Muscle Proximate Composition and Mineral Content of Dolphin fish (Coryphaena hippurus) from Coastal Waters of Visakhapatnam

G. Vijaya[1*], P. Yedukondala Rao[2]

[1*,2]Department of Marine Living Resources, College of Science and Technology
Andhra University, Visakhapatnam - 530 003, India.

Corresponding Author: G. Vijaya
***** E-mail: g.vijayasrinivask@gmail.com

Abstract
The present study was carried out to analyse the proximate and mineral composition of dolphinfish (*Coryphaena hippurus*) Visakhapatnam coast, for their nutritive value. Seasonal variation in the proximate composition of protein, fat, moisture and ash was analysed. Mineral composition of sodium, potassium, iron and calcium was also analysed for this study. The ranges of moisture, protein, fat, and ash contents were recorded as 73.97 - 77.18, 16.21 - 23.04, 0.26 - 2.76 and 1.23 - 2.7 %, sodium, potassium, calcium and Iron was 12.63, 16.94, 6.80 and 4.74 mg respectively.

Keywords: Proximate composition, *Coryphaena hippurus*, Minerals, Visakhapatnam.

Introduction

Understanding the biochemical composition of food is very important to determine its nutritive value. In the present day world, almost everybody is health conscious and wants to know about the composition of the food they consume. Fish is popular as a sources of high quality easily digestible protein and is now recommended as healthy food (Padmavati, 2017). Adequate consumption of protein is essential for the propre growth and development of children and energy sources of adult (Vijayan et al 2016). Seafood is very highly nutritious, easy to digest, and extremely edible. It is recognised as a good source of affordable protein and delicacy around the world, includes different kind of finfish and shellfish species (Pavan Kumar et al., 2018). Seafood has a special nutritional value due to the presence of proteins, lipids and some of the principal vitamins, which makes it important for human nutrition. Fish is also a rich sources of minerals like iron, copper and zinc. Fish lipids contain high levels of polyunsaturated fatty acids especially EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid). These ω-3 polyunsaturated fatty acids play an important role in the brain development and function of nervous system, photo reception and the reproductive system (Alsalvar et al., 2002).India currently ranks second among countries that produce fish. Making the necessary protein accessible to the current population is a difficulty because the demand for seafood is always rising. As the population grows, the capture sector is likewise experiencing an increase in fishing pressure.

Studies proximate composition of fish is an essential from the nutritional point of view. It is well understood that the proximate composition of the edible tissues of marine invertebrates is influenced by their dietary habits, age, sex, season, and alternative ecological factors (Srilatha et al., 2013). Fishes are exposed to considerable environmental changes and composition of feed also changes, which affects the proximate composition (Olsen et al., 1995). Besides, other factors such as age, sex and state of maturity also affect the proximate composition (Bandarra et al., 1997). Several studies deal with the proximate composition of biochemical components of many commercially important fishes (Ashwinikumar et al., 2014; Palanikumar et al., 2014). Variation of biochemical composition of fish flesh may also occur within same species depending on the species, fishing ground, fishing season, maturity, feeding regimes, age and sex of the individual and reproductive status. The spawning cycle and food supply are the main factors responsible for this variation (Love, 1980).

Moreover, fish muscle and bones are good source of calcium and phosphorus and also essential minerals, such as iron, zinc, iodine, magnesium, and potassium (Ersoy and Ozeren 2009 and Nurnada et al. 2013). Minerals are called micronutrients, and the physiological and biochemical mechanisms by which the human body acquires food are assimilated and used to sustain health and function and ensure adequate immune competence and cognitive development (Soundarapandian et al., 2010). These are essential for human health as they play many important body functions such as maintain acid–base balance, haemoglobin formation, regulate the body-water balance, help bones and teeth formation, and also involved in enzymatic reactions (Duran 2010 and Mendil 2010).

Fish is a good source of almost all the minerals present in seawater. Calcium and phosphorus account for more than 75% of the minerals in the skeleton. Besides forming a part of skeleton, phosphorus has many metabolic and physiological roles in fish. There are two main categories of essential minerals required for survival. Minerals occurring in appreciable amounts are called microelements, and those found in minute quantities are called trace elements or microelements.

Macrominerals include calcium, potassium, sodium, magnesium, chloride, and phosphorus. Humans need a minimum of 100 mg a day (Kommuri et al., 2021). About 65% of fish minerals are deposited in the bone. Generally, fish can absorb and assimilate these essential nutrients from the harvested water where they live in or from available diet (Lal and Tibbettes 2009).

Fish is important for a healthy diet. It is now widely known how valuable fish is as a source of complete, well-balanced, and easily digestible protein. In addition to being an excellent source of high-quality protein, fish is also commonly recognised as a nutritious diet and contains several other nutrients. It is essential to comprehend the metabolic makeup of fish in this perspective.

Materials and methods

Study area and sample collection

The experimental fish were collected from Visakhapatnam fishing harbour (Lat: 17°.729" N and Long: 83°.219" E), located in the north east coast of Andhra Pradesh, India. It has a long coastline, that stretches about 132 km long and has significant economic activity. The samples were collected in fresh condition and took in a sterile zipper polythene bag and stored in an ice box. Then, immediately the samples in an ice box were transported the Department of Marine Living Resources, Andhra University, Visakhapatnam. The samples were stored in – 20 ^{O}C refrigerator until analyzed.

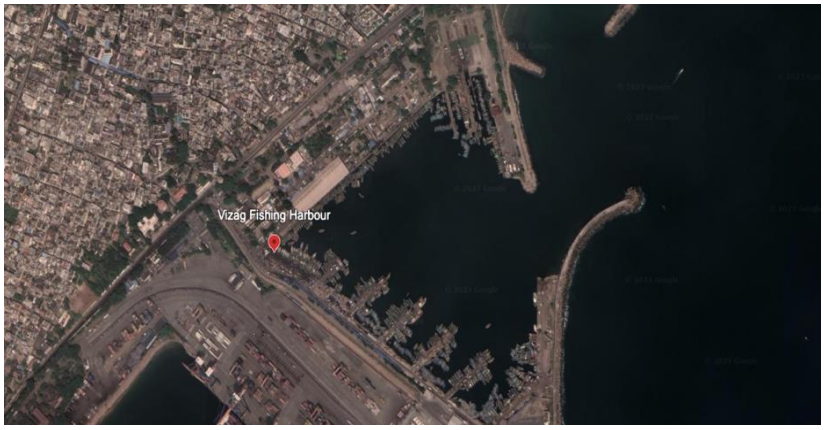

Fig 1. Map showing sampling station of Visakhapatnam fishing harbour

Sample preparation

Fish samples were prepared for proximate compositions analysis in a triplicate fashion at laboratories in Andhra University, and the average values were reported for each of the analyzed parameters. Firstly, the frozen samples were kept in room temperature for normal temperature and after that washed with deionized water to remove the impurities from the outer surface. These were then oven-dried at about 105 ◦C for overnight. The oven dried samples were grinded in a quartz mortar with a pestle and collected to store at - 4 ◦C for further analysis.

Proximate composition analysis

For this study, triplicate samples of 180 of dolphinfishes (*Coryphaena hippurus*) were analyzed. All the samples were pooled and required amount of the sample was taken. The following parameters were determined, which include crude protein, crude lipid, moisture, and total ash, by using the standard methods (AOAC, 2005). A dry weight basis was used to report the results of the determinations made in triplicate for each chemical analysis.

Moisture content

The amount of moisture in the species was determined according to AOAC (Association of Official Analytical Chemists). In a hot air oven, samples were dried at 60°C until persistent weights have been obtained, cooled, and reweighed in a desiccator. The variance between fresh and dry weights was assumed to be moisture content.

Crude protein content

The estimation of the samples of total nitrogen content was done using the Kjeldahl method (AOAC). The amount of crude protein was calculated by multiplying the total nitrogen result by using a 6.25 conversion factor. The samples went through the three necessary digestion stages: digestion, distillation, and titration. The protein percentage in the samples was determined accordingly.

Lipid content

Crude lipid was determined by weighing 5 g of each sample wrapped in a filter paper in a Soxhlet apparatus using petroleum ether. This was done each for 4 hours. The extracted materials left after the solvent had evaporated were weighed, and the fat content was calculated.

Ash content

Dried samples obtained during the determination of the moisture content process were heated in a muffle furnace at 600°C a few hours long. By subtracting the ash weight from the original weight, the percentage of ash was calculated.

Mineral analysis

Moisture free fish sample was used for the preparation of the ash solution. The mineral compositions of the samples were measured using the Spectrophotometric method of atomic absorption (AOAC, 2005).). The collected muscle tissue from the fish 2 g of sample was placed in digestion tubes with concentrated HNO_3 was added and kept for overnight for the estimation of minerals. This was continued with $HClO_4$. The analysis of Na, K, Ca and Fe was performed by flame Atomic Absorption Spectrophotometry.

Results and Discussion

In the present investigation deals with proximate analysis of four major components viz., moisture, protein, lipid and ash of the muscle tissue of *Coryphaena hippurus* during the present study exhibited a well- marked seasonal variation. Several studies have been done to establish the proximate body composition in fish (Craig, 1977; Ali et al 2005; Aberoumad and Pourshafi, 2010; Naeem 2011), and results from some of these have been used to establish the nutritional requirements in fish (Tidwell et al., 2010; Okumu and Mazlum, 2002). The proximate composition of fish muscle *Coryphaena hippurus* were represented in Table 1 respectively.

Moisture content is a crucial component of all living systems and contributes significantly to their essential properties. In this study, we found that the moisture content (%) of dolphinfish were observed in the ranges from 73.97±0.04 to 77.18±0.07. In month wise observation, the abundant moisture content was observed in the month of May (77.18±0.07) followed by October (76.82±0.08) and June (76.32±0.19), lowest was observed in the month of February with 73.97±0.04. The total mean values of moisture percentage were observed as 75.14±0.08. The values obtained in the present study are comparable with the moisture content (%) estimated for dolphin fish caught in the Pacific Ocean with its range from 77.8-80.3 with the mean values of 79.3 (Boiteanu, et al., 2014). Lower value (72.94%) compared to the dolphin fish caught from Indonesia (Thenu et al., 2017). Similar results were observed in tuna fishes in Visakhapatnam (Rani et al., 2016), These findings are consistent with the literature, which states that the moisture content of freshwater fish ranges from 70 to 80 % (Clucas & Ward, 1996). The variation in moisture content among species may be attributed to differences in season, age, sex, and feeding habits.

Results clearly indicated that the marked fluctuation of protein in all the months in the species. In the present study, the crude protein content of the *Coryphaena hippurus* were observed from the range of 16.21±0.04 to 23.04±0.01. Highest protein content was observed in month of February with 23.04±0.01 followed by 22.54±0.02 in the month of November. The lowest protein content was recorded in the month of July 16.21±0.03, followed by 17.73±0.04 month of October. Mean values of the total protein content were 19.91±0.01. The muscle tissue of composition of dolphin fish revealed that the mean value of 19.91% indicating that the dolphin fish can be considered as a good table fish (Viji et al., 2015). The present results were little higher than the earlier reports (19.3%) in the Arabian Sea (Assana et al., 2020) and Indonesia 19.16% (Thenu et al., 2017).

Lipids are the primary energy storage material in fish. Thus the lipid content of a fish indicates the surplus energy available for future maintenance, growth and reproduction (Adams, 1999, Tocher, 2003). The fat content of the dolphinfish varied from 0.26±0.07 to 2.76±0.01. For month wise, highest fat accumulated more in the month of November (2.76±0.01) followed by October with 2.65±0.01. The lowest fat content was observed in the month of March (0.26±0.07) followed by August (0.53±0.01). The total mean values of fat percentage accumulated in the entire year were 1.37±0.01. The average lipid value of 1.37% which was significantly high compared to the dolphin fish caught from Pacific waters 0.9% (Boiteanu *et al.,* 2014), and lower value compared to the *C. hippurus* from Indonesia (2.05%), and Arabian Sea 1.73% (Thenu et al., 2017 & Assana *et al.,* 2020).

In the current study, the ash content of the dolphinfish ranged from 1.23±0.02 to 2.7±0.05. In the month wise observation, highest ash content was observed in the month of July (2.52±0.01) followed by February (2.52±0.01). Lowest ash content was noticed in the month of April (1.23±0.02), followed by December (1.54±0.02). The total mean values of ash percentage was observed as 2.02±0.01. The findings of this study indicated that the mean ash content 2.02% was recorded for dolphin fish is higher than the Arabian Sea 0.89% (Assana et al., 2020), from Indonesia (Thenu et al., 2017) and Pacific Ocean 1.4% (Boiteanu et al., 2014).

Minerals are essential for growth, bone mineralisation, reproduction and energy metabolism in all living organisms. The major portion of minerals in fish body are concentrated in muscle, scale and vertebrae (Lall, 2002). The prominence of each mineral element in body tissue is closely related to its functional role. In dolphin fish, the content of potassium (K) was much higher than that of calcium, sodium, and iron among the mineral elements examined. The minerals investigated in this study are thought to be significant dietary components because they support the body's normal operation (Pye, 1986).

Among the minerals determined in the present study potassium (16.94±0.21) is the most abundant one in the dolphin fish muscle tissue followed by sodium (12.63±0.34), calcium (6.80±0.53) and Iron (4.72±0.48). The findings of the present study are consistent with information from earlier investigations. (Kosanovic et al., 2007; Younis et al., 2011, Kumar et al., 2014). Most of the trace elements found in terrestrial vertebrates are also detected in fish tissues (Hardy et al., 1984). Although the elemental composition of marine organisms are available, there are very few studies on the proximate and mineral composition of *Coryphaena hippurus*. The results of the minerals analysed in the muscle tissue of dolphin fish indicated that this species represents a good source of essential minerals.

Acknowledgement
Authors are gratefully acknowledge to the Head, Department of Marine Living Resources, Andhra University for providing the facilities to carry out this work. The authors would even be grateful to the CMFRI, Visakhapatnam for assisting in the sample collection and providing the laboratory facilities.

Reference:

1. Aberoumad A And Pourshafi K (2010). Chemical And Proximate Composition Properties Of Different Fish Species Obtained From Iran. World Journal Of Fish And Marine Science, 2 (3): 237 – 239.
2. Aneesh, P.A., Jones Varkey, Anandan, R., Suseela Mathew, Asha, K.K., Lakshmanan, P.T. And Sankar, T.V. (2012). Proximate Composition, Amino Acid And Fatty Acid Profiles Of Commerson's Anchovy (Stolephorus Commersonii) And Indian Mackerel (*Rastrelliger Kanagurta*), Biochem. Cell. Arch. 12(2):371-376.
3. Ashwinikumar, Sanjeev Kumar, Kannan, D, Baburao, Thirunavukkarasu, P And Soundrapandiyan, P (2014). Evaluation Of Nutrients In Trash Fish, Parangepettai (South East Coast Of India). International Journal Of Research In Fisheries And Aquaculture, 4(2): 82-85.
4. Assana, K., Rajesh, M., Rajesh, K. M., & Shaik, T. A. (2020). Length-Weight Relationship, Feeding Traits And Nutritional Value Of Mahi Mahi (*Coryphaena Hippurus*) In The South-Eastern Arabian Sea. Journal Of Environmental Biology, 41, 776-781.
5. BOIŢEANU, C. N., MANTHEY–KARL, M., KARL, H., MEYER, C., & SAVU, C. (2014). Proximate Composition, Microbiological Quality And Sensory Attributes Of Mahi-Mahi (*Coryphaena Hippurus*) And Emperor Sea Bream (Lethrinus Spp.) Fillets Sold On Retail Market. Bull. UASVM Food Sci. Tech, 71, 89-95.
6. Chrisolite, B., Shanmugam, S. A., Vijayarahavan, V., Sathish Kumar, K., & Kaliyamurti, V. (2016). Nutritional Profiling And Seasonal Variation In The Proximate Composition Of Emperor Fish (*Lethrinus Lentjan*) From Thoothukudi Coast Of Tamil Nadu, India, Fishery Technology, 53: 238–244.
7. Clucas, I. J., & Ward, A. R. (1996). Post-Harvest Fisheries Development: A Guide To Handling, Preservation, Processing And Quality. Natural Resources Institute.
8. Craig JF. (1977). The Body Composition Of Adult Perch, Perca Fluviatilis In Windmere, With Reference To Seasonal Changes And Reproduction. Journal Of Animal Ecology, 46 (2): 617 – 632.
9. Duran, A., Tuzen, M. And Soylak, M. (2010). Trace Element Concentrations Of Some Pet Foods Commercially Available In Turkey. Food And Chemical Toxicology, 48(10): 2833-2837.
10. Ersoy, B., And Özeren, A. (2009). The Effect Of Cooking Methods On Mineral And Vitamin Contents Of African Catfish. Food Chemistry, 115(2): 419-422.
11. Hardy, R. W., Shearer, K. D. And King, I. B. (1984). Proximate And Elemental Composition Of Developing Eggs And Maternal Soma Of Pen-Reared Coho Salmon (*Oncorhynchus Kisutch*) Fed Production And Trace Element Fortified Diets. Aquaculture, 43: 147–165.
12. Jayarani, R., Vijayan, D. K., Anas, K. K., Mathew, S., Ravishankar, C. N., & Anandan, R. (2018). Proximate Composition And Ω-3 Fatty Acid Profiling Of Two Deep Sea Fish Species Collected From Indian Coasts, International Journal Of Fisheries And Aquatic Studies, 6(4): 291-294.
13. Kommuri, P. K., Mugada, N., & Kondamudi, R. B. (2018). Fourier Transform Infrared (FTIR) Spectroscopy Study Of Spiny Lobsters From Visakhapatnam Coast, Andhra Pradesh, India, International Research Journal Of Pharmacy, 9(12):96-99.
14. Kommuri, P. K., Mugada, N., & Kondamudi, R. B. (2021). Proximate Analysis And Mineral Composition Of Commercially Important Spiny Lobsters From Visakhapatnam Coast, Andhra Pradesh, India. Asian Journal Of Fisheries And Aquatic Research, 14(2), 39-47.
15. Kongsbak, K., Thilsted, S. H., & Wahed, M. A. (2008). Effect Of Consumption Of The Nutrient-Dense, Freshwater Small Fish Amblypharyngodon Mola On Biochemical Indicators Of Vitamin A Status In Bangladeshi Children: A Randomised, Controlled Study Of Efficacy. *The British Journal Of Nutrition*, 99(3), 581–597.
16. Lal, S.P. And Tibbettes, S.M. (2009). Nutrition, Feeding, And Behaviour Of Fish. Veterinary Clinics Of North America: Exotic Animal Practice, 12(2), 361-372.
17. Lall, S. P. (2002). The Minerals. In: Halver, J. E. And Hardy, R.W. (Eds.), Fish Nutrition, 3rd Edn. San Diego, CA, Academic Press Inc., P. 259–308.
18. Love, R.M. (1980). The Chemical Biology Of Fishes. Brown, M.E. (Ed.), Academic Press. New York, U.S.A. 2: 547-551.

19. Mendil, D., Demirci, Z., Tuzen, M. And Soylak, M. (2010). Seasonal Investigation Of Trace Element Contents In Commercially Valuable Fish Species From The Black Sea, Turkey. Food And Chemical Toxicology, 48(3): 865-870.
20. Naeem, M., Rasul1, A., Salam, A., Iqbal, S, Ishtiaq, A., Khalid, M. And Athar, M. (2011). Proximate Analysis Of Female Population Of Wild Feather Back Fish (Notopterus Notopterus) In Relation To Body Size And Condition Factor. African Journal Of Biotechnology, 10: 3867-3871.
21. Nurnada, A.A., Azrina, A., Amin, I., Mohd Yunus, A.S. And Mohd Izuan Effendi, H. (2013). Mineral Contents Of Selected Marine Fish And Shellfish From The West Coast Of Peninsular Malaysia, International Food Research Journal, 20 (1): 431– 437.
22. Okumu T I And Mazlum MD. (2002). Evaluation Of Commercial Trout Feeds: Feed Consumption, Growth, Feed Conversion, Carcass Composition And Bio-Economic Analysis. Turkish Journal Of Fisheries And Aquatic Sciences, 2: 101-107.
23. Padmavati, G. (2017). Proximate And Elemental Composition Of Stolephorus Commersonnii (Lacepede, 1803) From The Coastal Waters Of South Andaman.
24. Palanikumar, M, Rubaannathai, A, Jeyashakila, R And Shanmugam, SA (2014). Proximate And Major Mineral Composition Of 23 Medium Sized Marine Fin Fishes Landed In The Thoothukudi Coast Of India. J Nutr Food Sci 4: 259. 1-7.
25. Pye M. (1986). Success In Nutrition. John Murray Ltd, London.
26. Rani, P. S. C. H. P. D., Kumar, V. P., Rao, K. R., & Shameem, U. (2016). Seasonal Variation Of Proximate Composition Of Tuna Fishes From Visakhapatnam Fishing Harbor, East Coast Of India. *International Journal Of Fisheries And Aquatic Studies*, 4(6), 308-313.
27. Rushinadha Rao, K., Viji, P., Sreeramulu, K. And Sreedhar, U. (2016). Proximate Composition And Heavy Metal Accumulation In Deep Sea Crustaceans From Selected Stations In The Indian EEZ, *Fish. Technol.*, **53:** 155-161.
28. Sivaraman, G.K., Renuka, V., Jha, A.K. , Susmitha, V., Sreerekha, P.R, Vimaladevi, S., Asha, K.K., Anandan, R., Suseelamathew And Mohanthy, B.P. (2016). Proximate Composition And Fatty Acid Profiling Of Four Marine Fish Species Of Gujarat Coast, *Fish. Technol.* 53(4):326–329.
29. Sreelakshmi, K. R., Manjusha, L., Vartak, V. R. And Venkateswarlu, G. (2016). Variation In Proximate Composition And Fatty Acid Profiles Of Mud Crab Meat With Regard To Sex And Body Parts. *Indian J. Fish*., 63(2): 147-150.
30. Srilatha, G., Chamundeeswari, K., Ramamoorthy, K., Sankar, G., & Varadharajan, D. (2013). Proximate, Amino Acid, Fatty Acid And Mineral Analysis Of Clam, Meretrix Casta (Chemnitz) From Cuddalore And Parangipettai Coast, South East Coast Of India. J. Mar. Biol. Oceanogr, 2(2), 2324-86.
31. Thenu, J. L., Lokollo, E., & Wenno, M. R. (2017). Chemical Compositions And Amino Acids Of Dolphin Fish (Coryphaena Hippurus) Roes. In Pattimura Proceeding: Conference Of Science And Technology, Pp. 077-082.
32. Tidwell JH, Coyle S, And Bright LA. (2010). Effects Of Different Types Of Dietary Lipids On Growth And Fatty Acid Composition Of Largemouth Bass. North American Journal Of Aquaculture 69:40-50.
33. Tripathi, S. H., Roos, N., & Hasan, N. (1997). The Role Of Small Indigenous Fish Species In Food And Nutritional Security In Bangladesh. NAGA News Letter, July-December. 13 Pp. Trout: Assessment Of Pyceze As An Antifungal Control Agent For Both Fish And Ova. Diseases Of Aquatic Organisms, 36, 129-141.
34. Vijayan, D.K., Jayarani, R., Singh, D.K., Chatterjee, N.S., Mathew, S., Mohanty, B.P., Sankar, T.V. And Anandan, R. (2016). Comparative Studies On Nutrient Profiling Of Two Deep Sea Fish (Neoepinnula Orientalis And Chlorophthalmus Corniger) And Brackish Water Fish (Scatophagus Argus). The Journal Of Basic And Applied Zoology, 77: 41-48.
35. Viji, P., Tanuja, S., Ninan, G., Lalitha, K. V., Zynudheen, A. A., Binsi, P. K., & Srinivasagopal, T. K. (2015). Biochemical, Textural, Microbiological And Sensory Attributes Of Gutted And Ungutted Sutchi Catfish (*Pangasianodon Hypophthalmus*) Stored In Ice. Journal Of Food Science And Technology, 52, 3312-3321.