CREATIVE SCIENCE

Journal home page: csj.snru.ac.th

Analysis of the Nile Tilapia fish's (*Oreochromis niloticus* L.) proximate composition in Sakon Nakhon province, Thailand

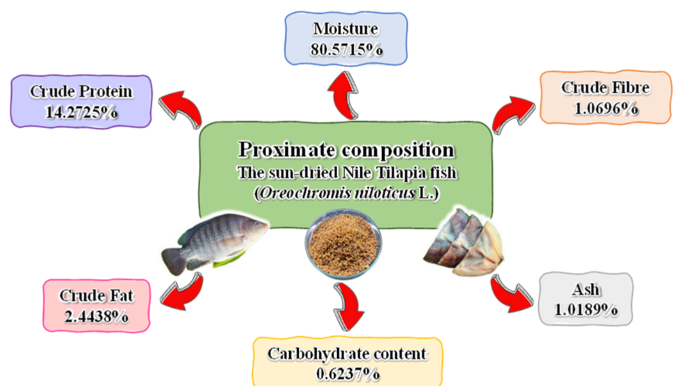
Kulwadee Suwannatrai[1], Krittiyanee Namwongsa[2], Natenapa Phanomkhet[1], Sumana Tawil[3], Wuttichai Roschat[3,4,*]
[1]Program of Biology, Faculty of Science and Technology, Sakon Nakhon Rajabhat University, Sakon Nakhon, 47000 Thailand
[2]Department of Biochemistry, Faculty of Science, Khon Kaen University, Khon Kaen, 40002 Thailand
[3]Program of Chemistry, Faculty of Science and Technology, Sakon Nakhon Rajabhat University, Sakon Nakhon, 47000 Thailand
[4]Biomass Energy Research Laboratory, Center of Excellence on Alternative Energy, Sakon Nakhon Rajabhat University, Sakon Nakhon, 47000 Thailand
[*]**Corresponding Author**: roschat1@gmail.com

DOI: https://doi.org/10.55674/cs.v15i2.251073

Received: 18 December 2022; **Revised:** 20 April 2023; **Accepted:** 24 April 2023; **Available online:** 1 May 2023

Abstract

Fish is a significant source of animal protein and contains additional vital nutrients for people. Fish popularly eaten in Thailand is the Nile Tilapia fish (*Oreochromis niloticus* L.), which is inexpensive. Therefore, this study aimed to ascertain and compare the proximate compositions of the sun–dried Nile Tilapia fish from the Suanpa Baandin farm in Chiang Khruea sub–district, Mueang Sakon Nakhon district, Sakon Nakhon province, Thailand. The parameters of proximate compositions consisting of moisture contents, crude proteins, crude fats, crude ashes, crude fibers, carbohydrate contents, and total carbohydrate contents were evaluated following the standard method from the official methods of the Association of Official Analytical Chemists International (AOAC; 2004). In this investigation, the dry matters of Nile tilapia fish were 19.43 ± 0.03%. According to the findings, the sample of sun-dried Nile Tilapia fish comprised 14.2725 ± 0.0601% of crude proteins, 2.4438 ± 0.0134% of crude fat, and 1.6933 ± 0.0460% of total carbohydrate contents, respectively. These results of the sun–dried Nile Tilapia fish showed that proximate nutritional compositions were consistent with the findings of other research reports. Therefore, the overall results indicated that the sun–dried Nile Tilapia fish samples were suitable for human protein requirements and should be recommended for consumption as it was a good source of nutrients.



Keywords: Proximate composition analysis; The sun–dried Nile Tilapia fish; Farmer Pond in Sakon Nakhon Province; *Oreochromis niloticus* L.

1. Introduction

Fish have a significant economic value that is derived via fisheries and aquaculture. Fish products also represent an essential component of the human diet, the third primary source of dietary protein humans consume after cereals and milk. Among the excellent quality animal protein sources, fishes are good sources of essential nutrients, easy digestibility, and the cheapest source of animal protein which is rich in protein with high quality amino acid composition [1 – 3]. Furthermore, they are a good source of vitamins A, B–series, and D, constituting desirable components of a healthy diet [4, 5]. Fish is a rich source of long–chain omega–3 polyunsaturated fatty acids (PUFAs) and minerals essential for maintaining a healthy body. Furthermore, they also contain eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) which serve as important components in the reduction of some risk factors associated with arteriosclerosis and heart disease [6, 7].

Several species of fish have been part of the diet of every continent for a long time. Nile tilapia (*Oreochromis niloticus* L.), a species of tilapia, is one of the most economically important fish widely cultured in the world. In Thailand, tilapia is high on the list of popular fish called "Plaa–Nin" in Thai. This fish culture has rapidly expanded, as it is economically attractive, has a high production rate, rapid growth, and high resistance to diseases. It is also included in consumer demands because of its tastiness, inexpensiveness, and availability in the market as a raw product. The Nile tilapia is a favorite not only with those who enjoy it at mealtimes but also with fish farmers, market vendors, exporters, and other people at different levels. To extend shelf life and increase its economic market value, products from fish undergo preservative processes. Fish are preserved through such traditional methods as drying, the simplest method of fish preservation employing hot heat from sun and air, which removes moisture from fish flesh [8, 9]. The sun-drying is one of the most critical low-cost methods of fish preservation and inhibits the growth of microorganisms. Although dried fish is an excellent source of nutrients, it may be infected, destroyed, or lose nutritional value during the drying process [10].

Therefore, exploring food composition data is essential for providing basic information on various aspects of the nutrition of the final dry products. The purpose of our study was to determine and compare the proximate composition of the sun–dried Nile Tilapia fish from the Suanpa Baandin farm in Chiang Khruea Sub–district, Mueang Sakon Nakhon District, Sakon Nakhon Province, Thailand.

2. Materials and Methods

Materials

The samples of the sun–dried Nile Tilapia fish as the raw material in this study were collected from the Suanpa Baandin–farm in Chiang Khruea Sub–district, Mueang Sakon Nakhon District, Sakon Nakhon Province, Thailand, as presented in Fig. 1(a) and (b). The chemicals used for the crude protein analysis consisted of sulfuric acid, hydrogen peroxide, copper sulfate, potassium sulfate, sodium hydroxide, and boric acid from QRëC, New Zealand, and Sigma, Germany. Petroleum ether (grade AR) as an organic solvent used to analyze the crude fat of the samples was bought from ANaPURE, New Zealand. The chemicals used to analyze the crude fiber of the sample, namely sodium hydroxide, sulfuric acid, and acetone (grade AR), were obtained from QRëC, New Zealand, and RCI Labscan, Thailand. Additionally, the other chemicals used in this research work experiment were the analytical grade.

Fig. 1 Shows the morphology of (a) the fresh Nile Tilapia fish and (b) the sun-dried Nile Tilapia fish.

Sample preparation and storage

The sun–dried Nile Tilapia fish was dried at 60 °C in a drying oven for 24 h. After the meat had separated from the fishbone, the samples were dried again at 60 °C in a drying oven for a further 24 h. Next step, the dried samples were finely ground into powder using a grinder. Finally, the samples were collected in an airtight and kept at 0 °C until further analysis of proximate compositions. An overview of the sample preparation step was shown in Fig. 2.

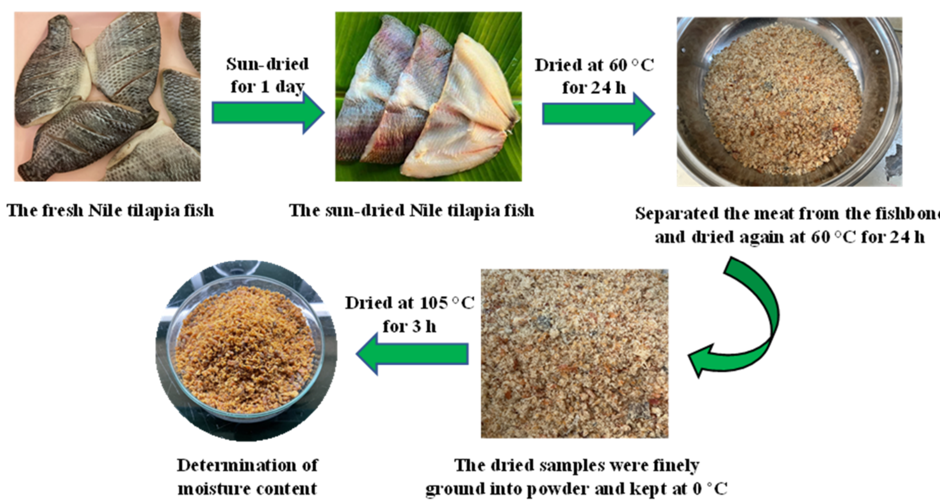


Fig. 2 An overview of the sample preparation step for the proximate analysis of the sun–dried Nile tilapia fish.

The proximate analysis of the sun–dried Nile tilapia fish

The percentage of moisture contents, crude proteins, crude fats, crude ashes, crude fibers, carbohydrate contents, and total carbohydrate contents of the sun–dried Nile Tilapia fish were analyzed following the standard method from the official methods of the Association of Official Analytical Chemists International (AOAC; 2004) and following the reports of Jim *et al.* [2], Desta *et al.* [3], Oko *et al.* [11], Verma and Srivastav [12], Akalu and Geleta [13], and Eze [14]. All these parameters were repeated 5 times to calculate the average value, standard deviation (SD), and relative standard deviation (%RSD).

The determination of moisture content was started by weighing 1 g of the dried sample (as displayed in Fig. 2). Then, the dried sample was placed in the hot air oven at 105.0 °C for 4 h. After that, the sample was cooled in desiccators to room temperature and reweighed until a constant weight was observed. The percentage of moisture content was calculated from the weight of the sample before drying at 105 °C minus the weight of the sample after drying and divided by the weight of the sample before drying.

Crude fat content analysis was determined using the Soxhlet method and petroleum ether solvent. A 1 g of the dried sample was put into a pre–dried porous thimble and assembled into the Soxhlet apparatus. Crude fat extraction was conducted for 6 hours by heating the solvent in the boiling flask. At the end of the specified time, the derived extracted mixture in the extraction flask was separated from the petroleum ether solvent by a rotary evaporator. Then the extraction flask was dried in a hot air oven at 100 °C for 1 h, cooled in a desiccator, and weighed. The crude fat content value was estimated by the difference in weight of the flask and extracted fat against the weight of the empty flask and divided with the weight of the dried sample used.

Determination of crude protein content was performed using the Kjeldahl method as described by AOAC. The powdered dried sample weighing 0.5 g was taken into a Kjeldahl flask and then 10 g of catalyst and 25 mL of concentrated sulfuric acid were added. The sample was then digested with a mixture of potassium sulfate, copper sulfate, and selenium mixed in a ratio of 94.8 : 5 : 0.2 until clear. Afterward, the sample was cooled and diluted with 100 mL of 40% sodium hydroxide. In the next step, 50 mL of 4% boric acid was prepared in a separate conical flask and connected to the distillation unit. The reaction mixture was distilled and collected into the boric acid until the volume was derived at around 150 mL. The obtained ammonia from the reaction was converted to ammonium metaborate and it was titrated with standardized 0.1 M hydrochloric acids. The percentage of protein was calculated using the equation followed by the report of Jim *et al.* [2].

Measuring ash content started by weighing 5 g of the sample into a crucible and igniting it in a muffle furnace at 550 °C for 12 h. After that, the furnace was turned off to cool to 150 °C before the sample removal and bring it to a desiccator. When the sample cooled to room temperature, each crucible was reweighed. The percentage of ash content was calculated with the weight of the sample after the ashing was divided against the original mass of the sample. The crude fiber was determined by weighing 1 g of dry sample into the flask. Subsequently, the sulphuric acid solution of 200 mL with a concentration of 1.25 $\%vv^{-1}$ was added to the flask and 3 – 5 drops of n-octanol were used as an antifoam agent. The sample was boiled for 30 minutes and then drained with sulfuric acid. Then, the sample was washed 3 times with 30 mL of hot deionized water and 150 mL of potassium hydroxide with a concentration of 1.25 $\%wv^{-1}$ was added. The sample was boiled again for 30 minutes. The sample was dried in a hot air oven for 2 h, then placed in a furnace, heated up to 525 °C for 3 h, and reweighed after cooling in a desiccator. The percentage of crude fiber content was calculated by the difference of the weight of fiber and ashes after drying versus the weight of ashes after calcination at 525 °C for 3 h and divided by the original sample weight.

The carbohydrate content can be determined by calculating the percent remaining after all the other components have been measured (%carbohydrates = 100 – %moisture – %protein – %fat – %crude ash – %crude fiber). Additionally, the total carbohydrate content was calculated by aggregating the percentage of crude fiber and carbohydrate content.

3. Results and Discussion

The proximate nutrient composition of the sun–dried Nile Tilapia fish (*Oreochromis niloticus* L.) from a farmer's pond in Sakon Nakhon province, Thailand, was given in Table 1 and Fig 3. The average moisture content for the sundried Nile Tilapia fish was 80.5715 ± 0.0329%. This result was similar to the study of Olopade *et al.* [1], but the value was lower than the study reported by

Premarathna *et al.* [15], as presented in Table 2. Generally, the range of moisture contents of Nile Tilapia fish recorded within values 70 − 80%, of the whole body moisture composition of fish [16, 17]. Therefore, the dry matter of Nile Tilapia fish in this study was 19.43 ± 0.03%, as shown in Table 2.

The crude protein content of the sun−dried Nile Tilapia fish from the Suanpa Baandin−farm in Chiang Khruea sub−district, Mueang Sakon Nakhon district, Sakon Nakhon province, Thailand, was presented in Table 1 which showed the result equal to 14.2725 ± 0.0601%. This result indicated that the crude protein percentage level of the sun−dried Nile Tilapia fish was in the acceptable range (13% − 25%) for fish and fishery products [3, 18]. The present study found that crude protein percentage content was close to the report of Olopade *et al.* [1], which reported both original Nile Tilapia and Hybrid Tilapia. Furthermore, Jim *et al.* [2] reported that the crude protein of Nile Tilapia fish from all three lakes ranged between 13.86% and 17.12%, with lake Kariba having the highest (17.12 ± 0.50%), lake Chivero (16.45 ± 0.50%), and lake Manyame the least (13.86 ± 0.50%), respectively. Hence, the crude protein content of the Nile Tilapia depended on various factors such as the food source, the fish sexes, and the effect of the water source used for cultivating [1 − 3].

The crude fat percentage values of the sun-dried Nile Tilapia fish showed the value of 2.4438 ± 0.0134% which in the range of crude fat percentages 1.73 ± 0.34 to 3.98 ± 0.553, were also reported by Desta *et al.* [3] and Jim *et al.* [2]. Moreover, the finding of this research accorded with the report of Tsegay *et al.* [19] which showed the fat value of Nile tilapia fish from Lake Hashenge, Tigray, Ethiopia as equal to 2.45% for males and 2.35% for females. Usually, fish is considered a relatively low-fat food compared to other meats such as chicken, pork, and beef.

Table 1 Proximate nutrient composition of the sun-dried Nile Tilapia fish (*Oreochromis niloticus* L.) from a farmer's pond in Sakon Nakhon Province, Thailand.

Replication (times)	Moisture (%)	Crude Proteins (%)	Crude Fats (%)	Crude Ashes (%)	Crude Fibers (%)	Carbohydrate Contents (%)	Total Carbohydrate Contents[a] (%)
1	80.6088	14.2154	2.4526	1.0629	1.0348	0.6255	1.6603
2	80.5611	14.2309	2.4338	1.0353	1.0938	0.6451	1.7389
3	80.5236	14.2650	2.4576	1.0105	1.0901	0.6532	1.7433
4	80.5556	14.3863	2.4203	1.0080	1.0261	0.6037	1.6298
5	80.6084	14.2650	2.4445	1.0219	1.0248	0.6353	1.6602
Average	80.5715	14.2725	2.4438	1.0189	1.0696	0.6237	1.6933
SD	0.0329	0.0601	0.0134	0.0201	0.0313	0.0172	0.0460
%RSD	0.0408	0.4211	0.5491	1.9706	2.9221	2.7521	2.7146

[a] Total carbohydrate contents were calculated by aggregating the percentage of crude fiber and carbohydrate content.

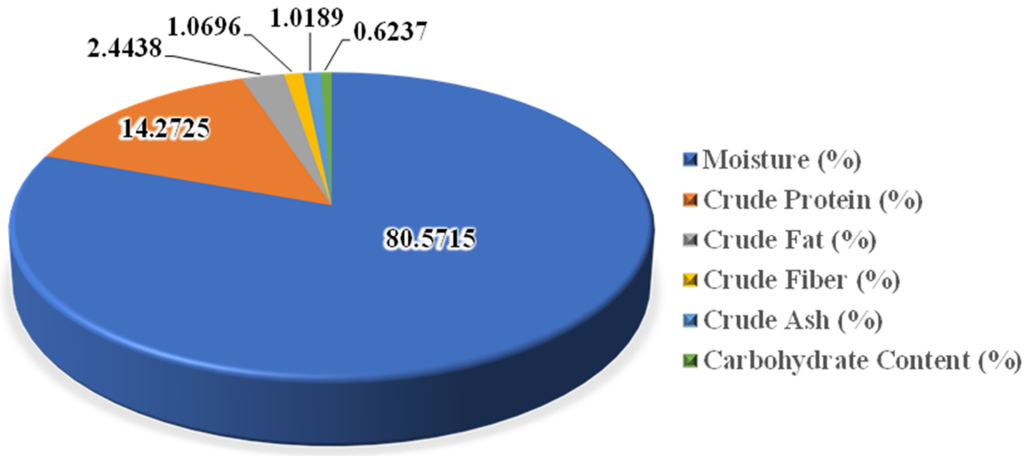


Fig 3. Shows the proximate nutrient composition of the sun-dried Nile Tilapia fish (*Oreochromis niloticus* L.) from farmer pond in Sakon Nakhon Province, Thailand.

The percentage ash content of a sample is relevant to the number of minerals contained in the sample [15]. The normal ash content of the sun–dried Nile Tilapia fish from the Suanpa Baandin–farm was 1.0189 ± 0.0201%. In this study, the results of ash content were lower than the reports of Desta *et al*. [3], Jim *et al*. [2], and Olopade *et al*. [1]. However, the results of ash content in this work were close to the reported by Alemu *et al*. [20] for 1.14% in male fish and 1.17% in female fish, and the report of Tsegay *et al*. [19] of 1.16%. Therefore, the ash content of Nile Tilapia fish depended on the environment for raising. The total carbohydrate contents of the sun-dried Nile Tilapia fish were 1.6933 ± 0.0460% which were calculated by aggregating the percentage of crude fibers and carbohydrate contents. This data on the total carbohydrate contents of this work were close to the result of Premarathna *et al*. [15]. The results indicated that the total carbohydrate contents of the sun-dried Nile Tilapia fish were a small proportion compared to moisture content, crude protein contents, and crude fat contents.

Overall results indicated that the sun–dried Nile Tilapia fish from the Suanpa Baandin–farm pond in Sakon Nakhon province, Thailand, were not inferior in terms of nutritional values compared to the other reports. However, the significant variations in percentages of the proximate nutrient compositions of Nile Tilapia could be interpreted by different possible factors such as the environment for raising (e.g., water source, pond size, temperature, and amount of oxygen dissolved in water), fish body composition, and the diet of the fish. Consequently, the current study indicated the utility of all data on the proximate nutrient compositions of the sun–dried Nile Tilapia fish from the Suanpa Baandin–farm pond in Sakon Nakhon province, Thailand, for consideration consumption of nutritional consumption.

Table 2 The comparison of percentage values of the proximate nutrient composition of Nile Tilapia (*Oreochromis niloticus* L.) in this current study versus previous studies.

Type of Analysis	Current Study	Previous studies							
		D.T. Desta[3]		O.A. Olopade[1]		F. Jim[2]			A.D. Premarathna[15]
		From farmers pond	From lake Hawassa	Nile Tilapia	Hybrid Tilapia	Source lake Kariba	Source lake Manyame	Source lake Chivero	Nile Tilapia
Moisture (%)	80.57 ± 0.03	73.62 ± 3.02	66.77 ± 4.71	81.39 ± 2.23	80.09 ± 2.58	–	–	–	89.51 ± 0.43
Dry matter (%)	19.43 ± 0.03	–	–	–	–	24.70 ± 0.73	19.18 ± 0.73	22.48 ± 0.73	10.49 ± 0.91
Crude Protein (%)	14.27 ± 0.06	14.77 ± 1.82	18.87 ± 4.24	13.66 ± 2.19	14.93 ± 1.57	17.12 ± 0.50	13.86 ± 0.50	16.45 ± 0.50	7.85 ± 0.11
Crude Fat (%)	2.44 ± 0.01	2.39 ± 0.34	3.98 ± 0.55	0.54 ± 0.08	0.59 ± 0.05	1.74 ± 0.34	1.73 ± 0.34	3.17 ± 0.34	0.07 ± 0.16
Crude Ash (%)	1.02 ± 0.02	1.51 ± 0.23	1.89 ± 0.26	1.36 ± 0.22	1.36 ± 0.22	3.30 ± 0.30	1.76 ± 0.30	2.27 ± 0.30	0.46 ± 0.14
Crude Fiber (%)	1.07 ± 0.03	–	–	–	–	–	–	–	–
Carbohydrate Content (%)	0.62 ± 0.01	–	–	–	–	–	–	–	–
Total Carbohydrate Content[a] (%)	1.69 ± 0.05	–	–	–	–	–	–	–	1.69 ± 0.24

[a] Total carbohydrate contents were calculated by aggregating the percentage of crude fiber and carbohydrate content.

4. Conclusion

According to all results obtained in this study, the relatively high quantity of sun–dried Nile Tilapia fish (*Oreochromis n*iloticus L.) in Sakon Nakhon province, Thailand contains protein contents and fat contents when compared to other research. The proteins and fats of a fish are crucial factors in evaluating its nutritional condition. In addition, this result also indicated that the sun-drying method did not cause nutritional deterioration in Nile Tilapia fish and could be recommended as a method for preservation. Hence, the sun–dried Nile Tilapia fish in this study is suitable as a source of animal protein. Moreover, it should be recommended for consumption because it has a high protein content at a low price.

5. Acknowledgement

The authors wish to extend sincere thanks to 1) the Program of Biology and the Program of Chemistry, Faculty of Science and Technology, Sakon Nakhon Rajabhat University, and 2) Biomass Energy Research Laboratory, Center of Excellence on Alternative Energy, Research and Development Institute, Sakon Nakhon Rajabhat University, for supporting the research funding, apparatus, and equipment required for this project.

6. Reference

[1] O.A. Olopade, I.O Iyabode Olusola Taiwo, A.A. Lamidi, O.A. Awonaike, Proximate composition of Nile Tilapia (*Oreochromis niloticus*) (Linnaeus, 1758) and Tilapia Hybrid (*Red Tilapia*) from Oyan Lake, Nigeria. Bull. Univ. Agric. Sci. Vet. Med. Cluj-Napoca, Food Sci. Technol. 73(1) (2016) 19 – 23.

[2] F. Jim, P. Garamumhango, C. Musara, Comparative analysis of the nutritional value of *Oreochromis niloticus* (Linnaeus), Nile Tilapia, meat from three different ecosystems, J. Food Qual. 2017(6714347) (2017) 1 – 8.

[3] D.T. Desta, G.A. Zello, F. Alemayehu, T.K. Estfanos, K. Zatti, M. Drew, Proximate analysis of Nile Tilapia, (*Oreochromis niloticus*), fish fillet harvested from farmers pond and lake Hawassa, Southern Ethiopia, Int. J. Res. Dev. Technol. 11(1) (2019) 94 – 99.

[4] D.K. Singh, A Ranjan, Comparative study on macro and micro-nutrient profiling of selected freshwater, brackish water and marine water food fishes available in Kerala, India. Food Nutr. Sci. 1(4) (2016)1 – 7.

[5] I. Marques, G. Botelho, R. Guiné, Comparative study on the nutritional composition of fish available in Portugal, Nutr. Food Sci. 49(5) (2019) 925 – 941.

[6] A. Jaya-Ram, F. Fuad, M.S. Zakeyuddin, A.S.R.M. Sah, Muscle fatty acid content in selected freshwater fish from Bukit Merah Reservoir, Perak, Malaysia. Trop. Life. Sci. Res. 29(2) (2018) 103 – 117.

[7] M.R. Ullah, M.A. Rahman, M.N. Haque, M.R. Sharker, M.M. Islam, M.A. Alam, Nutritional profiling of some selected commercially important freshwater and marine water fishes of Bangladesh, Heliyon. 8(10) (2022) e10825.

[8] M.D. woyemi, A.A. Eyo, Studies on the use of salt, vegetable oil and insecticide for control of dermestes maculates infecting dried fish in storage, FAO Fisheries Report. 574 (1998) 103 – 104.

[9] N. Fitri, S.X.Y. Chan, N.H. Che Lah, Jam, F.A.N.M. Misnan, N. Kamal, M.N. Sarian, M.A. Mohd Lazaldin, C.F. Low, H.S. Hamezah, E.R. Rohani, A. Mediani, F. Abas, A comprehensive review on the processing of dried fish and the associated chemical and nutritional changes, Foods. 11(19) (2022) 2938.

[10] N. Tenyang, R. Ponka, B. Tiencheu, F.T. Djikeng, H. M. Womeni, Effect of traditional drying methods on proximate composition, fatty acid profile, and oil oxidation of fish species consumed in the Far-North of Cameroon, Glob. Chall. 4(8) (2020) 2000007.

[11] A.O. Oko, B.E. Ubi, A.A. Efisue, N. Dambaba, Comparative analysis of the chemical nutrient composition of selected local and newly introduced rice varieties grown in Ebonyi State of Nigeria, Int. J. Agric. For. 2(2) (2012) 16 – 23.

[12] D.K. Verma, P.P. Srivastav, Proximate composition, mineral content, and fatty acids analyses of aromatic and non–aromatic Indian rice, Rice Sci. 24(1) (2017) 21 – 31.

[13] Z.K. Akalu, S.H. Geleta, Comparative analysis on the proximate composition of tubers of Colocasia Esculenta, L. Schott and Dioscorea alata cultivated in Ethiopia, Am. J. Biosci. Bioieng. 7(6) (2019) 93 – 101.

[14] P.C. Eze, Determination of the proximate composition and amylose content of new rice for Africa (NERICA) flour, Turk. J. Agr. Eng. Res. 1 (2020) 131 – 140.

[15] A.D. Premarathna, A.M.C.P. Kumara, A.P. Jayasooriya, D.A. Satharasinghe, E. Pathirana, Proximate analyses of Nile tilapia (*Oreochromis niloticus*) and Black Tiger Prawn (*Penaeus monodon*) from Sri Lanka, Oceanogr. Fish Open Access J. 7(5) (2018) 1 – 5.

[16] F.A. Anani, E. Agbeko, Health condition and proximate composition of Nile tilapia (*Oreochromis niloticus* L.) fed with tilapia grower diets of commercial, farm-made and their 1:1 mixture, J. Fish. Aquat. Res. 3(1) (2018) 9 – 15.

[17] M.M. Gaber, Growth of Nile tilapia fingerling (*Oreochromis niloticus*) fed diets containing different levels of clove oil. Egypt, J. Aquat. Biol. Fish. 4 (2000) 1 – 18.

[18] United State Department of Agriculture (USDA), Agricultural research service, national nutrition database for standard reference. Release, 23 Nutrition Laboratories, 2010.

[19] T. Tsegay, P. Natarajan, T. Zelealem, Analysis of diet and biochemical composition of Nile Tilapia (*O. niloticus*) from Tekeze Reservoir and Lake Hashenge, Ethiopia. J. Fisheries Livest. Prod. 4(2) (2016) 1 – 7.

[20] L.A. Alemu, A.Y. Melese, D.H. Gulelat, Effect of endogenous factors on proximate composition of Nile tilapia (*Oreochromis Niloticus* L.) fillet from Lake Zeway, Am. J. Res. Commun. 1(11) (2013) 405 – 410.