determine the effect of oven-drying on the proximate composition (moisture content, crude protein, crude fibre, fat, ash, carbohydrate) and organoleptic qualities (taste, texture, aroma, colour and general acceptability) of *Gymnarchus Niloticus*.

MATERIALS AND METHODS

The materials used to determine the proximate and organoleptic properties of Aba knife fish sample were 25kg capacity, oven dryer, fresh Aba knife fish, salt, water, plastic containers, digital weighing scale, thermo-hygrometer and digital stop watches (PGE DSTP2).

The instruments used for this research were soxhlet reflux flask (CG 1368), electronic balance (model XY200L), muslin cloth, digital thermometer (HVAC IP69K), trays, measuring cylinders (100ml boro-silicate glass), petri dish (pyrex), whiteman filter paper, kjeldahl distillation apparatus (MGD 1000X), porcelain crucible, muffle furnace and thimble (STD 9612). The reagents used are concentrated sulphuric acid (H_2SO_4), boric acid, selenium powder, sodium hydroxide (NaOH), petroleum ether hydrogen chloride (HCl), and distilled water (H_2O).

Sample collection and preparation

Fresh Aba knife fish were purchased from local fishermen at Atani fish market in Anambra State of Nigeria. Fresh samples were preserved in ice to prevent deterioration while some samples were taken to the oven for drying. Then the samples were taken for proximate composition analysis at the Laboratory of the National Root Crops Research Institute (NRCRI), Umudike, Nigeria.

Experimental procedure

The methodology prescribed by [18] was used for the production of the oven-dried Aba fish. The fresh fish samples were measured in length (cm) and mass (kg) and the average length of the fresh samples was 61.85cm with a range of 58.9 - 64.8 cm while the average mass was 12.9 kg with a range of 7.8 – 10.2 kg. The dimensions of the fillet samples were taken as follows. The average yield length of the fillet was 12.37cm with a range of 11.78 – 12.96 cm while the average mass of fillet was 1.77 kg with a range of 1.1 – 2.4 kg and was cut into twenty-one fillets and clean water was used to wash the fillets. Brining was done by dipping the fillets into 75% saturated brine solution which was made by dissolving 27g of salt solution (NaCl) in 100ml of water.

The fillets were rinsed in fresh clean water and sprayed in trays while seven fillets were taken to the laboratory for proximate analysis of the fresh sample and the other fourteen fillets were taken for oven drying. The mean temperature of the oven during the drying process was 105ºC. The fish fillets were loaded on the oven tray and the temperature was taken hourly until a constant weight was achieved when the fish fillet was properly dried.

The oven-dried sample was divided into two, seven fish fillets were used for the organoleptic analysis and the other seven were taken to the laboratory to conduct the proximate analysis of the oven-dried samples. The oven drying process of the fish sample is shown in Fig. 1 below.

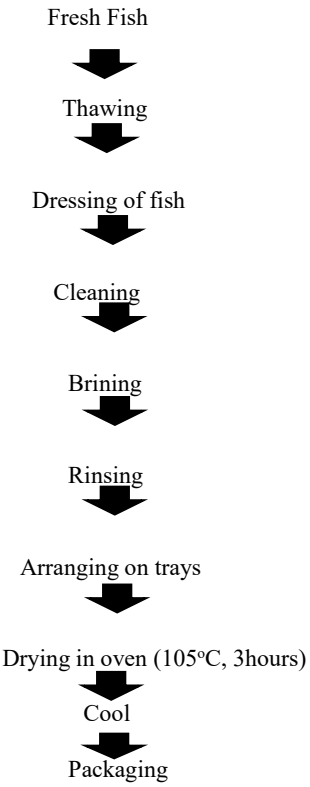

Figure 1. Flow chart of Aba Knife fish oven drying process

Proximate analysis

The proximate composition of the fresh and oven-dried samples were determined using the prescribed method described by Association of Official Analytical Chemists [19].
The procedures for the determination of the proximate properties of the fresh and oven-dried fillet samples are as follows:

Determination of moisture content

A mass of 10g of the sample was poured into a previously weighed moisture can. The sample in the can was dried in the oven at 105^0C for three hours.

It was cooled in a desiccator and weighed, returned to the oven for further drying after which it was left to cool and weighed repeatedly at hour intervals until a constant weight was obtained. The weight of the moisture lost was calculated as a percentage of the mass of the sample analyzed. It was given by the expression as shown in Equation (1):

$$\text{Moisture content} = \frac{100}{1} \text{ x} \frac{W_1 - W_3}{W_2 - W_3} \quad \text{.....(1)}$$

Where: W_1 = mass of empty moisture can,
W_2 = mass of moisture can + weight of sample before drying,
W_3 = mass of moisture can + weight of sample dried to constant mass (g).

Determination of ash content

A mass of 3g of the processed sample was poured into a previously weighed porcelain crucible. The sample was burnt to ashes in a muffle furnace at 550^{o}C. When it was completely ashed, it was cooled in a desiccator and weighed. The weight of the ash was expressed in percentage of mass of sample analyzed as shown in the Equation (2):

$$\%_{ash} = \frac{100}{1} \text{ x} \frac{W_2 - W_1}{W3} \quad \text{..... (2)}$$

Where: W_1 = mass of empty crucible (g), W_2= mass of crucible + ash (g),
W_3=mass of sample (g).

Determination of crude fiber content

A mass of 3g of the processed sample was boiled in 150ml of 1.25% H_2SO_4 solution for 30mins under reflux. The boiled sample was washed in several portions of hot water using a two-fold muslin cloth to trip the particles which were returned back to the flask and boiled again in 150 ml of 1.25% NaOH for another 30 mins under the same condition.

After washing in several portions of hot water, the sample was allowed to drain dry before being transferred to a weighed crucible where it was dried in an oven at 105^{0}C to a constant mass. It was burnt to ashes in a muffle furnace. The mass of fiber was calculated as a percentage of weight of sample analyzed. It was given by the expression as shown in Equation (3):

$$\%_{\text{crude fiber}} = \frac{100}{1} \text{ x} \frac{W_2 - W_3}{\text{Mass of sample}} \quad \text{..... (3)}$$

Where: W_2 = mass of crucible + sample after boiling, washing, and drying (g);
W_3 = mass of crucible + sample as ash (g).

Determination of fat content

A mass of 3g of the processed sample was wrapped in a porous paper (Whiteman filter paper) and put in a thimble. The thimble was placed in a soxhlet reflux flask and mounted in a weighed extraction flask containing 200 mls of petroleum ether.

The upper end of the reflux flask was connected to a water condenser. The solvent (petroleum ether) was heated. It boiled, vaporized and condensed into the reflux flask. The reflux flask filled up and symphonized over carrying its oil extract down to the boiling flask. The process was allowed to go on repeatedly for 4hours before the defatted sample was removed, the sample recovered and the oil extract was left in the flask.

The flask containing the oil extract was dried in the oven at 60^{o}C for 30minutes (to remove the residue solvent) cooled in a desiccator and weighed.
By difference the weight of fat extract was determined and expressed as a percentage of the weight of the analyzed sample and is given by Equation (4):

$$\%Fat = \frac{100}{1} x \frac{W2-W1}{\text{weight of sample}} \quad \text{..... (4)}$$

Where: W_1= mass of empty extraction flask and
W_2 = mass of extraction flask + fat extract (g)

Determination of protein content

This was done by the Kjeldahl method. The total N_2 was determined and multiplied with a factor of 6.25 to obtain the protein content. 1.0g of processed sample was mixed with 10ml of concentrated H_2SO_4 in a digestion flask. A tablet of selenium catalyst was added to it before it was heated in a fume cupboard until a clear solution was obtained (i.e., the digest) which was diluted to 100ml in a volumetric flask. 10mls of the digest was mixed with an equal volume of 45% NaOH solution in a Kjeldahl distillation apparatus. The mixture was distilled into 10mls of 4% boric acid containing 3 drops of mixed indicator (bromoseressol green/methyl red). A total of 50mls of distillates was collected and titrated against 0.02N. The N_2 content and hence the protein content was calculated using Equation (5):

$$\% \text{ Protein} = \% N_2 \text{ x } 6.25$$
$$\% N_2 = \left(\frac{100}{W} * N * \frac{14}{1000} * \frac{Vt}{Va}\right) \quad \text{..... (5)}$$

Where: W = mass of sample (g),
N = normality of titrant (0.02 H_2So_4),
Vt = Total digest volume (100ml)
Va = Volume of digest analyzed (10ml),
T = Titre value of sample (40ml) and
B = Titre value of blank (50 ml).

Determination of carbohydrate content

It was estimated using the Equations (6) – (7):

%carbohydrate=100% (protein+lipid+ash+crude fibre+moisture content+dry matter) ..... (6)

$$\%_{CHO} = P_c + L_c + A + F_c + MC_{db} \quad \text{..... (7)}$$

Where: CHO = carbohydrate, L_c = crude lipid,
F_c = crude fat,
MC_{db}= moisture content dry basis,
A= ash and
P_c = crude protein.

Organoleptic Evaluation

The organoleptic evaluation of the oven-dried fillet samples was carried out using a 5-point hedonic scale [20] analyzed by a panel of 10 persons from the Bioprocess and Food Engineering option of the Department of Agricultural and Bioresources Engineering, Michael Okpara University of Agriculture, Umudike, Nigeria. The quality attributes evaluated include taste, colour, aroma, texture and general acceptability. The panel scores were analyzed using Duncan's Multiple Range Test to check for samples' treatment that differ significantly from each other. From the score sheet used (Table 1). The fresh and oven-dried fish samples used for the experiment are shown below in Figs 2 and 3, respectively

Table 1. Indexes adopted by the panel for accessing the characteristics of the Oven-dried fish

Colour	Rating	Taste/Aroma	Rating	Texture	Rating
Golden (Dark lustre)	5	Excellent	5	Very dry	5
Golden (Lustre)	4	Very good	4	Dry	4
Brown (Normal)	3	Good	3	Fairly dry	3
Brown (Slightly)	2	Fair	2	Spongy	2
Silvery (Normal)	1	Poor	1	Wet	1
Mean value					

Fig. 2. Fresh Aba knife fish

Fig. 3. Oven-dried Aba knife fish

RESULTS AND DISCUSSION

The result of the proximate analysis carried out on the fresh and oven-dried fish samples is presented in Table 2. The mean crude protein content of the oven-dried samples increased by 3.55% when dried, whereas moisture content was grossly reduced to a mean safe level of 38.13% for storage. Similar results were obtained by [17]. Because there was no crude fiber content in the fresh fish sample, the crude fiber value remained 0.0% after drying. The mean ash and carbohydrate content of the oven-dried sample increased 2.17% and 31.52% respectively. More so, the fat content and energy increased 3.02 and 167.53%, respectively.

The result obtained from the study indicated weight loss as presented in Table 2, this shows that the fresh fish sample lost moisture content due to dehydration during the oven-drying process which took 3 hours before the final weight was obtained, these findings is in line with [2] and [11]. The loss in moisture of oven dried fish samples is as a result of the application of heat which decreases water activity in fish tissue, while high moisture content provides a conducive environment for spoilage by microbes [18].

Table 2. Mean proximate composition (mean± SD)
n=3 of the fresh and oven dried Aba Knife Fish

Proximate Property	Fresh Sample	Oven dried Sample
Moisture Content (%)	78.34 ± 0.03	38.13 ±0.02
Protein Content (%)	14.68 ± 0.01	18.23 ±0.01
Fat (%)	1.32 ± 0.02	4.34 ±0.03
Crude Fibre (%)	0.00	0.00
Ash Content (%)	1.23 ±0.01	3.40 ±0.01
Carbohydrate (%)	4.44 ±0.005	35.96 ±0.05
Energy (Cal/100g) (%)	88.29 ±0.08	255.82 ±0.02

The recorded lowest moisture content in dried fish samples entails a longer shelf life of the product. It has been reported by [12] that the principle of fish oven-drying is the removal of moisture content as a result of heat application from an oven. The quality of fish protein is superior to that which could be obtained from milk, meat and eggs. The increase in protein content of oven-dried sample as shown in Table 2 may be due to product dehydration which concentrated the protein during drying thereby increasing the nutritive value of the fish. A Similar findings was reported by [21] who compared the crude protein level of *Clarias Gariepinus* to the processed oven-dried sample.

The result obtained in Table 2 shows that fresh Aba knife fish has a high moisture content (78.34%) with a low fat content (1.32%) after drying there was a significant increase in fat content (Table 3). [10] reported that as the water content decrease in a fish, the fat increases and vice-versa. The increase in fat content could also be as a result of the heat generated by the oven which increases the concentration of nutrient in the mass of fat due to lipid oxidation. This finding is in line with [9] who reported that during drying fish losses its moisture content which result in increase in the concentration of nutrient in the remaining mass of fats.

Ash is the inorganic residue that remains after matter has been burnt off which was found in little non-significant traces in the fish sample. Ash is the measure of the mineral content of any food including fish [22]. Oven-drying increase significantly (≤ 0.05) the ash content of *Gymnarchus Niloticus* (Table 3) which could be attributed to the fish species, season and food availability. Similar findings was reported by [8] who observed significant difference in ash content of some oven dried C*larias Gariepinus*. The ash content of the dried sample increased 1.23% to 3.40% (Table 2) which is similar to the works of [6] on Bonga Spp, Sardinella Spp and *Heterotis Niloticus*.

Carbohydrate content in the fresh fish sample is 4.44% which is minimal and practically minute [23]. From Table 2, after drying it was observed that the carbohydrate value of the oven-dried fish sample increased from 4.44% to 35.96%. Fresh fish generally do have very low levels of carbohydrates because glycogen does not contribute much to the reserves in the fish body tissue [24].

Author [2] also observed that increase in carbohydrate of dried fish could be due to the fish consumption, absorption capacity and conversion potentials of essential nutrients from their diet or local environment into such biochemical attributes needed by the organism.

Table 3. Analysis of Variance (ANOVA) of the Mean proximate composition of Oven Dried Fish Sample.

Parameters	Source of Variation	Sumof Squares	df	Mean Square	F	Sig.
Moisture Content	Between Groups	2425.266	2	2425.266	247526	0.0001
	Within Groups	0.0004	1	235.02		
Protein Content	Between Groups	44.04	2	18.7974	751896	0.0004
	Within Groups	54.66	1	18.001		
Fat Content	Between Groups	3.95	2	13.7182	822649	0.0008
	Within Groups	13.02	1	0.00167		
Ash Content	Between Groups	3.66	2	7.19415	179853	0.0002
	Within Groups	10.23	1	0.0004		
Carbohydrate	Between Groups	13.29	2	1490.26	149265	0.0002
	Within Groups	107.85	1	0.0001		
Energy	Between Groups	264.89	2	4212.12	538864	0.0001
	Within Groups	767.61	1	0.7817		

Organoleptic characteristics of oven-dried Aba knife fish fillet

The result of the organoleptic analysis carried out on the oven-dried fish samples is presented in Table 4. The mean texture and aroma of the dried samples increased by 3.1 and 2.0, also there was increase in the mean colour, taste and general acceptability of the oven dried samples which is 2.9, 3.5 and 2.2 respectively. Similar results were obtained by [12]. The organoleptic qualities of a processed fish sample are of great importance due to the fact that every consumer wants good qualities from fish consumption. The organoleptic qualities of a fish are what normally attract consumers to it [21]. The high temperature in the oven (105^{o}C) contributes to the loss of amino acids as a result of millard reaction which involves amino group of amino acids with sugars and carbonyls. It is this reaction that necessitates the characteristic golden brown colour of the oven dried fish.

Table 4. Mean scores of the ratings of respondents on fresh and oven dried fish sample

Organoleptic Property	Mean Score of Fresh Sample	Mean Score of Oven-dried Sample
Texture	1.2	4.2
Aroma	2.4	4.4
Colour	1.5	4.5
Taste	1.0	4.5
General Acceptability	2.2	4.4

The concentration of nutrients and the denaturation effect of drying increases the taste of oven-dried fish. The influence of the high temperature is important in chemical reactions in the fish samples leading to the production of the flavour, colour, and other properties of oven dried fish [12]. Results from Table 5 show the statistical analysis carried out to ascertain the level of significance of the organoleptic qualities of the oven-dried fish sample. The texture mean score of 4.3 shows that the oven dried fish sample dry (Table 1) was statistically significant (≤ 0.05) with P-value of 0.010. It can also be seen that the mean aroma score of 4.4 indicates very good taste (Table 1) is statistically significant (≤ 0.05) with P-value of 0.005. A mean score of 4.4 rating was given by the respondents on colour of the samples. This implies that the colour of the oven dried samples is equated to a golden lustre (Table 1). In terms of taste and general acceptability, the respondents rated a mean score of 4.5 and 4.4 indicating very good taste and general acceptance, more so they are both statistically significant (Table 5).

Table 5. Analysis of variance (ANOVA) of the mean scores of respondents rating on oven dried Aba knife fish

Parameters	Source of Variation	Sum of Squares	Df.	Mean Square	F-value	Sig.
Texture	Between groups	36.45	1	36.45	46.532	0.010
	Within groups	14.10	8	0.783		
Aroma	Between groups	12.80	1	12.80	12.659	0.005
	Within groups	18.20	9	1.011		
Colour	Between groups	4.05	1	4.05	2.632	0.100
	Within groups	27.70	8	1.539		
Taste	Between groups	22.05	1	22.05	22.424	0.010
	Within groups	17.70	8	0.983		
General acceptability	Between groups	8.45	1	8.45	24.934	0.002
	Within groups	6.10	8	0.339		

CONCLUSION

In this experimental study, the proximate composition and organoleptic qualities of oven dried *Gymnaruchus Niloticus* were investigated. Considering the results established from this work, the following conclusions are drawn:

I. Oven drying increases the crude protein content, ash content, fat content, and carbohydrate content of Aba knife fish.
II. There was no crude fiber content in the fresh Aba knife fish. Hence, oven drying did not affect the fiber content.
III. The oven dried Aba knife fish was rated high in texture, aroma, colour, taste, and general acceptability.

The result of the current study may be useful in determining the influence of oven drying on the qualitative (nutritional) and quantitative (organoleptic) characteristics of local fish species in the tropical climates. Future empirical studies will consider the optimization of the proximate composition and organoleptic qualities at varying pretreatment conditions and oven drying techniques. It will be expedient to establish prediction relations for the energy demand and shrinkage influence of the different sizes of the *Gymnarchus Niloticus* species.

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PRIBLIŽAN SASTAV I ORGANOLEPTIČKE OSOBINE SUŠENE RIBE ABA (*Gimnarchus Niloticus*)

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Apstrakt: Ova studija istražuje kvalitet uređenja (obrade) Aba ribe nožastog oblika (*Gimnarchus Niloticus*) koja dominira u jugoistočnoj Nigeriji. Uzorci ribe zahtevaju odgovarajuće tehnike obrade da bi se očuvale organoleptičke osobine tokom značajnog perioda.

Cilj rada je ispitivanje uticaja procesa sušenja u sušari (pećnici) na približne i organoleptičke kvalitete ribe *Gimnaruchus Niloticus*.

Fileti sveže ribe su isprani u čistoj vodi, salamureni i raširenі (položeni) na metalnu površinu pre nego što su uneti zbog sušenja u pećnicu (sušaru). Proces sušenja je obavljen u pećnici (sušari) sa oznakom modela FALC STF-F-52.

Analize približnih sastava sadržaja vlage, sirovih lipida, sirovih proteina, sadržaja pepela i sirovih vlakana su obavljene na uzorcima sveže i sušene ribe.

Studija je pokazala da sušenje ispitivanih uzoraka ribe u navedenom modelu sušare smanjuje sadržaj vlage na bezbedan nivo od 38,13±0,01% suve materije, a povećava sadržaj sirovih proteina je 18,23±0,01; sadržaj masti je 4,34±0,01; sadržaj pepela je 3,40±0,01 i sadržaj ugljenih hidrata bio je 35,96±0,01.

U uzorcima sveže ribe nije bilo sadržaja sirovih vlakana (0,00). Proces sušenja u pećnici nije imao primetan uticaj na sadržaj vlakana.

Uzorci ribe sušene u sušari su visoko ocenjeni u pogledu ukusa, arome, boje, teksture i opšte prihvatljivosti od strane panela ocenjivača.

Značaj dobijenih rezultata ima preporuke za dalja istraživanja.

Ključne reči: *Riba, proces sušenja, kvalitetni sastav, fileti, sušara.*

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