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Food composition of diamondback puffer *Lagocephalus guentheri* Miranda Ribeiro, 1915 from the northeastern Mediterranean Sea

Kuzeydoğu Akdeniz'den elmas sırtlı balon balığı *Lagocephalus guentheri* Miranda Ribeiro, 1915'in besin kompozisyonu

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ABSTRACT

Stomach content analysis of fish not only helps document their food spectrum but also provides an overview of the food network they are involved in. In this study, we aimed to investigate the food composition of *L. guentheri* from the Iskenderun Bay, northeastern Mediterranean Sea. Specimens were collected between January 2022 and August 2022. A total of 215 *L. guentheri* specimens stomachs were examined during the study for stomach content analysis. All stomachs were analyzed, 60 (27.9%) were empty and 155 (72.1%) contained food items. Analysis of diet composition showed that the species is carnivorous and prey on teleosts, crustaceans, bivalves and cephalopods. When the food composition of the samples is analyzed numerically, teleost was the most important prey (68%), followed by crustaceans (14%), bivalves (5%), cephalopods (0.5%) and unidentifiable materials (12.5%). Bony fish species such as *Plotosus lineatus*, *Parupeneus forsskali*, *Saurida lessepsianus*, *Scorpaena sp.* and *Siganus sp*. were identified in the food composition. Therefore, it is thought that this species has a high feeding tendency towards bony fish species. This study increases the knowledge about the food composition of *L. guentheri* on the Mediterranean coast of Türkiye.

Keywords: Pufferfish, Food composition, Stomach content, Alien species

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ÖZET

Balıklarda mide içeriği analizi çalışmaları türün besin yelpazelerini belgelemeye yardımcı olur ve aynı zamanda dahil oldukları besin ağı ile ilgili genel bilgi sağlar. Bu çalışmada, kuzeydoğu Akdeniz'de İskenderun Körfezi'nde yakalanan *L. guentheri*'nin beslenme ekolojisi araştırılmıştır. Türe ait bireyler Ocak 2022 ile Ağustos 2022 tarihleri arasında yakalanmış ve çalışmada mide içeriği analizi için toplam 215 *L. guentheri* örneğinin midesi incelenmiştir. Analiz edilen tüm midelerin 60'ı (% 27.9) boş, 155'i (% 72.1) ise besin grubu içermektedir. Besin kompozisyonunun analizi sonuçları, türün etçil olduğunu ve kemikli balıklar, kabuklular, çift kabuklular ve kafadanbacaklıları avlağını göstermektedir. Örneklerinin besin kompozisyonu sayısal olarak incelendiğinde, kemikli balıkların en önemli av olduğu (% 68), bunu kabukluların (% 14), çift kabukluların (%5), kafadanbacaklıların (% 0.5) ve tanımlanamayan materyallerin (% 12,5) izlediği tespit edilmiştir. Besin kompozisyonunda *Plotosus lineatus, Parupeneus forsskali, Saurida lessepsianus, Scorpaena sp.* ve *Siganus sp.* kemikli balık türleri tanımlanmıştır. Bu nedenle bu türün kemikli balık türlerine karşı yüksek bir beslenme eğilimine sahip olduğu düşünülmektedir. Yapılan çalışma Türkiye'nin Akdeniz kıyılarındaki *L. guentheri*'nin besin kompozisyonu hakkındaki bilgileri arttırmaktadır.

Anahtar sözcükler: Balon balığı, Beslenme kompozisyonu, Mide içeriği, Yabancı türler

1. INTRODUCTION

Alien species have a negative impact on the Mediterranean Sea (Langeneck *et al.*, 2023). Biodiversity in the Mediterranean Sea has changed significantly since the opening of the Suez Canal in 1869 and the warming of the waters due to climate change (Turan *et al.*, 2016; Fitori *et al.*, 2021; Turan and Doğdu, 2022). Over 700 species of fish live in the Mediterranean Sea. These include at least 80 non-native migrants from the Red Sea and Indo-Pacific (Gurlek *et al.*, 2016; Turan *et al.*, 2022; Mutlu *et al.*, 2023). The eastern Mediterranean coast of Türkiye is one of the most important stopping points for alien fish species entering the Mediterranean Sea. To date, almost 100 alien fish species have been reported from the coast of Türkiye (Turan *et al.*, 2018; Karataş *et al.*, 2021).

Pufferfish is present in Turkish marine waters and is composed of seven species across four genera, namely *Lagocephalus lagocephalus, L. guentheri, L. sceleratus, L. suezensis, Sphoeroides pachygaster, Torquigener hypselogeneion*, and *Tylerius spinosissimus* (Erguden *et al.*, 2017; Doğdu *et al.*, 2021a; Doğdu and Turan, 2021; Bilecenoğlu and Yokeş, 2022). The diamondback puffer, *L. guentheri* Miranda Ribeiro, 1915 is found from the Indo-Pacific to the Red Sea and Southwest Atlantic. This species usually occurs in shallow waters (Froese and Pauly, 2023). In 2015, the first report of *L. guentheri* from the Mediterranean Sea was reported from Egyptian waters (Farrag *et al.*, 2016) and then the presence of the species in Türkiye was confirmed with a single record from Çandarlı Bay, Izmir in the northern Aegean Sea (Akyol and Aydın, 2016). After that, *L. guentheri* was recorded a second time in Türkiye from Iskenderun Bay (Ergüden *et al.*, 2017).

Pufferfish species have been declared an invasive alien species by the European Alien Species Information Network due to their damage to fisheries and also, they are non-commercial species (Doğdu *et al.*, 2021a). With its strong jaw structure and teeth, it causes great economic damage to small-scale fishermen and is targeted by fishermen. In addition, since it feeds on species of economic importance, it causes serious damage to the stock of native species (Yalnız *et al.*, 2017; Doğdu *et al.*, 2021b). Tetrodotoxin (TTX), a potent neurotoxin, is known to be extensively present in the body of the pufferfish species (Kosker *et al.*, 2019).

Knowledge of the food composition of species provides important information about the ecosystem and the relationships between species (Sivadas and Bhaskaran, 2009; Huang and Shao, 2022). This information can be used in the conservation of ecosystems and also it can be a key factor in the understanding of the interaction between species (Begum *et al.*, 2008; Braga *et*

al., 2012; Tonella *et al.*, 2018; Renjithkumar *et al.*, 2020). Food composition analysis of fish not only helps document their food composition but also provides an overview of the food network they are involved in. *L. guentheri* has no economic value, it is caught as by-catch and therefore there is no fishing pressure on it. To date, only one study on stomach content analysis of this species has been conducted in the Mediterranean (Gabel *et al.*, 2022).

In this study, we investigate the stomach content of *L. guentheri* from the Iskenderun Bay, northeastern Mediterranean Sea. The present paper is information on the diamondback puffer *L. guentheri* food composition on Mediterranean coast of Türkiye.

2. MATERIALS AND METHODS

Specimens were caught in Iskenderun Bay, between January 2022 and August 2022. All specimens were caught as bycatch by local trawlers. All specimens were individually placed in plastic bags and transported to the Molecular Ecology and Fisheries Laboratory in Iskenderun Technical University (Figure 1). A total of 215 specimens stomachs were examined.

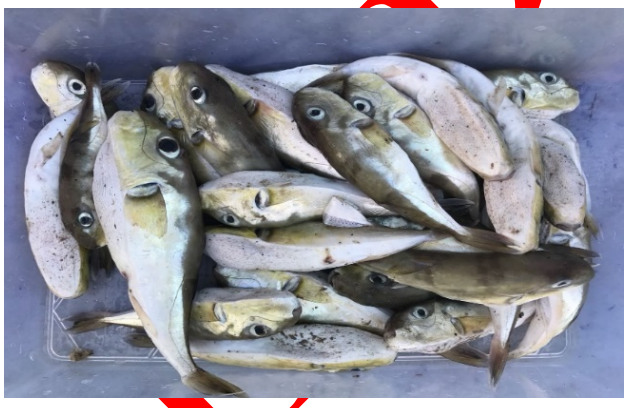

Figure 1. *Lagocephalus guentheri* specimens caught from Iskenderun Bay.

Body and stomach weights were measured with an accuracy of ± 0.1 g. The abdomens of the specimens, whose total length and body weights measured respectively, were carefully cut with scissors starting from the anus to the larynx without damaging the internal organs. Stomachs were removed from abdominal sectioning in the laboratory, weighed full and empty, and the food items in each stomach were identified to the lowest possible taxon using stereoscopy and light microscopy. Where identification is not possible due to further digestion, prey items were categorized as "unidentifiable". The number of empty stomachs was recorded. Food composition was grouped into major taxon categories; Decapoda, Mollusca, Cephalopoda and Teleost to facilitate dietary comparisons and eliminate biases associated with comparisons based on variable levels of identification (Cortes, 1997). Hyslop, (1980) and Kelleher *et al.*, (2000) were used to analyses the data obtained from stomach content analysis. These indices are;

Frequency of occurrence (I_{FO})

$$I_{FO} = \frac{n}{N_S} \times 100 \quad (1)$$

Catch percentage (I_P)

$$I_P = \frac{n'}{N_P} \times 100 \quad (2)$$

n is the number of stomachs containing a particular prey, N_s is the total number of stomachs analyzed, n' is the total number of individuals of a particular prey and N_p is the total number of prey individuals. According to I_P values, prey categories were divided into preferential (I_P > 50%) and secondary (10% < I_P < 50%) (Savva *et al.*, 2020; Tanrıverdi *et al.*, 2022).

Feeding activity was assessed using the void index (I_V), which means the percentage of empty stomachs according to the following equation (Hureau, 1970):

$$I_V = \frac{E}{T} \times 10 \quad (3)$$

E is the number of empty stomachs and T is the number of stomachs examined (Hureau, 1970).

The index of stomach fullness (I_{SF}) was calculated as an average of weights (g) of all prey items in the stomach divided by the average of the fish's total length (TL_{ort})

3. RESULTS

A total of 215 stomachs were examined during the study for food composition analysis. The analyzed index results are given in Table 1.

Table 1. Indexes obtained as a result of stomach content analysis of *L. guentheri*.

Index	%
Frequency of occurrence (I_{FO})	72.1
Void Index (I_V)	27.9
Catch Percentage of Fish (I_P)	68.0
Stomach Fullness Index (I_{SF})	0.40

As a result of stomach content analysis, frequency of occurrence index was 72.1%, catch percentage of fish 68%, void index 27.9% and stomach fullness index 0.40%. Analysis of the diet composition showed that the species are carnivorous and prey on teleost, cephalopods, crustaceans and bivalves. Teleost were identified as the most important prey (68%), followed by crustaceans (14%), bivalves (5%), cephalopoda (0.5%) and digested materials (12.5%) (Table 2). *Plotosus lineatus, Parupeneus forsskali, Saurida lessepsianus, Scorpaena* sp. And *Siganus* sp. Species were identified teleost species (Table 2, Figure 2).

Figure 2. *Plotosus lineatus* species detected in *Lagocephalus guentheri* stomach.

Table 2. General diet composition of *Lagocephalus guentheri* (%F= Frequency of occurrence, %N= Numerical presence; n: Number of stomachs).

Species	F%	N%	n
Decapoda			
Digested shrimps	7.74	7.50	12
Digested crab	9.68	6.50	15
Mollusca			
Bivalvia	5.16	5.00	8
Cephalopoda			
Sepia spp.	0.65	0.50	1
TELEOST			
Scorpaena spp.	5.16	12.50	8
Saurida lessepsianus	10.97	15.00	17
Parupeneus forsskali	14.19	13.50	22
Siganus spp.	5.16	4.00	8
Plotosus lineatus	23.87	17.00	37
Digested fish	5.16	6.00	8
Unidentifiable materials	12.26	12.50	19
Total	**100**	**100**	**155**

4. DISCUSSIONS

Pufferfish species have significant negative impacts on human health, biodiversity and fisheries (Ulman *et al.*, 2021). It is of great importance to reveal the diet composition of invasive species such as pufferfish (Aydın, 2011). The present paper provides information on the diamondback puffer *Lagocephalus guentheri* food composition in the Mediterranean Sea.

The vast majority of these fish that compose the diet composition are alien species. Interestingly, finding invasive venomous lessepsian species (*Plotosus lineatus*, *Siganus* sp. and *Scorpaena* sp.) among stomach content, shows the ability of *L. guentheri* to resist venom.

The contribution of other invertebrate groups to the species diet was comparatively low. Gabel et al. (2022) found similar results with our study in the analysis of the nutrient composition of *L. guentheri* in their study on the Mediterranean coast of Israel. When we look at the studies on other pufferfish; Sabrah et al., (2006) reported for *L. sceleratus* diet composition as 70% cephalopods (squids and cuttlefishes), 25%

crustaceans (particularly crabs) and 5% fishes from the Gulf of Suez Egypt. Aydın (2011) analyzed diet composition of the *L. sceleratus* from the Antalya Bay. According to the results of the study *L. sceleratus* species is carnivorous and the diet composes of 54% shrimps (Penaeidae), 17% crabs (Portunidae), 14% fishes 4% squids and cuttlefish (Cephalopods) and 11% others. Denadai et al., (2012) examined the diet composition of *L. laevigatus* from Brazil. According to the study *L. laevigatus* diet was composed of 60.49% Cnidaria, 20.24% fishes, 10.42% Amphipodaa and 8.73% crustacea. Mohamad and Isa, (2013) analysed the diet composition of the *L. lunaris* from the two sampling sites from Malaysia. According to the result of the study, *L. lunaris* diet was composed of prawns (36.3, 38.2%), fish (5.6, 11.2%), squids (0.7, 2.9%) and bivalves (0.1, 1.7%). Kumar *et al.,* (2013) analyzed the food items of the pufferfish species from the south Andaman Sea. According to the result of the study, *L. guetheri* species food items were determined as 41.81% Rock oyster, %21.81 Polychaetes, %16.36 micro alg, 12.72% Zooplankton, 7.27% seaweed pieces. Hussain *et al.,* (2020) reported the feeding habits of *L. sceleratus* in the Ain El-Ghazala lagoon and Derna Coast from the eastern coast of Libya. In their study, they found that the main diet was composed of molluscs (72.5%) supplemented by crustaceans (17.4%) and fishes (10.2%). In Derna Coast samples the main diet was fish (100%). Ulman *et al.,* (2021) reported the diet composition of *L. scelerétus* as 26% crustaceans, 24% fish and 11% cephalopods. Our results and other studies showed that the pufferfish is mainly carnivorous feeding on fish, crustaceans and cephalopods. Also, cannibalism has been reported in some species such of *L. sceleratus* (Ulman *et al.*, 2021).

5. CONCLUSIONS

In conclusion, the results show that pufferfish have a diversified diet that allows them to easily adapt to their new environment. This plays an important role in the inability to prevent the spread of the species. Our study is expected to make a great contribution to future research on this species and similar species. It is thought that it will be a source of important information about the food composition of the pufferfish species invading the Mediterranean Sea and will provide important data on the control and management of pufferfish.

AUTHORSHIP CONTRIBUTION STATEMENT

Servet Ahmet DOĞDU: Conceptualization, Methodology, Validation, Analysis, Resources, Writing - Original Draft, Writing-Review and Editing. **Cemal TURAN:** Methodology, Validation, Analysis, Resources, Writing - Original Draft, Writing-Review and Editing. **Funda TURAN:** Validation, Analysis, Resources, Writing - Original Draft, Writing-Review and Editing. **Ayşegül ERGENLER:** Analysis, Resources, Writing - Original Draft, Writing-Review and Editing.

CONFLICT OF INTERESTS

The author(s) declare that for this article they have no actual, potential or perceived conflict of interests.

ETHICS COMMITTEE PERMISSION

No ethics committee permissions is required for this study.

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