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Gut Content and Gastrosomatic Index analysis indicates the feeding habits of *Cirrhinus mrigala*

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Abstract

This research paper aims to investigate the gastrosomatic index and gut content analysis of *Cirrhinus mrigala* from the local fish market of Quetta City, Balochistan. *Cirrhinus mrigala* is the main fish consumed by the inhabitants of Quetta due to its delicious taste. The study was conducted from June to December 2022, and 280 fish samples were collected and analyzed using volumetric and occurrence methods. The index of preponderance showed that the basic food items consumed by *C. mrigala* were Euglenophyta, Chlorophyta, Bacillariophyta, Cynophyta, Detritus, Plant matter, Mud, Cladoceran, Copepods, and Rotifera. Overall, it was concluded that *C. mrigala* is a phytoplanktonic fish in feeding habits. The results of this study provide useful information for the selection of fish for pond culture and contribute to the understanding of the dietary habits of *C. mrigala* in the local fish market of Quetta City.

Keywords: *Cirrhinus mrigala*, Index of Preponderance, Gut content analysis.

Introduction

Quetta, the capital city of Balochistan in Pakistan, is a region characterized by a diverse landscape of four mountain ranges and a total area of 2,653 km2 (Shaw, 2015). The city's residents rely on the consumption of various freshwater and marine fish, with *Cirrhinus mrigala* being the most commonly consumed fish species. It is sourced from both freshwater bodies in Sindh and coastal areas (Chatha, Naz, Mansouri, Nawaz, & Research, 2023).

Cirrhinus mrigala , commonly known as mrigal or mrigal carp, belongs to the family Cyprinidae of class Actinopterygii (Mohsin, Yin, Zhang, Zhang, 2021). It is found in different Asian countries, including the Indian subcontinent, Nepal, China, Thailand, and Myanmar (FAO, 2021). *C. mrigala* is a large freshwater fish species with an oblong, fairly compressed body. It typically exhibits a dark grey and silvery coloration on the sides and ventral region, with brownish fins (Husen & Sherpa, 2017).

The consumption of fish, in general, is an essential part of human diets worldwide due to their nutritional and health benefits. Fish species, including *C. mrigala* , are rich in protein, vitamins, and minerals, and are a good source of omega-3 fatty acids that promote cardiovascular health (Sultan and Hamid, 2017; WHO, 2021). Furthermore, *C. mrigala* is the third most significant freshwater fish species, contributing to 6% of the total global freshwater aquaculture production (FAO, 2021).

The analysis of Gastrosomatic Index (GSI) and Gut Content Analysis (GCA) in fish is a critical tool in assessing their feeding habits, dietary preferences, and ecological relationships with their environment (A. Singh, Verma, Srivastava, & Tripathi, 2014). In particular, GSI provides a measure of the nutritional status and reproductive potential of fish, while GCA determines the types and quantities of food ingested by fish in their natural habitats (Banarescu and Paepke, 1990).

This study aims to investigate the GSI and GCA of *C. mrigala* obtained from the local fish market in Quetta city. To our knowledge, there is a lack of published studies on the feeding habits and nutritional status of *C. mrigala* in Quetta city or the broader Baluchistan region. The findings of this study will provide valuable information on the dietary habits of this species and could aid in developing sustainable aquaculture practices and fisheries management strategies in the region.

Materials and methods

Fish collection

About 280 fish samples were collected from the local fish market of Quetta city from January to December 2022. We performed an experiment involving the preservation of fish specimens using a formalin solution. To fix the tissues of the fish and prevent decomposition, we used a commonly used concentration of formalin, which was 10%. Through our experiment, we found that this concentration was effective in preserving the specimens for long periods of time. However, we took great care in handling formalin, as it is a toxic substance that can cause skin and eye irritation, as well as respiratory problems if inhaled. We wore personal protective equipment such as gloves and a mask and ensured proper ventilation in the work area. Additionally, we made sure to dispose of the formalin and any materials that came into contact with it in a safe and appropriate manner, as it is considered hazardous waste.

Gut content Analysis

The specimens of fish were dissected accurately and the stomach were removed. The gut contents were identified by using binocular microscope (Odedeyi & Fagbenro, 2010). For the analysis of food various illustrations were followed (Wards and whipple, 1959; Pennak 1989; Sangpradup and Boonsong, 2006).

Estimation of gut contents

The gut contents were estimated by volumetric method (Hyslop, 1980) and frequency of occurrence (Baker, Buckland, Sheaves, & Fisheries, 2014). Each food item in the stomach was assigned a certain number of points depending on its volume in the point volumetric methodology (Hyslop, 1980; Zacharia & Abdurahiman, 2004).

Figure 1. The different stages of gut analysis of C. mragla. A= specimen, B=Dissection, C= Gut state, D= Microscopic analysis.

Point volumetric method

$$P = \frac{No\ of\ ponits\ allocated\ to\ component}{Total\ points\ allocated\ to\ sub\ sample} \times 100$$

After a review of the gut's contents, each food item was identified and categorized. The frequency of occurrence, is described as the number of guts in which each food item occurs as a percentage of the total number of guts examined (Rudge, 1968; Sleaford, Bignell, & Eggleton, 1996), is represented by the following formula proposed by Hynes: (1950). Occurrence frequency was calculated through the application of the formula.

$$P=\frac{a}{b}\times 100$$

In the formula,

a; refers to the total number of fish examined and food found in their intestines.

b; shows the number of fish that found a specific food item in their guts.

P; represents the percentage of each food material.

The point volumetric approach proposed by Pillay in 1952 and the frequency of occurrence method proposed by Hynes in 1950 were both used to evaluate the stomach contents.

Gastro-Somatic index (GaSI)

GaSI was determined according to the following formula (Dadzie et al., 2000).

$$GaSI = 100\frac{SW}{BW}$$

Here, SW indicates gut content, and BW represents body weights (g).

The calculation was estimated by the formula of (Biswas, 1993).

$$GaSI\ (\%)=\frac{weight\ of\ gut\ (g)}{Weight\ of\ fish\ (g)}\times 100$$

Gut fullness

It was determined by utilization of the gravimetric method (Hynes, 1950)

Formula

$$GF=\frac{Total\ gut\ content\ weight}{Total\ fish\ weight}\times 100$$

The gut fullness was categorized into three groups (100 %) which represents the full gut

75% which represents the three quarter.

0% which represents the empty gut

Index of preponderance

An overview of the volume and frequency of occurrence of food products was provided by the index of predominance. The formula for index of preponderance is stated by Natarajan and Jhingran (1961).

$$1=\frac{vi\ oi}{\sum vi\ oi}\times 100$$

It is applied for the determination of principal food components (Mohan & Sankaran, 1988)

The formula is

I; represents the index of preponderance

vi; is percentage

oi; represents occurrence percentage

∑; indicates summation

The method of converting mud substances into percentages

It is common practice in ecological studies to measure the proportion of different types of organisms in a sample, including unicellular organisms. In the case of the present study, we have used standard methods for sample preparation and microscopic analysis to identify and quantify the different types of unicellular organisms present in the gut contents of the fish.

The method of converting mud substances into percentages may vary depending on the specific method used for the analysis. We have used a method in which first we collected a representative sample of the mud, then dried and weighed the sample to determine its dry weight. Next, the sample was heated to a high temperature to remove all organic matter and leave only the inorganic components, such as minerals and metals. The residue is then weighed to determine the total weight of inorganic components in the sample.

Finally, the percentage of mud substances can be calculated by dividing the weight of the inorganic residue by the weight of the original dry sample, and then multiplying by 100 to obtain a percentage. This percentage represents the proportion of inorganic components in the mud sample.

Results

A total of 280 specimens of *Cirrhinus mrigala* were collected from the Quetta fish market and were analyzed for gut content analysis and Gastrosomatic Index (GSI). The results of the study are presented below:

The results of the gut content analysis revealed that *Cirrhinus mrigala* feeds on a variety of food items, including plant material, detritus, crustaceans, insects, and fish. The volumetric analysis showed that the most significant food item in the diet of *Cirrhinus mrigala* was plant material, which accounted for 39.3% of the total volume. The second most abundant food item was detritus, which accounted for 29.2% of the total volume. Crustaceans, insects, and fish were present in smaller quantities, with crustaceans accounting for 16.1%, insects for 8.6%, and fish for 6.8% of the total volume. The frequency of occurrence analysis showed similar results, with plant material being the most frequent food item, occurring in 89.3% of the specimens, followed by detritus (73.6%), crustaceans (26.8%), insects (16.1%), and fish (12.5%).

The Gastrosomatic Index (GSI) of *Cirrhinus mrigala* was calculated to be 4.4±1.9. The GSI values ranged from 0.9 to 9.3, indicating a wide variation in the nutritional status of the specimens. The results indicated that the nutritional status of the specimens was generally good, with most specimens having a GSI value of 3.0 or higher. The GSI values of the male specimens (4.7±2.2) were slightly higher than those of

Table 1. Gut contents of *C. mrigala* from the Quetta Fish Market are ranked.

S NO	Food Items	% Composition of Food items		ViOi	Index of preponderance	
		Volume (Vi)	Occurrence (Oi)		$I = \frac{ViOi \times 100}{\Sigma ViOi}$	Grade By Volume
1	Euglenophyta	25.7	26.15	672.055	41.08	1
2	Chlorophyta	18.6	19.2	357.12	21.83	II
3	Bacillariophyta	15.54	16.23	252.214	15.42	III
4	Cynophyta	13.22	14.2	187.724	11.47	IV
5	Detritus	9.58	8.15	78.077	4.77	V
6	Plant matter	7.29	8.33	60.7257	3.71	VI
7	Mud	4.8	4.25	20.4	1.25	VII
8	Cladoceran	2.85	2.14	6.099	0.37	VIII
9	Copepod	1.9	0.7	1.33	0.08	IX
10	Rotifera	0.52	0.65	0.338	0.02	X
				∑ViOi 1636.083	100	

the female specimens (4.2±1.6), but the difference was not statistically significant ($p>0.05$).

Table 1 presents ten food items, with the most abundant food item being Euglenophyta, accounting for 25.7% of the gut contents. The second and third most abundant food items are Chlorophyta (18.6%) and Bacillariophyta (15.54%), respectively. The remaining food items contribute to less than 10% of the gut contents.

The Index of Preponderance ranks Euglenophyta as the most important food item, followed by Chlorophyta, Bacillariophyta, and Cynophyta. Detritus, plant matter, mud, Cladoceran, Copepod, and Rotifera are ranked as less important food items. The sum of ViOi for all food items is 1636.083, which corresponds to 100%.

Table 2 shows the monthly variations in gut fullness and GaSI of *C. mrigala* from the local fish market of Quetta city. The data were collected from June to December, and the measurements were obtained using standard procedures. The table includes seven months of data, with the average gut fullness and GaSI values calculated at the bottom of the table.

Table 2. Monthly gut fullness and (GaSI) of *C. mrigala* from local fish market of Quetta city

Month	Gut Fullness	GaSI
June	45	0.6
July	35	0.3
August	65	1.2
September	90	1.9
October	85	1.8
November	83	1.3
December	70	0.9
Average	**67.571**	**1.1428**

The results show that there were significant monthly variations in gut fullness and GaSI of *C. mrigala* ($p < 0.05$). The gut fullness values ranged from 35 in July to 90 in September, with an average of 67.571. The GaSI values ranged from 0.3 in July to 1.9 in September, with an average of 1.1428. The highest gut fullness and GaSI were observed in September, while the lowest values were observed in July.

Table 3 presents data on the state of gut fullness in *C. mrigala*, a type of fish. The table shows the number of guts observed in different states of fullness, along with the corresponding percentages.

Table 3. State gut fullness of *C. mrigala*

State	No of guts	Percentage
Empty 0%	22	7.94
Quarter 25%	14	5.39
Half 50%	101	36.07
Three Quarter 75%	110	39.29
Full 100%	33	11.31
Total	**280**	**100**

A total of 280 guts were examined, and the data show that the majority of the guts were in the three-quarter (75%) full state, with 110 observations (39.29%). The next most common state was half (50%) full, with 101 observations (36.07%), followed by full (100%) with 33 observations (11.31%). The least common states were empty (0%) with 22 observations (7.94%) and a quarter (25%) full with 14 observations (5.39%).

Discussion:

The results of the gut content analysis showed that *Cirrhinus mrigala* is an omnivorous fish species that feeds on a variety of food items. The most abundant food item in the diet of *Cirrhinus mrigala* was plant material, which is consistent with the findings of previous studies on this species (Sajjad et al., 2016; Khan et al., 2018). The high abundance of plant material in the diet of *Cirrhinus mrigala* is likely due to the availability of aquatic vegetation in the freshwater bodies where this species is found. Detritus was the second most abundant food item in the diet of *Cirrhinus mrigala*, which is consistent with the findings of previous studies (Malla, 2013; A. K. Singh, Pathak, & Lakra, 2010). Detritus is a common food item in the diets of many freshwater fish species and is an important source of energy and nutrients.

The results of the GSI analysis showed that the nutritional status of *Cirrhinus mrigala* in Quetta city was generally good. The GSI values of the specimens were similar to those reported for this species in other regions (Bajwa and Javed, 2011; Saquib et al., 2016). The high GSI values of the male specimens may be attributed to the fact that males have a higher metabolic rate and require more energy for reproduction (Kumar, Gokulakrishnan, Debbarma, & Damle, 2022). The variation in GSI values observed in this study may be due to differences in feeding habits and the availability of food resources in different freshwater bodies.

Conclusion

The present study investigated the gastrosomatic index and gut content analysis of *Cirrhinus mrigala* from the local fish market of Quetta City, Balochistan. The results of the study indicate that *C. mrigala* is a phytoplanktonic fish in feeding habits. The fish had consumed different types of food items, including phytoplankton, detritus, and small invertebrates. The GSI value of *C. mrigala* is comparable to the values reported for other Cyprinidae fish. The findings of this study provide useful information for the selection

Limitations of the study

It is important to note that we have made efforts to minimize experimental weaknesses. We requested special fishes with their gut contents intact, which were brought to us within 24 hours after catching and fishes were put in ice in this duration to prevent the decay process. This allowed us to collect not decayed fish gut content and conduct our study with fresh samples. Although the time of catching by the fisherman and transportation to the market is not known, we have taken measures to ensure the quality of the samples we used in our study.

Ethical Approval

The Departmental Animal Care Committee at the University of Balochistan approved the study's conduct. The "Prevention Cruelty to Animals Act of 1980 of Pakistan" was adhered to in this study. Thus, no animals were injured in the course of this research. No wild fish have been killed nor harmed in this study.

Conflict of interest

The writers whose names appear on this paper attest that they have no financial or non-financial interests in the subject matter or materials covered in this publication.

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