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CONTENT

Research Article
Turkish Journal of Maritime and Marine Sciences Volume: 5 Issue: 1 (2019) 8-16

The Seasonally Determination of Disc Diameter-Weight Relationship of Moon Jellyfish *Aurelia aurita* in the Black Sea Coasts of Turkey

Türkiye'nin Karadeniz Kıyılarındaki Ay Denizanası (*Aurelia aurita*)'nın Çap-Ağırlık İlişkisinin Mevsimsel Olarak Belirlenmesi

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 5 Sayı: 1 (2019) 8-16

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ABSTRACT

In this study, seasonal disc diameter-weight relationship of moon jellyfish (*Aurelia aurita*) were determined in the Black Sea coasts of Turkey. The samples of jellyfish were collected monthly from Sinop coasts in the southern Black Sea between December 2012 and November 2013 with plankton net. A total 1358 moon jellyfish were measurement in the study. Mean length and weight of all individuals were established, 8.3±0.10 cm and 43.2±1.58 g respectively. Disc diameter-weight relationship of moon jellyfish were calculated as $W_w=0.1207L^{2.5887}$ for general, $W_w=0.1251L^{2.5567}$ for autumn, $W_w=0.0815L^{2.7181}$ for winter, $W_w=0.1012 L^{2.6813}$ for spring and $W_w=0.1289L^{2.6844}$ for summer. The results showed that "a" and "b" value of moon jellyfish varied with seasons in the Black Sea coasts.

Keywords: Moon jellyfish, *Aurelia aurita,* Disc diameter-weight relationship, Season, Black Sea

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ÖZET

Bu araştırmada Türkiye'nin Karadeniz kıyılarındaki ay denizanası (*Aurelia aurita*)'nın mevsimsel olarak çap-ağırlık ilişkileri belirlenmiştir. Denizanası örnekleri aylık olarak Aralık 2012-Kasım 2013 tarihleri arasında Güney Karadeniz'in Sinop kıyılarından plankton ağı ile toplanmıştır. Çalışmada 1358 adet denizanasının çap ve ağırlığı ölçülmüştür. Tüm denizanaları için ortama boy ve ağırlıkları 8.3±0.10 cm ve 43.2±1.58 g olarak tespit edilmiştir. Denizanalarının çap-ağırlık ilişikleri tümü için $W_w=0.1207L^{2.5887}$, sonbahar için $W_w=0.1251L^{2.5567}$, kış için $W_w=0.0815L^{2.718}$, ilkbahar için $W_w=0.1012\ L^{2.6813}$ ve yaz için $W_w=0.1289L^{2.6844}$ olarak hesaplanmıştır. Bu sonuçlar Karadeniz kıyılarındaki ay denizanasının "a" ve "b" değerlerinin mevsimsel olarak değiştiğini göstermiştir.

Anahtar sözcükler: Ay deniz anası, *Aurelia aurita,* Çap-Ağırlık ilişkisi, mevsim, Karadeniz

1. INTRODUCTION

The moon jellyfish *Aurelia aurita* is an important macrogelatinous zooplankton species of the world's marine systems. This species of zooplankton has received quite a lot of interest from the scientific and other people due to its major role in pelagic ecosystems (Möller, 1980; Mutlu, 2001). This jelly is important predator on small pelagic fish, fish larvae and eggs in the Black Sea (Mutlu, 1999; Shiganova and Bulgakova, 2000; Birinci-Özdemir et al., 2014).

The scyphomedusa moon jellyfish is a widespread macrozooplankton organism in coastal water and shelf sea (Schroth et al., 2002). In much more attention is recently being devoted to jellyfish than previously, possibly because of some spectacular outbreaks, such as for example in the Black Sea ecosystem (Weisse and Gomoiu, 2000).

Moon jellyfish is very common in the mixed layer down to the sub-thermocline region in the Black Sea. Small individuals are mostly found above the thermocline, while larger individuals up to 40 cm are found just below it (Mutlu, 1999, Kideys and Romanova, 2001). Jellyfish have effected commercial and economical fisheries (Kingsford et al., 2000; Özdemir et al., 2014). As a result, it can be expected that studies of the life history, biology, population dynamic and ecology of jellyfish are likely to be intensified.

Most of these studies require estimates of population parameters (i.e., growth, age, condition factor, the relationship between disc diameter and weight), which then allows mortality rates to be inferred (Palomare and Pauly, 2009). Length-weight relationships are widely used in aquatic organism especially fishes applications and marine systems management. Consequently, variability in size has important implications for diverse aspects of marine science and population dynamics (Erzini, 1994). Studies concerning moon jellyfish at the Turkish coasts of Black Sea (Mutlu et al., 1994; Mutlu, 2001; Mutlu, 2007; Bat et al., 2009) have reported on spatial distribution, relationship of length-weight and morphometry of *A. aurita*. On the other hand, there are scarce studies on population dynamics (such as asymptotic length $L\infty$, growth coefficient K, total mortality

coefficient Z and natural mortality rate M) of moon jellyfish. The studies are essential for other jellyfish and aquatic organism. In this study disc diameter-weight relationships of moon jellyfish were determined seasonally.

2. MATERIAL AND METHOD

Samples were collected monthly between December 2012 and November 2013 from Sinop coasts in the southern Black Sea of Turkey (Fig 1). Sampling of moon jellyfish was carried out using R/V "Seydi Ali Reis" and a commercial fishing boat. All samples were obtained during daytime.

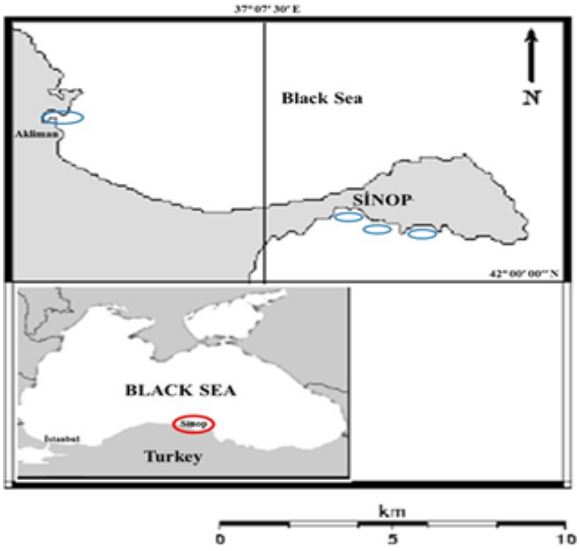

Figure 1. Sampling areas

Hauls were taken from the bottom to surface using a standard plankton nets (50 cm diameter mouth opening, 500 µm mesh size for horizontal hauls, 210 µm mesh size for vertical hauls). Water depth was 1-45 m and the boat's speed 2,5 knot. At the end of each haul, nets were exteriorly washed and their cod-end contents were washed through a 2 mm sieve to retain the jellyfish. Disc diameters of specimens were measured to the nearest millimeter and weight were determined individual displacement volumes (ml). Weight was given as wet weight (g);
1 g = 0.962 volume (ml) (~1 ml) (Kideys and Romanova, 2001).
The disc diameter-weight relationship (DWR) of moon jellyfish was determined using the equation; $W_w=aL^b$ (Pauly, 1984). The parameters a (intercept, condition factor) and b (slope, indicating growth type) of the disc diameter-weight relationship (DWR) were estimated by least square regression.
Slope and intercept of the volume (wet weight) to length (disc diameter) relationship was tested using ANCOVA. The ANOVA were used for statistical analyze of seasonal condition factor.

3. RESULTS

A total 1358 moon jellyfish *A. aurita* specimens were sampled by plankton net and analyzed in the study. Moon jellyfish sampled ranged in size from 1.5 to 26 mm of total length, and weighed between 1.1 and 543 g. The highest rate were established 7.5 mm diameter group (30%), 10 mm diameter group (22%) and 5 mm diameter group (20%) respectively, while the lowest rate were determined 27.5 mm diameter group (1%) for *A. auirta* in general. Seasonally and generally disc diameter frequency distribution of moon jellyfish were showed in Fig 2.
Mean disc diameter and weight of all individuals were estimated 8.3 ± 0.10 cm and 43.2 ± 1.58 g, respectively. Disc diameter and weight data of *A. aurita* was changed seasonally. Minimum and maximum values of each parameter were also given in parentheses (Table 1).

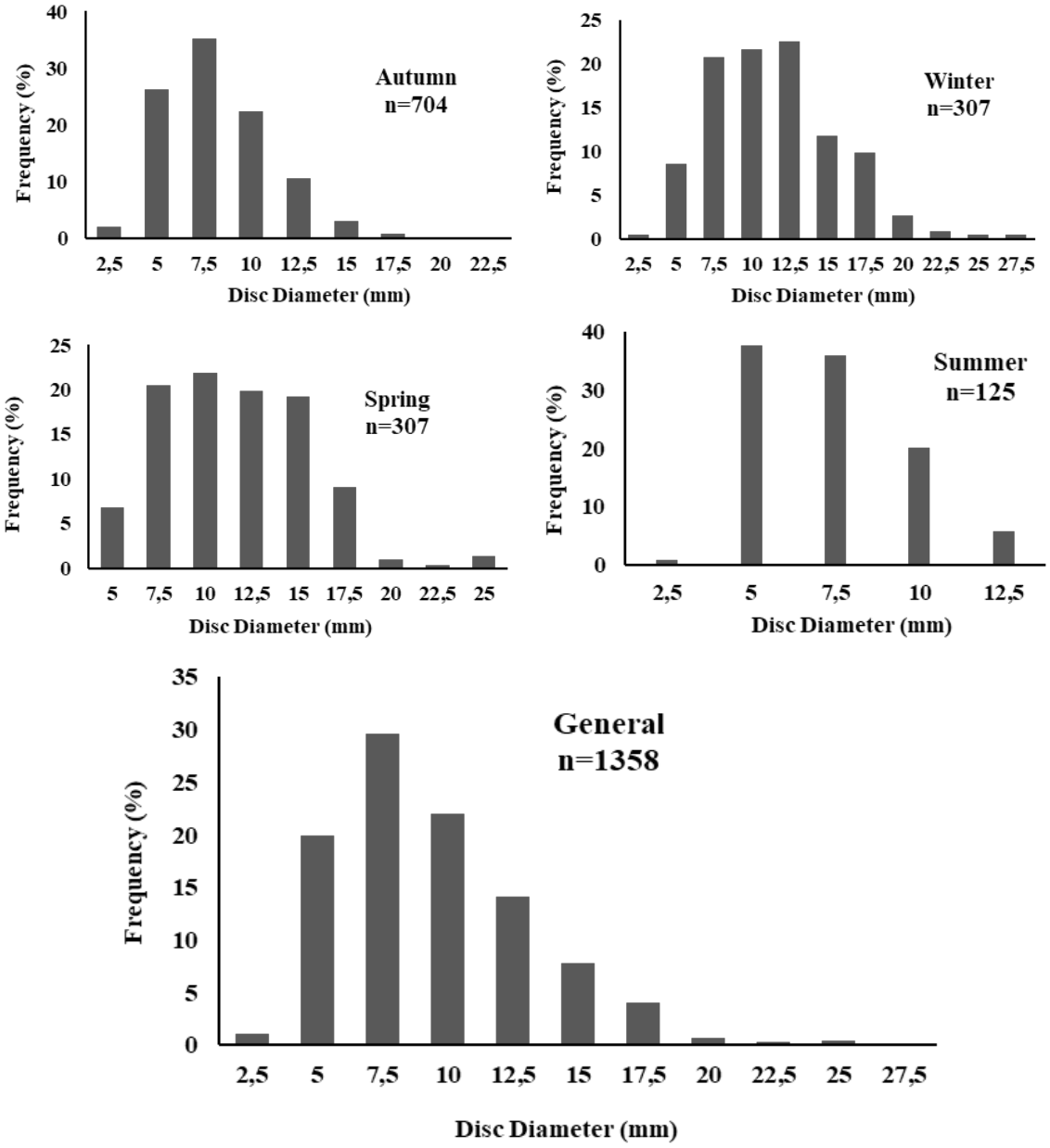

Fig 2. Seasonally and general disc diameter frequency distribution of *A. aurita.*

Table 1. Seasonal disc diameter and weight of moon jellyfish *Aurelia aurita* (min-max)

Seasons	n	Mean Diameter (cm)	Mean Weight (g)
Autumn	704	7.0 ± 0.10 (2.1-20.4)	25.2 ± 1.10 (0.3-319.4)
Winter	222	10.4 ± 0.28 (2.5-26.0)	67.8 ± 5.15 (1.1-523)
Spring	307	10.5 ± 0.22 (3.1-24.6)	75.4 ± 4.54 (2.7-543)
Summer	125	6.1 ± 0.19 (1.5-12.3)	21.9 ± 1.93 (1.09-108.8)
All	**1358**	**8.3 ± 0.11 (1.5-26.0)**	**43.2 ± 1.58 (1.1-543)**

A significant difference was detected especially in May, June July and months of autumn (ANOVA, $P < 0.05$). The test of homogeneity of slopes and differences between slopes were not found to be statistically significant (ANOVA, $P > 0.05$). Significantly difference was found for the DWR among seasons (ANCOVA of log-transformed data, $P < 0.001$).

The DWR of moon jellyfish could be fitted to a power function of the form $Ww = a L^b$ (Fig 3). Note that although the curve fit was generally good, individual data points may deviate from the curve by a factor of up to 2.

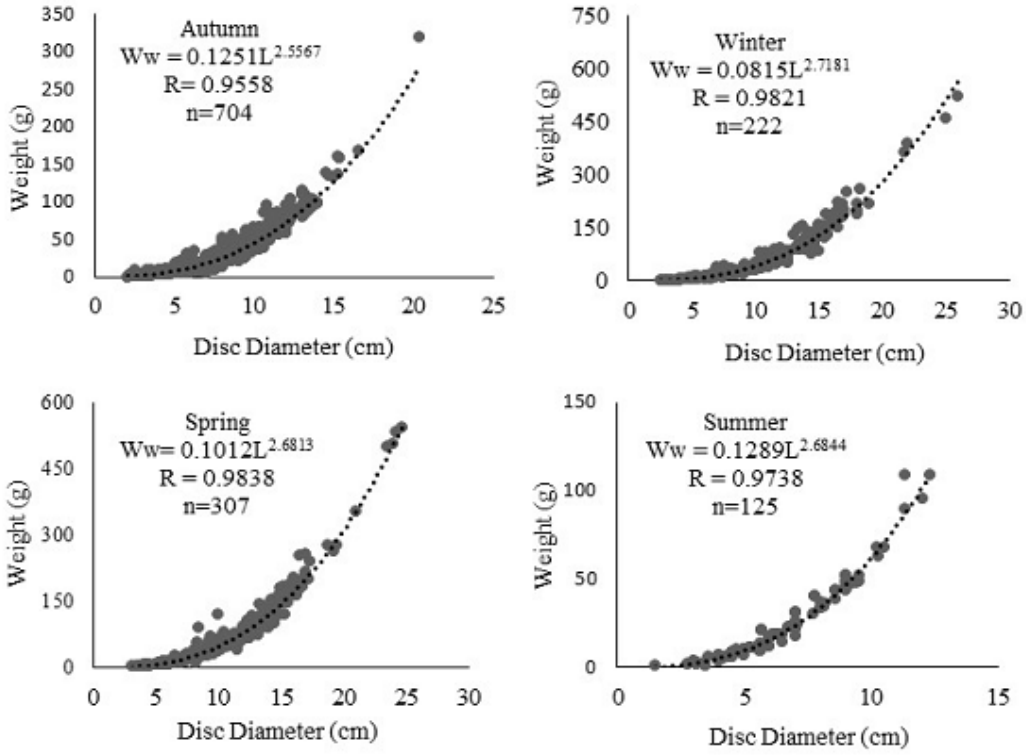

Figure 3. DWR graphics of moon jelly fish *Aurelia aurita* seasonally

The diameter and weight, parameters of DWR ("a" and "b"), 95% confidence intervals of "b" and the coefficient of determination (R) are given seasonal moon jellyfish in Table 2. In the present study, "b" (based on disc diameter) of moon jellyfish varied from a minimum of 2.5567 for autumn season to a maximum 2.7181 for spring season. The "R" values of moon jellyfish ranged from 0.96 to 0.98. All "b" values of moon jellyfish were significant ($P < 0.05$), with all R values > 0.96. The highest condition factor were in autumn and summer seasons (Table 2).

Table 2. The DWR parameters of moon jelly fish *Aurelia aurita* for the seasonally (A: allometric)

Seasons	a	b	95% Confidence interval of b	Standard error of b	R	Growth type	P
Autumn	0.1251	2.5567	2.4984 - 2.6149	0.0296	0.96	-A	< 0.05
Winter	0.0815	2.7181	2.6489 - 2.7878	0.0351	0.98	-A	< 0.05
Spring	0.1012	2.6813	2.6262 - 2.7364	0.0280	0.98	-A	< 0.05
Summer	0.1289	2.6844	2.5727 - 2.7960	0.0564	0.97	-A	< 0.05
All	**0.1217**	**2.5887**	**2.5551 - 2.6223**	**0.0171**	**0.97**	**-A**	**< 0.05**

4. DISCUSSION AND CONCLUSION

Climatic change, anthropogenic pollution, exploitation of fish stocks have effected increasing jellyfish blooms. Biomass of moon jellyfish was reported rising in Black Sea (Daskalov et al., 2007; Bat et al., 2007). The predatory impact of the moon jellyfish and its effect on the planktonic community is far from understood. Therefore, more ecological studies, on population dynamic, fluctuations of abundance and biomass are needed to better understand the mechanisms causing jellyfish blooms.

Comparison of DWR parameters of moon jellyfish in the Black Sea were given in Table 3. In the present study, DWR parameters showed difference from other studies in the Black Sea (Tuncer, 1990; Weisse and Gomoiu, 2000; Mutlu, 2001; Bat et al., 2009; Birinci-Özdemir, 2011). "a" and "b" value differences have been reported for moon jellyfish in different regions and seasons. Black Sea ecosystem changes have affected the jellyfish growth. The differences of *a* and *b* values of aquatic organism might have been changed by several ecological factors, such as growth increment, differences in feeding, quality and quantity of food, differences in the sampling periods, stage of maturity, as well as environmental conditions, temperature, salinity and seasonality differences in the number of specimens examined (Tesch, 1971; Pauly, 1984; Wootton, 1990; Froese, 2006).

Temperature and food are determining factors growth of moon jellyfish. Higher growth rate is parallel with increasing of this factors (Möller and Riisgard 2007; Webster & Lucas 2012).

Bloom of moon jellyfish usually is in spring seasons but we found reproductive period as autumn and summer depend on condition factor (parameter a) of moon jellyfish. It is thought to be predation pressure of moon jellyfish on zooplankton and ichthyoplankton in this periods.

It is important that the size and weight of the samples are made to follow the sampling process. However, making measurements on the boat in difficult weather conditions is sometimes inconvenient. In sampling this will alleviate the workload in the sample measurements while providing both temporal gain. This study presents the first data on seasonally DWR for moon jellyfish from southern Black Sea coast of Turkey.

Table 3. Comparison of moon jellyfish *Aurelia aurita* disc diameter (D), wet weight (g) and DWR parameters in the Black sea

Authors	**Area**	**(Max-Min-Mean)**		**n**	**a**	**b**	**R**
		D (cm)	**Ww (g)**				
Tunçer (1990)	Eastern Black Sea-Turkey	17.5–2.5–9.3	147.6–3.53–52.7	32	0.210	1.880	0.92
Weisse & Gomoiu (2000)	Northwestern Black Sea-Romania & Bulgaria	17– * – *	*	737	0.852	2.940	*
Mutlu (2001)	Black Sea-Turkey	43 – * – *	*	243	0.120	1.790	0.89
Bat et al (2009)	Southern Black Sea-Turkey	26–1.2–6.5	* – * – 31.3	351	0.277	2.182	0.94
Birinci-Özdemir (2011)	Southern Black Sea-Tukey	21–1.2 – *	*	256	0.289	2.165	0.93
Present study (2018)	Southern Black Sea-Turkey	26–1.5–8.3	543–0.3–43.2	1358	0.121	2.588	0.97

** No data.*

In conclusion, it is considerable determination of biology, ecology, life cycle, population dynamics and distribution of moon jellyfish increasing in Black Sea with climatic changing. This study revealed seasonal DWR of moon jellyfish in Black sea. In addition to this study data ecological status and environmental conditions causing bloom of moon jellyfish should be investigated. There needs to be more fundamental research on polyp stage, ecology and ecosystem roles of jellyfish in the Black Sea.

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Short Communication
Turkish Journal of Maritime and Marine Sciences Volume: 5 Issue: 1 (2019) 17-20

Occurrence of Pilotfish *Naucrates ductor* (Carangidae) in Izmir Bay (Aegean Sea)

İzmir Körfezi'nde (Ege Denizi) Malta Palamudu *Naucrates ductor* (Carangidae)'un Bulunuşu

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 5 Sayı: 1 (2019) 17-20

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ABSTRACT

This paper reports the occurrence of *Naucrates ductor* in Izmir Bay, northeastern Aegean Sea. A specimen, measuring 275 mm in TL, was captured from Urla coast, Izmir Bay on 13 November 2018. This short note presents additional record of *N. ductor* on the ichthyofaunal richness of the Turkish Aegean Sea.

Keywords: Rare species, record, Izmir Bay, Aegean Sea

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ÖZET

Bu makale İzmir Körfezi'nde (Kuzeydoğu Ege Denizi) *Naucrates ductor*'un ortaya çıkışını rapor etmektedir. 13 Kasım 2018 tarihinde, İzmir Körfezi Urla kıyılarından 275 mm TL boyunda ölçülmüş bir birey yakalanmıştır. Bu kısa not Türk Ege Denizi'nin ihtiyofaunal zenginliği üzerine *N. ductor*'un ilave bir kaydını sunmaktadır.

Anahtar sözcükler: Nadir tür, kayıt, İzmir Körfezi, Ege Denizi

1. INTRODUCTION

Pilotfish, *Naucrates ductor* (Linnaeus, 1758) is a pelagic oceanic species, and found usually in close proximity in large cartilaginous or bony fishes, turtles or marine mammals. It feeds on waste of its large hosts and possibly as a cleaner that consumes ectoparasites; also small fishes and invertebrates. Young pilotfish are usually associated with jellyfish and drifting seaweed. Maximum length is 70 cm TL, common length is 40 cm TL (Golani et al., 2006; Froese and Pauly, 2018).

N. ductor distributes circumtropical in tropical seas. Eastern Atlantic: British Isles, the Azores and Madeira, Norway and Bay of Biscay to Namibia, including the Mediterranean and the Canaries. It is common throughout the Indian Ocean and nearly cosmopolitan in tropical seas (Smith-Vaniz, 1986; Froese and Pauly, 2018).

In the eastern Mediterranean, *N. ductor* has been known from Israel (Ben-Tuvia, 1971) and from Egypt (Akel and Karachle, 2017). In Turkish seas, Geldiay (1969) firstly mentioned only by name for the coasts of Izmir, Aegean Sea. In addition, it has been listed among the fish species, caught from Mersin and Iskenderun Bays, Turkey since early 1980s (Gücü and Bingel, 1994). Özgül (2015) recently observed the juveniles of *N. ductor* (n=21, length range: 40-80 mm) beneath the experimental FADs in Kuşadası Bay, southern Aegean Sea. This short note presents the additional record of *N. ductor* on the ichthyofaunal richness of the Turkish Aegean Sea.

2. MATERIAL AND METHOD

On 13 November 2018, a specimen of *Naucrates ductor*, measuring 275 mm TL (Figure 1) was captured by a gillnetter from Urla, Izmir Bay, northern Aegean Sea (coordinates: 38°22'15'' N - 26°47'51'' E) at a depth of 10 m (Figure 2). The specimen was fixed with 5% formaldehyde solution and deposited in the ichthyological collection of Ege University, Fisheries Faculty (catalogue no: ESFM-PIS/2018-09).

Figure 1. Pilotfish, *Naucrates ductor* (ESFM-PIS/2018-09), captured from Izmir Bay, NE Aegean Sea

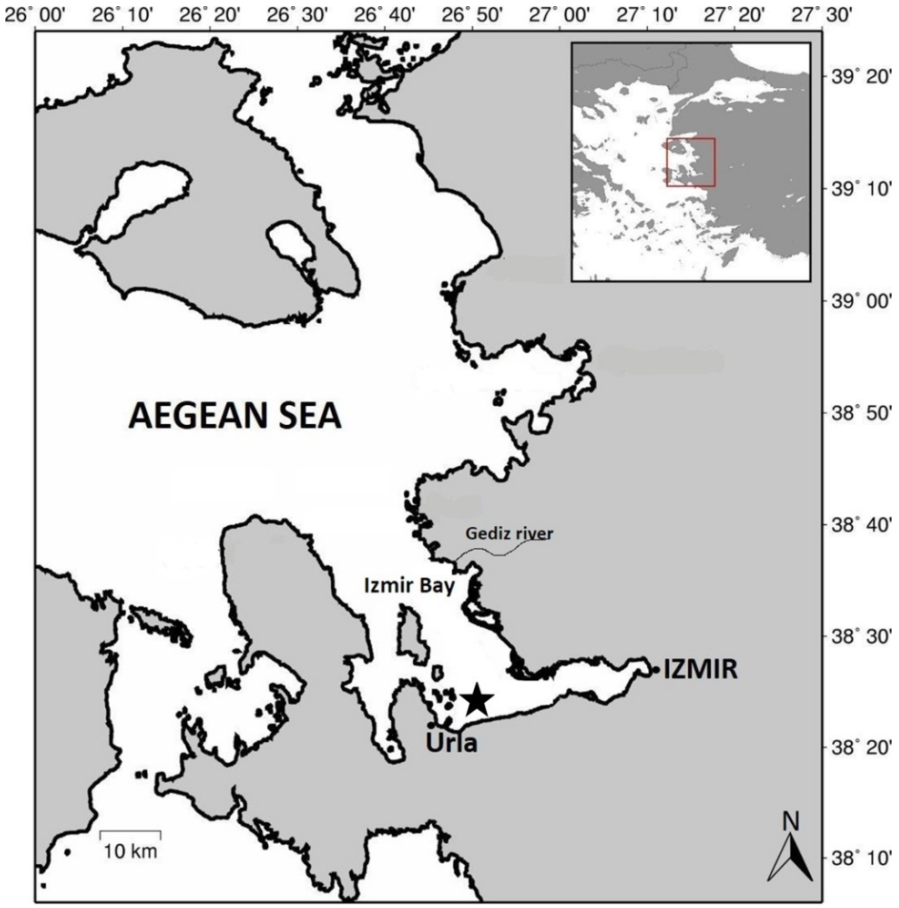

Fig 2. Map of sampling area: black star indicates capture site of *Naucrates ductor* in Izmir Bay, Aegean Sea

3. RESULTS AND DISCUSSION

N. ductor entangled the gill net (72 mm mesh size) with a sea turtle. Sea turtle was released as alive by the fisherman and only one specimen among the 5-6 fish was brought to the laboratory for further examination. Description, measurements and percent in total length (Table 1), recorded of the specimen are in total accordance with Smith-Vaniz (1986), Golani et al. (2006) and Froese and Pauly (2018).

According to the manager of local fishery cooperative, three specimens of *N. ductor* were previously caught in Izmir Bay at the beginning of November 2018 and they were sold in the fish auction of local fishery cooperative (İ. Temiztepe, pers. comm.).

Even though, specimens of *N. ductor* were caught twice within a month from Izmir Bay, it does not indicate that there is an established population, yet. Nevertheless, I think that the new specimens with sea turtles and cartilaginous fish likely to enter to the Bay of Izmir can be observed much more due to the alteration of sea water temperatures.

Table 1. Morphometric measurements in mm and as percentage of total length (%TL) and counts recorded in *Naucrates ductor*, captured from Izmir Bay, Aegean Sea

Reference	ESFM-PIS/2018-08	
Measurements	mm	%TL
Total length	275	100.0
Fork length	247	89.8
Standard length	224	81.5
Predorsal fin length	84	30.5
Prepectoral fin length	62	22.5
Pre-anal fin length	134	48.7
Head length	58	21.1
Eye diameter	11	4.0
Preorbitary length	18	6.5
Counts		
Dorsal fin rays	IV+I+28	
Anal fin rays	III+15	
Pectoral fin rays	18	
Ventral fin rays	I+5	

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Port Management Students' Metaphoric Perceptions Related to the Port Concept

Deniz ve Liman İşletmeciliği Öğrencilerinin Liman Kavramına İlişkin Metaforik Algıları

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ABSTRACT

Port's stakeholders' perception related to the port is important for the port sector. Positive perceptions of the stakeholders will positively affect the performance and development of the sector. The aim of this research is to determine the perceptions of Port Management students, who are one of the future stakeholders of the sector, about port. The study is a metaphor study. Metaphors and their categories were determined by using a five-step method for the analysis of the data obtained. Findings show that the participants (n=121) produced 66 metaphors related to the port concept. These metaphors were distributed into 16 conceptual categories. While the port perception did not differ according to the variables of class and gender, a difference was determined according to experience variable. This study may be supported by further studies aiming to determine the port perceptions of port workers.

Keywords: Port Perception, Metaphoric Research, Student Perceptions.

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ÖZET

Liman paydaşlarının liman kavramı hakkındaki algısı, limancılık sektörü açısından önemlidir. Paydaşların olumlu yöndeki algısı, sektörün performansını ve gelişimini de olumlu etkileyecektir. Bu araştırmanın amacı, limancılık sektörünün gelecekteki paydaşlarından olan Deniz ve Liman İşletmeciliği öğrencilerinin liman algısını ortaya koymaktır. Çalışma bir metafor çalışmasıdır. Elde edilen verilerin analizi için beş aşamalı bir yöntem kullanılarak metaforlar ve oluşturdukları kategoriler belirlenmiştir. Araştırma bulguları, katılımcıların (n=121) liman kavramına ilişkin 66 adet metafor ürettiğini göstermektedir. Bu metaforlar 16 adet kavramsal kategoriye dağılmaktadır. Sınıf ve cinsiyet değişkenlerine göre liman algısı farklılık göstermezken, deneyim değişkenine göre farklılık tespit edilmiştir. Bu çalışma, limanlarda çalışmakta olan personelin liman algısını ölçmeye yönelik çalışmalarla desteklenebilir

Anahtar sözcükler: Liman Algısı, Metaforik Araştırma, Öğrenci Algıları.

1. GİRİŞ

Liman nedir? Çoğu kişi büyük olasılıkla bu soruyu "*gemiler için yanaşma yeri*" şeklinde yanıtlayacaktır. Geleneksel kullanım amaçları bakımından limanlar, farklı biçimlerde tanımlanabilir (Esmer ve Karataş Çetin, 2016). Son dönemlerde oldukça küreselleşmiş ve uzmanlaşmış bir işletmecilik alanı olan limanlar (Muslu, 2017), Türk Dil Kurumu tarafından genel bir ifade ile; "*gemilerin barınmalarına, yük alıp boşaltmalarına, yolcu indirip bindirmelerine yarayan doğal veya yapay sığınak*" olarak tanımlanmaktadır (TDK, 2018). Bu tanım, her ne kadar olguyu ifade ederken oldukça kullanışlı olsa da bireylerin liman olgusu hakkındaki öznel düşüncelerini açıklamaya yetmez. Bireyin liman olgusu hakkındaki düşüncesini anlayabilmek için, zihnindeki *liman* algısını anlamak gerekir.

Özellikle limandan hizmet alan ve limana hizmet sunan kişi ve kurumların yani paydaşların liman algısını anlamak önemlidir; çünkü bir sektördeki gelişim ve performans, o sektörün paydaşlarınca nasıl algılandığı ile doğrudan ilişkilidir. Performans, bireyin yetkinlikleri ile inanç ve değerlerine bağlıdır (Morillo, 1990). Limancılık sektörünün iyi performans gösterebilmesi ve gelişebilmesi için öncelikle paydaşların limana dair değerlerinin olumlu olması beklenir. Deniz ve Liman işletmeciliği öğrencileri, mezuniyetleri sonrasında limanda hizmet veren kişiler olarak görev aldıklarından bu paydaşlar arasında yer almaktadır. Deniz ve Liman İşletmeciliği öğrencilerinin liman algılarının anlaşılması onların eğitimlerinin niteliğinin arttırılması ve bu yolla limanlardaki iş performanslarının yükseltilmesi bakımından önemlidir. Öte yandan, bir sektörün ya da mesleğin, o programda okuyan öğrenciler tarafından nasıl algılandığı, öğrencinin mezun olduktan sonra bu alanda çalışmayı tercih edip etmeyeceği açısından önem taşır (Türker vd., 2016). Bu bağlamda, Deniz ve Liman İşletmeciliği öğrencilerinin *liman* algıları, bu bireylerin limancılık alanının bir çalışanı olup olmayacakları konusunda rol oynayacaktır.

Olguları anlamak ve olayları yorumlamak, onlar hakkında

geliştirdiğimiz metaforlar ile daha kolaylaşmaktadır. Kelime anlamı ile metafor, "*mecaz*" ya da "*eğretileme*" demektir ve konu hakkındaki algımızı yansıtır. Metaforlar, dünyayı kavrayışımızı etkileyen bir düşünce kalıbı olarak nitelendirilebilir (Morgan, 1998). Ayrıca, bir konu hakkında benzetmeler ile vurgulama yaparak anlayışın geliştirilmesini sağlar. Bilgi ve deneyimlerimizi aktarırken metaforları sıklıkla kullanırız. Anlatamadığımız veya anlatmakta zorluk çektiğimiz olgu ve olayları, deneyimlerimizden edindiğimiz metaforlar ile dile dökeriz. "*Okyanus sonsuzluğa benzer*" dediğimizde okyanus olgusu ile ilgili bir metafor geliştirmiş oluruz ve bunu "*çünkü uçsuz bucaksızdır*" şeklindeki bir ifadeyle gerekçelendiririz. Metafor, her alanda problem çözmek için kullanılabilecek, hayalimizdeki gerçekliği yansıması olan zihinsel bir araçtır (Oxford vd., 1998).

Bu çalışmanın amacı, limanların gelecekteki paydaşlarından olan Deniz ve Liman İşletmeciliği öğrencilerinin *liman* algılarını geliştirdikleri metaforlar yardımıyla belirlemektir. Bu amaç doğrultusunda aşağıdaki sorulara yanıt aranmıştır:

- Deniz ve Liman İşletmeciliği öğrencilerinin *liman* kavramına ilişkin geliştirdikleri metaforlar nelerdir?
- Geliştirilen bu metaforlar, kavramsal açıdan hangi kategorilere ayrılabilir?
- Belirlenen kavramsal kategoriler, öğrencilerin *sınıf, cinsiyet ve deneyimi* açısından farklılık göstermekte midir?

2. MATERYAL VE YÖNTEM

Bu çalışmada, öğrencilerin liman kavramına ilişkin görüşlerini belirlemek amacı ile bir metaforik araştırma yapılmıştır. Araştırmanın gerçekleştirilmesi için hazırlanan metaforik bilgi formu ile katılımcılardan elde edilen veriler içerik analizine tabi tutulmuştur. İçerik analizinin temel amacı, toplanan verileri açıklamak için kavramlar oluşturmak ve kavramlar arası ilişkiler geliştirmektir. Bu amaç doğrultusunda, toplanan verilerin önce kavramlara dönüştürülmesi, sonra kavramların düzenlenmesi ve son olarak verileri açıklayan temaların belirlenmesi gerekir (Yıldırım ve Şimşek, 2013). İçerik analizi sonrasında elde edilen metaforlar ve kategorileri kodlanarak nicel veriye çevrilmiştir.

2.1. Katılımcı Grubu

Çalışma, Çanakkale Onsekiz Mart Üniversitesi, Gelibolu Piri Reis Meslek Yüksekokulu Deniz ve Liman İşletmeciliği Programı'nda ön-lisans düzeyinde öğrenim görmekte olan 135 öğrenci ile gerçekleştirilmiştir. Metaforları kodlama aşamasında 14 katılımcıdan elde edilen veri, değerlendirmeye uygun bilgi içermemesi nedeni ile devre dışı bırakılmış, 121 katılımcıdan elde edilen veri analize tabi tutulmuştur. Değerlendirmeye alınan 121 katılımcı 28 kadın (%23,1) ve 93 erkekten (%76,9) oluşmakta iken; katılımcıların 67'si 1. sınıf (%57), 54 tanesi (%43) 2. sınıf öğrencisidir. Veri toplama aracında geçen "Daha önce herhangi bir limanda staj ya da çalışma amaçlı bulundunuz mu?" sorusuna 35 kişi (%28,9) olumlu yanıt verirken 86 kişi (%71,1) olumsuz yanıt vermiştir. Katılımcılar ile ilgili bilgiler Tablo 1'de verilmiştir. Katılımcılar "1EY" şeklindeki üç basamaklı bir kod ile kodlanmıştır. Bu koddaki birinci basamak katılımcının sınıfını belirten 1 veya 2 rakamından, ikinci basamak cinsiyeti belirten E (erkek) veya K (kadın) harfinden, üçüncü basamak ise liman deneyimini belirten V

(var) veya Y (yok) harfinden oluşmaktadır.

Tablo 1. Katılımcı grubunun özellikleri

Değişken	Alt değişken	f	%
Cinsiyet	Kadın	28	23,1
	Erkek	93	76,9
	Toplam	**121**	**100**
Sınıf	1	67	57,0
	2	54	43,0
	Toplam	**121**	**100**
Liman deneyimi	Var	35	28,9
	Yok	86	71,1
	Genel Toplam	**121**	**100**

2.2. Verilerin Toplanması ve Analizi

Araştırmada kullanılacak verilerin toplanması amacıyla bir "metaforik bilgi formu" oluşturulmuştur. Bu form birinci bölümde katılımcı ile ilgili sınıf, yaş, cinsiyet ve liman deneyimi sorularına yanıt aramaktadır. İkinci bölümde ise katılımcıdan "Bence liman …….'a benzer, çünkü ……." cümlesindeki boşlukları tamamlaması istenmiştir. Veriler 2018 yılının Ekim ayında toplanmıştır.

Metafor çalışmalarında veri analizi için beş aşamadan oluşan bir yöntem kullanılmıştır. Benzer çalışmalardan faydalanılarak veri analizi beş aşamada tamamlanmıştır (Saban vd., 2006; Saban, 2009; Ertürk, 2017; Uzun ve Erdem, 2017; Uzun ve Özcan, 2017): 1- kodlama ve ayıklama, 2- örnek metafor derleme, 3- kategori oluşturma, 4- geçerlik ve güvenilirliğin sınanması, 5- verilerin bilgisayara aktarılması.

Kodlama ve ayıklama aşamasında, katılımcının yanıtında net bir metafor ifade edip etmediği analiz edilmiştir. Bunun yanı sıra, belirtilen metaforlara ilişkin belirgin bir gerekçe sunulup sunulmadığı incelenmiştir. Bu inceleme sonucunda 2 adet yanıtın eksik bilgi içermesi ve 12 adet yanıtta verilen metafora ilişkin yeterli ve anlamlı gerekçe sunulmaması ya da metafor ile nedeni arasında bağlantı olmaması nedeniyle toplam 14 katılımcı çalışma kapsamı dışına çıkarılmıştır. Bu aşama neticesinde liman kavramına ilişkin 78 adet metafor kodlanmıştır.

Önceki aşamada kodlanan metaforlar örnek metafor derleme aşamasında birbiriyle karşılaştırılarak benzer ifadeler içeren ve aynı imgeyi betimleyen metaforlar değerlendirilmiştir. Eşanlamlı kelimeler, kelimenin türemiş ve çoğul halleri ile aynı imgeden bahseden farklı kelimeler bir arada değerlendirilerek ifade olarak en güçlü anlamı taşıyan ortak bir metafor altında toplanmıştır. Bu aşama sonrasında, liman kavramına ilişkin çalışma kapsamında incelenecek metafor sayısı 66 olarak belirlenmiştir.

Kategori geliştirme aşamasında, katılımcıların liman kavramı ile ilgili ürettikleri metaforlar ortak özellikler bakımından incelenmiş, belirlenen 66 adet metaforun liman imgesini nasıl ifade ettiğine bakılmıştır. Bu inceleme sonrasında, benzer kavramları işaret eden metaforlar bir kategori altında toplanarak 25 adet kategori elde edilmiştir.

Geçerlik ve güvenilirlik aşaması, araştırma sonuçlarının ikna edici olması için önem taşımaktadır. Nitel araştırmalarda geçerliğin sağlanması için toplanan verilerin ayrıntılı şekilde paylaşılması ve sonuçlara ulaşma yolunun betimlenmesini gerekir (Yıldırım ve Şimşek, 2013). Bu çalışmada geçerlik iki aşamada gerçekleştirilmiştir (1) veri analiz sürecinin ayrıntılı şekilde açıklanması, (2) elde edilen metaforların tamamının bulgular kısmında paylaşılması.

Çalışmanın güvenilirliğinin sağlanması için uzman görüşüne başvurulmuştur.

Başvurulan uzmandan 66 adet metaforu 25 adet kategoriye dağıtması istenmiştir. Miles vd.; nitel çalışmalarda güvenilirlik sağlanması için, kodlayıcılar arası uyuşmanın en az %80 olması gerektiğinden bahsetmektedir (Miles vd., 1994). Uzman görüşü sonucu elde edilen sınıflandırma ile araştırmacının ulaştığı sonuçlara bakıldığında 20 metaforun kategorisinde uyuşma olmadığı (kodlayıcılar arası uzlaşma = 0,83) görülmüştür. Uzman görüşü sonrası arı metaforunu üreten 2 katılımcı yanıtının kategorisi destekleyici olarak değiştirilmiş; alışveriş merkezi, ağaç, kalp, hal, yeni dünya, yol ve evin temeli metaforları yeniden görüşülerek kategorilerinde uzlaşma sağlanmıştır. Son durumda kodlayıcılar arası görüş birliği 0,91 olarak elde edilmiştir.

Verilerin bilgisayara aktarılması aşamasında ise elde edilen metaforlar ve kategorileri temsil eden katılımcı sayıları (f) ve yüzdelik oranları (%) hesaplanmıştır. Kategoriler ve kapsadıkları metaforları gösteren tablolar oluşturulmuştur.

3. BULGULAR

Deniz ve liman işletmeciliği öğrencilerinin *liman* kavramına ilişkin geliştirdikleri metaforlar Tablo 2'de gösterilmiştir.

Tablo 2. Liman kavramına ilişkin geliştirilen metaforların frekans ve yüzdeleri

No	Metafor adı	f	%	No	Metafor adı	f	%	No	Metafor adı	f	%
1	Ev	13	10,7	**23**	Anakart	1	0,8	**45**	Kahvehane	1	0,8
2	Ağaç	6	5,0	**24**	Anne	1	0,8	**46**	Kamu dairesi	1	0,8
3	Kapı	6	5,0	**25**	Aşure	1	0,8	**47**	Köprü	1	0,8
4	Hayat	5	4,1	**26**	Baba	1	0,8	**48**	Kutu	1	0,8
5	Kalp	5	4,1	**27**	Borsa	1	0,8	**49**	Lojistik firması	1	0,8
6	Alışveriş merkezi	4	3,3	**28**	Buzdolabı	1	0,8	**50**	Makine	1	0,8
7	İstasyon	4	3,3	**29**	Çanta	1	0,8	**51**	Nar	1	0,8
8	Beyin	3	2,5	**30**	Dalga	1	0,8	**52**	Orman	1	0,8
9	Kargo şirketi	3	2,5	**31**	Delik Şişe	1	0,8	**53**	Para kaynağı	1	0,8
10	Otogar	3	2,5	**32**	Devlet	1	0,8	**54**	Pazar	1	0,8
11	Şehir	3	2,5	**33**	Dipsiz bardak	1	0,8	**55**	Rüzgâr	1	0,8
12	Arı	2	1,7	**34**	Evin temeli	1	0,8	**56**	Saklama kabı	1	0,8
13	Arı kovanı	2	1,7	**35**	Fabrika	1	0,8	**57**	Sera	1	0,8
14	Ayrılık	2	1,7	**36**	Futbolcu	1	0,8	**58**	Sığınak	1	0,8
15	Banka	2	1,7	**37**	Gümrük	1	0,8	**59**	Sınır	1	0,8
16	Çark	2	1,7	**38**	Güneş	1	0,8	**60**	Su şişesi	1	0,8
17	Depo	2	1,7	**39**	Hal	1	0,8	**61**	Şarap	1	0,8
18	Havaalanı	2	1,7	**40**	Holding	1	0,8	**62**	Şirket	1	0,8
19	Karınca yuvası	2	1,7	**41**	İnternet sağlayıcı	1	0,8	**63**	Yapboz parçaları	1	0,8
20	Okul	2	1,7	**42**	Kablo	1	0,8	**64**	Yemekteki tuz	1	0,8
21	Otel	2	1,7	**43**	Kadın	1	0,8	**65**	Yeni dünya	1	0,8
22	Otopark	2	1,7	**44**	Kafa	1	0,8	**66**	Yol	1	0,8
Toplam										**121**	**100**

Tablo 2 incelendiğinde, öğrencilerin liman kavramına ilişkin 66 adet metafor geliştirdikleri görülmüştür. En çok geliştirilen metafor %10,7 ve 13 kez kullanılan *ev* metaforu olmuştur. Sık kullanılan diğer metaforlar ise *ağaç* (f=6, %5,0), *kapı* (f=6, %5,0), *hayat* (f=5, %4,1), *kalp* (f=5, %4,1), *alışveriş merkezi* (f=4, %3,3) ve *istasyon* (f=4, %3,3) şeklinde sıralanmıştır. Geriye kalan 59 metafordan 4 tanesinin üçer kez, 11 tanesinin ikişer kez ve 44 tanesinin de birer kez kullanıldığı görülmüştür.

Geliştirilen metaforların kategorilere dağıtılması sonucunda toplam 25 adet *kavramsal kategori* elde edilmiştir. Bazı kategorilerin yalnızca 1 veya 2 metafordan oluştuğu görülmüştür. Az sayıda (3'ten az) eleman içeren 10 kategorideki metaforlar *diğer* başlığındaki bir kategori altında toplanmış, bu yolla kategori sayısı 16 olarak belirlenmiştir (Tablo 3). Bazı metaforlar, önerdikleri nedenlerin veya liman olgusuna ilişkin geliştirdikleri kavramların farklı olması nedeniyle birden farklı kategoride yer almıştır. Örneğin *arı kovanı* metaforu, bir katılımcı tarafından "*sürekli bir operasyon, işlem ve faaliyet olduğu için hep aktiftir"* şeklinde gerekçelendirildiği için *sürekli etkin* kategorisinde yer alırken aynı zamanda başka bir katılımcı tarafından *"gemilerin getirdiği yükler burada toplanır"* şeklinde gerekçelendirildiği için *depo* kategorisinde de yer almıştır.

Tablo 3. Metaforların oluşturduğu kategoriler

No	Kategori	Kullanılan Metaforlar	Metafor Sayısı	%
1	Barınak	Ev, ağaç, otel, otopark, baba, sığınak, otogar	21	17,4
2	Ticaret merkezi	Alışveriş merkezi, kapı, aşure, gümrük, hal, kalp, kutu, pazar, şehir, yapboz parçaları	14	11,6
3	Ulaştırmacı	Kargo şirketi, ağaç, istasyon, kablo, köprü, lojistik firması, otogar	10	8,3
4	Destekleyici	Arı, kalp, beyin, anne, holding, istasyon	9	7,4
5	Yükleme ve tahliye merkezi	Havaalanı, istasyon, buzdolabı, delik şişe, depo, otogar, su şişesi	9	7,4
6	Hayati	Kalp, ağaç, evin temeli, güneş, hayat, yemekteki tuz	7	5,8
7	İşletme	Banka, borsa, devlet, fabrika, okul, şirket	6	5,0
8	Sürekli etkin	Alışveriş merkezi, arı kovanı, karınca yuvası, makine, sera	5	4,1
9	Yeniliklere açılan kapı	Kapı, kadın, sınır, yeni dünya	5	4,1
10	Depo	Arı kovanı, depo, ev, saklama kabı	4	3,3
11	Gelir getiren	Banka, futbolcu, kapı, para kaynağı	4	3,3
12	Koordinatör	Anakart, beyin, internet sağlayıcısı, karınca yuvası	4	3,3
13	Karmaşık	Hayat, kafa, nar	3	2,5
14	Öngörülmez	Dalga, hayat, rüzgar	3	2,5
15	Sistematik	Çark, kamu dairesi	3	2,5
16	Diğer	Ayrılık, şehir, yol, ağaç, şarap, çanta, dipsiz bardak, okul, orman, hayal, kahvehane, hayat	14	11,6
Toplam			**121**	**100,0**

En fazla metaforu içeren kategori *barınak* (f=21, %17,4) kategorisi olmuştur. *Ticaret merkezi* ve *ulaştırma* kategorileri de en ikinci ve üçüncü sırada (f=14, %11,6; f:10, %8,3) yer almıştır. Kavramsal kategoriler ve içerdikleri metaforlar aşağıda detaylı şekilde açıklanmıştır.

3.1. Barınak olarak liman kategorisi

Öğrencilerin barınak olarak liman kategorisi altında 7 farklı metafor ürettikleri görülmektedir. En fazla geliştirilen metaforun *ev* (f=12, %9,9) olduğu görülmüştür. Diğer metaforlardan *ağaç, otel* ve *otopark* ikişer kez; *baba, sığınak* ve *otogar* ise birer kez kullanılmıştır. Barınak kategorisindeki metaforlar ile ilgili katılımcıların kurduğu ilişkiler şöyledir:

"Bence liman eve benzer, çünkü zor hava şartlarında sığındığımız yerdir."(1EV)
"Bence liman eve benzer, çünkü suda yüzen taşıtların dinlenme ve konaklama gibi ihtiyaçlarını karşılar."(1EY)
"Bence liman ağaca benzer, çünkü gemiler kuşların ağaçta konakladığı gibi limanda konaklar."(1EY)
"Bence liman otele benzer, çünkü gemiler bir süre konaklayıp rotalarına devam eder."(1EY)
"Bence liman otoparka benzer, çünkü gemiler bir süreliğine park eder."(2KV)
"Bence liman babaya benzer, çünkü zor durumlarda ona sığınırız."(1EY)
"Bence liman sığınağa benzer, çünkü teknelerin dalgalarda güvenli durduğu yerdir."(1KV)
"Bence liman otogara benzer, çünkü birçok çeşit gemi gelir konaklar ve gider."(2KY)

3.2. Ticaret merkezi olarak liman kategorisi

Öğrencilerin ticaret merkezi olarak liman kategorisinde 10 adet metafor geliştirdiği görülmüştür. Bu metaforlardan *alışveriş merkezi* ve *kapı* üçer kez, *aşure, gümrük, hal, kalp, kutu, pazar, şehir* ve *yapboz parçaları* ise birer kez kullanılmıştır. Ticaret merkezi kategorisi metaforlarıyla ilgili katılımcıların kurduğu ilişkiler şöyledir:

"Bence liman alışveriş merkezine benzer, çünkü büyük bir Pazar gibi bir sürü mal ve eşya bulunur."(1EY)
"Bence liman dünyaya açılan bir kapıya benzer, çünkü ülkede var olan ürünleri diğer ülkelere ihraç etmek ve diğer ülkelerden mal ithal etmek için kullanılır."(2EV)
"Bence liman gümrüklere benzer, çünkü ithalat ve ihracat oradan yapılır."(1KY)
"Bence liman hale benzer, çünkü alıcı ve satıcının buluştuğu yerdir."(1EY)
"Bence liman kalbe benzer, çünkü ticarete kan pompalayan yerdir."(1EY)
"Bence liman kutuya benzer, çünkü içinde herkese hitap eden mallar vardır."(1EY)
"Bence liman pazara benzer, çünkü ticaret yapılır ve para alışverişi vardır."(2EY)
"Bence liman şehre benzer, çünkü ticari faaliyetler yoğun yaşanır."(2EV)
"Bence liman yapboz parçalarına benzer, çünkü birleştiklerinde ticaret ve ulaşımın gerçekleşmesini sağlar."(1KY)

3.3. Ulaştırmacı olarak liman kategorisi

Öğrencileri ulaştırmacı olarak liman kategorisine ilişkin 7 adet metafor geliştirdikleri görülmüştür. Bu metaforlardan *kargo şirketi* (f=3, %2,5) en fazla kullanılan metafor olurken, *ağaç* iki kez; *istasyon, kablo, köprü, lojistik firması* ve *otogar* metaforları birer kez kullanılıştır. Ulaştırmacı kategorisindeki metaforlarla ilgili katılımcıların kurduğu ilişkiler şöyledir:

"Bence liman kargo şirketine benzer, çünkü bir gemi bir limandan aldığı yükü

diğer limana ulaştırır."(1EY)
"Bence liman ağaca benzer, çünkü ağacın dalları gemilerin gittiği yollardır. Hayvanlar ağaçta yuva edinir ve yavrular. Yavrular gemiler gibidir ve dallarda gezinirler."(1EY)
"Bence liman istasyona benzer, çünkü insanlar ve eşyalar bir yerden bir yere sürekli hareket halindedir."(2EY)
"Bence liman kablolara benzer, çünkü gemilerin karaya bağlantısını sağlar."(1KY)
"Bence liman köprüye benzer, çünkü ulaşım ve ekonomi sağlar."(2KY)
"Bence liman lojistik firmasına benzer, çünkü gelen ürünler dünyanın başka yerlerine ulaştırılır."(2EY)
"Bence liman otogara benzer, çünkü gemiler de otobüslerin otogarı kullandığı gibi limanı kullanarak taşımacılık yapar.(2KV)

3.4. Destekleyici olarak liman kategorisi

Öğrenciler destekleyici olarak liman kategorisine ilişkin 6 adet metafor geliştirmiştir. Bu metaforlardan *arı, kalp* ve *beyin* ikişer; *anne, holding* ve *istasyon* birer kez kullanılmıştır. Destekleyici kategorisi metaforları ile ilgili katılımcıların kurduğu ilişkiler şöyledir:
"Bence liman arıya benzer, çünkü arılar dünya için nasıl yararlıysa limanlar da öyle yararlıdır."(1EY)
"Bence liman kalbe benzer, çünkü üç tarafı denizlerle çevrili olan ülkemizi besler."(1EY)
"Bence liman beyne benzer, çünkü devleti ayakta tutar ve ona büyük ölçüde yardımcı olur."(1EY)
"Bence liman anneye benzer, çünkü suda yüzen araçlar yakıt ve diğer ihtiyaçlarını burada giderir."(1EV)
"Bence liman holdinge benzer, çünkü ülkenin genel ihtiyaçları buradan karşılanır."(1EY)
"Bence liman istasyona benzer, çünkü insanlar karaya çıkıp ihtiyaçlarını giderir."(2EY)

3.5. Yükleme ve tahliye merkezi olarak liman kategorisi

Öğrencilerin yükleme ve tahliye merkezi olarak liman kategorisine ilişkin 7 adet metafor geliştirdikleri görülmüştür. Bu metaforlardan *havaalanı* ve *istasyon* ikişer; *buzdolabı*, *delik şişe*, *depo*, *otogar* ve *su şişesi* ise birer kez kullanılmıştır. Yükleme ve tahliye merkezi kategorisindeki metaforlar ile ilgili katılımcıların kurduğu ilişkiler şöyledir:
"Bence liman havaalanına benzer, çünkü havaalanındaki uçakların yolsu indirip bindirmesi gibi limana gelen gemiler de yüklerini elleçleyip limandan yeni yükler alıp rotalarına devam ederler."(2EV)
"Bence liman istasyona benzer, çünkü gemilerin yük alıp boşalttığı yerdir."(2EY)
"Bence liman buzdolabına benzer, çünkü içi dolar ve boşalır."(2EY)
"Bence liman delik şişeye benzer, çünkü gelen ve giden gemiler nedeniyle sürekli dolup boşalır."(1EY)
"Bence liman depoya benzer, çünkü gemilere yük verilir ve gemilerden yük alınır."(2EY)
"Bence liman otogara benzer, çünkü otobüsler de gemiler gibi sürekli bir yerde dolup boşaltılır."(2EV)
"Bence liman su şişesine benzer, çünkü her gelen ya içindekini alır ya da içini doldurur."(2EV)

3.6. Hayati olarak liman kategorisi

Öğrencilerin hayati olarak liman kategorisine ilişkin 6 adet metafor geliştirdikleri görülmüştür. Bu metaforlardan *kalp* metaforu 2 kez; *ağaç, evin temeli, güneş, hayat* ve *yemekteki tuz* metaforları ise birer kez kullanılmıştır.

Hayati kategorisindeki metaforlar ile ilgili katılımcıların kurduğu ilişkiler şöyledir:
"Bence liman kalbe benzer, çünkü kalp olmadan yaşayamayız, limanlar olmazsa da ihtiyaçlarımızı karşılayamayız."(2EV)
"Bence liman ağaca benzer, çünkü ağaçlar nasıl karaya hayat verirse limanlar da denize hayat verir."(1EY)
"Bence liman evin temeline benzer, çünkü bütün işler limanda başlar."(1KY)
"Bence liman güneşe benzer, çünkü var oldukça hayat devam eder."(1EY)
"Bence liman hayata benzer, çünkü en öncelikli olandır."(2EY)
"Bence liman yemekteki tuza benzer, çünkü limanlar bir ülkenin olmazsa olmazıdır."(2EY)

3.7. İşletme olarak liman kategorisi

Bu kategoriye ilişkin geliştirilen metaforlar; *banka, borsa, devlet, fabrika, okul* ve *şirket* metaforlarıdır. Bu altı metafor birer kez kullanılmıştır. İşletme kategorisindeki metaforlar ile ilgili katılımcıların kurduğu ilişkiler şöyledir:
"Bence liman bankaya benzer, çünkü para gelmezse bankalar gemi gelmezse Limalar çalışamaz." (2EV)
"Bence liman borsaya benzer, çünkü gemiler geldikçe değeri artar." (1EY)
"Bence liman devlete benzer, çünkü yönetilirken özveri, disiplin ve çok çalışma ister. Bunlar olmazsa limanlar da devlet de batar." (2EY)
"Bence liman fabrikaya benzer, çünkü içinde bir sürü çalışan vardır." (1EY)
"Bence liman okula benzer, çünkü çalışmak gerekir ve belirli iş saatleri vardır."(2EY)
"Bence liman şirkete benzer, çünkü içerisinde çalışanlar, yapılan bir iş vardır ve kar elde edilir."(2KV)

3.8. Sürekli etkin olarak liman kategorisi

Katılımcılar bu kategori ile ilgili 5 adet metafor (*alışveriş merkezi, arı kovanı, karınca yuvası, makine, sera*) geliştirmiştir. Metaforların her biri birer kez kullanılmıştır. Sürekli etkin kategorisi metaforları ile ilgili katılımcıların kurduğu ilişkiler şöyledir:
"Bence liman alışveriş merkezine benzer, çünkü giden gelen çok olur ve hep işler."(2EY)
"Bence liman arı kovanına benzer, çünkü 7/24 çalışır; hep bir operasyon, işlem ve faaliyet vardır."(1KV)
"Bence liman karınca yuvasına benzer, çünkü devamlı çalışır, hiç durmaz."(2EV)
"Bence liman makineye benzer, çünkü gece gündüz durmadan çalışır."(1EY)
"Bence liman seraya benzer, çünkü her mevsim ve her saat bir döngü içerisindedir ve hiçbir zaman durmaz."(1EY)

3.9. Yeniliklere açılan kapı olarak liman kategorisi

Bu kategoride 4 adet metafor geliştirilmiştir. Bu metaforlardan *kapı* iki kez; *kadın, sınır* ve *yeni dünya* birer kez kullanılmıştır. Yeniliklere açılan kapı kategorisindeki metaforlar ile ilgili katılımcıların kurduğu ilişkiler şöyledir:
"Bence liman kapıya benzer, çünkü ülkeler arası geçişi sağlar."(2EV)
"Bence liman kadına benzer, çünkü her zaman merak edilecek tarafları vardır."(1EY)
"Bence liman sınıra benzer, çünkü deniz özgürlüktür. Limanlar özgürlüğümüzün önündeki son duvarlardır."(1EY)
"Bence liman kadına benzer, çünkü her zaman merak edilecek tarafları vardır."(1EY)
"Bence liman yeni dünyaya benzer, çünkü her liman yeni yaşantılar, yeni kültürler,

yeni hayatlar ve yeni insanlar demektir."(1EV)

3.10. Depo olarak liman kategorisi

Katılımcılar bu kategoriye ilişkin 4 adet metafor (arı kovanı, depo, ev, saklama kabı) geliştirilmiştir. Her bir metafor birer kez kullanılmıştır. Depo kategorisindeki metaforlar ile ilgili katılımcıların kurduğu ilişkiler şöyledir:

"Bence liman arı kovanına benzer, çünkü tüm ürünler gemiler sayesinde limanda toplanır."(2EV)

"Bence liman depoya benzer, çünkü taşınacak yükün gemiye sevk edilmeden önce beklediği yerdir."(1EY)

"Bence liman eve benzer, çünkü konteynerler burada saklanır."(2EV)

"Bence liman saklama kabına benzer, çünkü yük bir yerden gelir, orada depo edilir ve sahipleri oradan alır."(2EV)

3.11. Gelir getiren olarak liman kategorisi

Bu kategoriye ilişkin birer kez kullanılan 4 adet (*banka, futbolcu, kapı, para kaynağı*) metafor geliştirilmiştir. Gelir getiren kategorisi metaforları ile ilgili katılımcıların kurduğu ilişkiler şöyledir:

"Bence liman bankaya benzer, çünkü gemiler para getirir."(1EY)

"Bence liman futbolcuya benzer, çünkü forvet olmadığında futbol takımının verimi sınırlı olacağı gibi, liman olmazsa bölgedeki ekonomik faaliyet kısıtlı olur."(2EY)

"Bence liman kapıya benzer, çünkü ülkenin ekonomik girişi buradan gerçekleşir."(2EV)

"Bence liman para kaynağına benzer, çünkü milyon dolar değerinde yüklerin elleçlemesi yapılır."(2EY)

3.12. Koordinatör olarak liman kategorisi

Bu kategoriye ilişkin 4 adet metafor (*anakart, beyin, internet sağlayıcısı, karınca yuvası*) geliştirilmiştir. Bu metaforlar birer kez kullanılmıştır. Koordinatör kategorisi metaforları ile ilgili katılımcıların kurduğu ilişkiler şöyledir:

"Bence liman anakarta benzer, çünkü ticaret buradan yönetilir."(1EY)

"Bence liman beyne benzer, çünkü her yer ile bir bağlantısı vardır."(1EY)

"Bence liman internet sağlayıcısına benzer, çünkü ticaret ağı bu merkezden yönetilir."(1EY)

"Bence liman karınca yuvasına benzer, çünkü gemileri karıncalar gibi yönlendirir, çalıştırır ve yuvasına döndürür."(1EY)

3.13. Karmaşık olarak liman kategorisi

Bu kategoriye ilişkin *hayat, kafa* ve *nar* olmak üzere birer kez kullanılan 3 adet metafor geliştirilmiştir. Karmaşık kategorisindeki metaforlar ile ilgili katılımcıların kurduğu ilişkiler şöyledir:

"Bence liman hayata benzer, çünkü her zaman merak edilecek yönleri ve çözülmesi gereken sorunları vardır."(1KY)

"Bence liman kafaya benzer, çünkü çok karışık bir yapısı vardır."(1EY)

"Bence liman nara benzer, çünkü dışarıdan her şey basit görünse de içine girince bir sürü ayrıntısı vardır."(1EY)

3.14. Öngörülmez olarak liman kategorisi

Katılımcılar bu kategoriye ilişkin *dalga, rüzgar* ve *hayat* olmak üzere 3 metafor geliştirmiştir. Her metafor birer kez kullanılmıştır. Öngörülmez kategorisi metaforları ile ilgili katılımcıların kurduğu ilişkiler şöyledir:

"Bence liman dalgaya benzer, çünkü ne zaman alabora edeceği belli olmaz."(1EY)
"Bence liman hayata benzer, çünkü ne zaman neyin olacağı, hangi sorunlarla karşılaşılacağı belli değildir."(2EY)
"Bence liman rüzgara benzer, çünkü ne yöne savurduğu belli değildir."(1EY)

3.15. Sistematik olarak liman kategorisi

Katılımcılar sistematik olarak liman kategorisine ilişkin *çark* (f=2) ve *makine* (f=1) olmak üzere 2 metafor geliştirmiştir. Sistematik kategorisi metaforları ile ilgili katılımcıların kurduğu ilişkiler şöyledir:
"Bence liman çarka benzer, çünkü her şey birbiri ile bağlantılıdır. Bir şey aksarsa hepsi aksar."(1EY)
"Bence liman kamu dairesine benzer, çünkü her şey bir sistemle yürütülür."(1KY)

3.16. Liman olgusuna ilişkin diğer metaforlar

Elde edilen 15 kategori içerisinde yer almayan ve bağımsız kategori oluşturmayan metaforlar (f=15) *diğer* bağlığı altında toplanmıştır. Bu metaforlardan *ayrılık* ve *şehir* ikişer kez, diğer 11 metafor ise birer kez kullanılmıştır. Diğer kategorisi altında incelenen metaforlar ile ilgili katılımcıların kurduğu ilişkiler şöyledir:
"Bence liman ayrılığa benzer, çünkü gemiler limana veda eder."(1EY)
"Bence liman ayrılığa benzer, çünkü vedalar yaşatır."(1KY)
"Bence liman şehre benzer, çünkü her yıl dünyanın farklı yerlerinden farklı şeyler bir noktada buluşur."(2EV)
"Bence liman şehre benzer, çünkü huzur verir."(2KV)
"Bence liman yola benzer, çünkü gelen geçen çok olur."(1EY)
"Bence liman ağaca benzer, çünkü emek harcayıp işlersen bir şekil elde eder, değerinin artmasını sağlarsın."(1EY)
"Bence liman şaraba benzer, çünkü yıllar geçtikçe gelişip güzelleşir."(2EY)
"Bence liman çantaya benzer, çünkü geniş bir hacme sahiptir."(2EY)
"Bence liman dipsiz bardağa benzer, çünkü kapasitesi hiç dolmaz."(1KY)
"Bence liman okula benzer, çünkü limanda okuldaki öğrenciler gibi çeşit çeşit yük bulunur."(2EV)
"Bence liman ormana benzer, çünkü etraf huzur kokar."(1KY)
"Bence liman hayallere benzer, çünkü beklentilerle doludur."(1KY)
"Bence liman kahvehaneye benzer, çünkü oradaki çalışanlar sohbet eder ve zaman geçirmek için birlikte eğlenir."(1EY)
"Bence liman hayata benzer, çünkü içindeki koşturmaca ve kalabalıktan zamanın nasıl geçtiği fark edilmez."(1KV)

3.17. Metaforlar ve kategorileri ile ilgili genel bulgular

Metaforların oluşturduğu kategorilerin değişkenlere (*sınıf, cinsiyet, deneyim*) göre dağılımı Tablo 4'te gösterilmektedir. *Sınıf* değişkeni incelendiğinde, *barınak olarak liman* kategorisinin 1. ve 2. sınıflar için en çok kullanılan (%16,4, %18,5) kavramsal kategori olduğu görülmektedir. Ancak genel kategori sıralaması düşünüldüğünde hem 1. sınıf hem de 2. sınıf öğrencileri için sıralamada değişiklik olmuştur. Örneğin, genel sıralamada *ticaret merkezi* (%11,6) ikinci sırada iken 1. sınıf öğrencileri *destekleyici* (%12) kategorisini ikinci sıraya yerleştirmiş, 2. Sınıf öğrencileri ise *yükleme ve tahliye merkezi* (%14,8) kategorisini *ticaret merkezi* (%14,8) kategorisi ile eş önemde değerlendirmiştir. Bunun yanı sıra, 1. sınıf öğrencilerinin metaforları tüm kategorilere dağılırken 2. sınıf öğrencilerinde *koordinatör ve öngörülmez* kategorileri boş kalmıştır.

Cinsiyet değişkeni incelendiğinde, barınak kategorisinin erkek ve kadın öğrencilerde ilk sırada (%21,4, %16,1) yer aldığı görülmüştür. Kategorilerin sıralamasının erkek öğrencilerde genel sıralamadan çok farklılık arz etmemiş ve metaforların, genel dağılıma yakın bir şekilde bütün kategorilere dağılmıştır.

Tablo 4. Kategorilerin, katılımcıların özelliklerine göre dağılımı

Kategori	Sınıf				Cinsiyet				Deneyim				Genel Toplam	
	1		**2**		**Kadın**		**Erkek**		**Var**		**Yok**			
	f	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**
Barınak	11	16,4	10	18,5	6	21,4	15	16,1	10	28,6	11	12,6	21	17,4
Ticaret merkezi	6	9,0	8	14,8	4	14,3	10	10,8	5	14,3	9	10,3	14	11,6
Ulaştırmacı	5	7,5	5	9,3	4	14,3	6	6,5	2	5,7	8	9,2	10	8,3
Destekleyici	8	12,0	1	1,9	-	0,0	9	9,7	1	2,9	8	9,2	9	7,4
Yükleme ve tahliye merkezi	1	1,5	8	14,8	1	3,6	8	8,6	3	8,6	6	6,9	9	7,4
Hayati	4	6,0	3	5,6	1	3,6	6	6,5	1	2,9	6	6,9	7	5,8
İşletme	2	3,0	4	7,4	1	3,6	5	5,4	3	8,6	3	3,4	6	5,0
Sürekli etkin	3	4,5	2	3,7	1	3,6	4	4,3	2	5,7	4	4,6	6	4,1
Yeniliklere açılan kapı	4	6,0	1	1,9	-	0,0	5	5,4	2	5,7	3	3,4	5	4,1
Depo	1	1,5	3	5,6	1	3,6	3	3,2	2	5,7	2	2,3	5	3,3
Gelir getiren	2	3,0	2	3,7	-	0,0	4	4,3	-	0,0	4	4,6	5	3,3
Koordinatör	4	6,0	-	0,0	-	0,0	4	4,3	-	0,0	4	4,6	5	3,3
Karmaşık	2	3,0	1	1,9	2	7,1	1	1,1	-	0,0	3	3,4	3	2,5
Öngörülmez	2	3,0	1	1,9	-	0,0	3	3,2	-	0,0	3	3,4	3	2,5
Sistematik	3	4,5	-	0,0	1	3,6	2	2,2	-	0,0	3	3,4	3	2,5
Diğer	9	13,5	5	9,3	6	21,4	8	8,6	4	11,4	10	11,4	14	11,6
Toplam	**67**	**100**	**54**	**100**	**28**	**100**	**93**	**100**	**35**	**100**	**86**	**100**	**121**	**100**

Kadın öğrencilerde ise sıralama ve dağılım genelden farklı gerçekleşmiş ve *destekleyici, yeniliklere açılan kapı, gelir getiren, koordinatör* ve *öngörülmez* kategorilerinde metafor yer almamıştır. Bunun yanı sıra kadın öğrencilerin metaforlarından %21,4'ü kategori oluşturmayan metaforların yer aldığı *diğer* başlığı altında toplandığı görülmüştür.

Deneyim değişkeni incelendiğinde, liman deneyimi olmayan öğrencilerin metaforlarının kategorilere dağılımının genel dağılıma benzer olduğu görülmektedir. Liman deneyimi olan öğrencilerin kategorilerinin dağılımı ise genel dağılımdan farklı olmuş; sıralamada farlılık olduğu gibi, *gelir getiren, karmaşık, koordinatör, öngörülmez ve sistematik* kategorilerinde metafor yer almamıştır. Hem deneyimi olan hem de olmayan öğrencilerde *barınak* kategorisi ilk sırayı (%28,6, %12,6) almıştır.

4. TARTIŞMA VE SONUÇ

Dünya küresel bir pazardır. Limanlar, bu dev pazar içerisindeki malların dağıtım noktalarıdır. Hem ucuzluğu hem de kapasitesi açısından denizyolu ve limanlar, küresel ticaret ve taşımacılık işlemlerinin ana unsurudur. Küresel ölçekteki faaliyetlerin bu önemli durakları hakkında toplumun ve paydaşların zihnindeki algının olumlu olması da önem taşır. Olumlu algı, performansın artmasını ve dolayısı ile gelişimin hızlanmasını sağlayacaktır. Bu çalışma, yakın zamanda limanların paydaşları arasına katılacak Deniz ve Liman İşletmeciliği öğrencilerinin *liman* kavramına ilişkin algılarını yansıtmaktadır.

Öğrencilerin *liman* algılarına ilişkin 66 adet metafor ürettikleri görülmektedir. Bu sayıda metaforun varlığı, öğrencilerin algılarının oldukça farklılaştığını göstermektedir. En fazla üretilen metafor 'ev' (f=13, %10,7) metaforu olmuştur. 'Ev' metaforunun diğer metaforlara göre oldukça fazla kullanıldığı görülmüştür. Bu durum, limanın bir *yuva, sığınak, barınak veya konaklama yeri* olduğu konusundaki algının yaygın olduğunu göstermektedir.

Üretilen metaforların oluşturdukları kategoriler incelendiğinde 'barınak' (f=21, %17,4) kategorisinin öne çıktığı görülmüştür. Bu durum, üretilen metaforlardan elde edilen sonuç ile paralel olarak limanın bir *yuva, sığınak, barınak veya konaklama yeri* şeklinde algılandığını göstermektedir. En yaygın kullanılan ikinci kategori olan 'ticaret merkezi' (f=14, %11,6) ile 'işletme' (f=6, %5) ve 'gelir getiren' (f=4, %3,3) kategorileri, limanda *parasal işlemlerin yapıldığı* algısını yansıtmaktadır. 'Ulaştırmacı' (f=10, %8,3), 'yükleme ve tahliye merkezi' (f=9, %7,4) ve 'depo' kategorileri ise, limanın *taşımacılığın önemli bir aktörü* olduğu algısının bir ürünüdür. Limanın bir diğer algılanış biçimi de, 'destekleyici' (f=9, %7,4) ve 'hayati' (f=7, %5,8) kategorilerinden anlaşılacağı üzere *toplumun/ülkenin ihtiyaçlarını karşılayan* olduğu yönündedir.

Çalışmada üç adet değişken (*sınıf, cinsiyet, deneyim*) mevcuttur. *Sınıf* değişkeni açısından bakıldığında, 'destekleyici' ve 'yükleme ve tahliye merkezi' kategorilerindeki dağılımda farklılık görülmektedir. Bu iki kategori dışında, öğrencilerin ürettiği metaforlara ilişkin kategorilerin birbirinden çok farklılaşmadığı ve genel dağılımla benzerlik gösterdiği düşünülmektedir. Bu nedenle *sınıf* değişkeninin öğrencilerin liman algısı üzerinde belirgin rol oynamadığı sonucuna ulaşılmıştır.

Bir diğer değişken olan *cinsiyet* açısından değerlendirildiğinde, öğrencilerin ürettikleri metaforlara ilişkin kategorilerin dağılımında farklılıklar gözlemlenmiştir. Erkek öğrencilerin kategori dağılımı genel dağılımla benzerlik gösterirken, kadın öğrencilerin *destekleyici, yeniliklere açılan kapı, gelir getiren, koordinatör ve öngörülmez* kategorilerine ilişkin metafor üretmedikleri sonucuna ulaşılmıştır. Ancak bu şekilde bir sonucun, çalışma örnekleminde yer alan kadın öğrenci sayısının erkek öğrencilere daha az olmasından kaynaklandığı düşünülebilir.

Bulgular *deneyim* değişkeni açısından incelendiğinde; liman deneyimi olan öğrencilerde 'barınak' kategorisinin olmayanlara göre belirgin şekilde fazla (%28,6; %12,6) oranda metafor içerdiği görülmektedir. Bunun yanı sıra, deneyimi olmayan öğrencilerin metaforları tüm kategorilere dağılırken, deneyim olan öğrencilerin metaforlarının 16 kategorinin 11'ine dağıldığı görülmüştür. Bu bulgular, liman deneyimi olan öğrencilerin algısının daha belirgin olduğunu göstermektedir. Bu durum, deneyimin Deniz ve Liman İşletmeciliği öğrencilerinin *liman* olgusu hakkındaki algılarını etkileyen bir unsur olduğu sonucunu doğurmaktadır.

Bu çalışmanın sonuçları, Deniz ve Liman İşletmeciliği alanında ön-lisans düzeyinde öğrenim gören bir grup öğrenciden elde edilen verilerin yansımasıdır. Ortaöğretim, lisans ya da lisansüstü düzeyde öğrenim gören öğrenciler ile yapılmış çalışmalarda farklı sonuçlar ortaya çıkabilir. Ayrıca limanlarda çalışan personel ile yapılacak çalışmalar da farklı durumlara işaret edebilir. Bu bağlamda, özellikle liman personelinin *liman* algısını belirleyecek ve bu algının liman ve personelin performansı ile ilişkisini irdeleyecek yönde gerçekleştirilecek çalışmalar önemli görülmektedir.

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Research Article
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Purification of Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA) From Fish Oil Using HPLC Method and Investigation of Their Antibacterial Effects on Some Pathogenic Bacteria

Balık Yağındaki Eikosapentaenoik Asit (EPA) ve Dokosaheksaenoik Asit (DHA)'in Yüksek Performanslı Sıvı Kromatografi (HPLC) Yöntemi ile Saflaştırılması ve Bazı Patojenik Bakteriler Üzerine Etkisinin Incelenmesi

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 5 Sayı: 1 (2019) 35-43

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ABSTRACT

The aim of this study was to purified eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) essential oils from trout oil using high performance liquid chromatography (HPLC) method, and bioconverted EPA and DHA into bioconverted EPA (bEPA) and bioconverted DHA (bDHA) extracts by *P. aeruginosa* PR3. Moreover, in vitro antibacterial activity of bEPA and bDHA was investigated using disc diffusion methods and minimum inhibitory concentration (MIC). EPA and DHA concentration in trout oil increased after HPLC optimisation. In this study, EPA and DHA enriched products were obtained which are to be used as valuable supplements for food and pharmaceutical purposes. The bioconverted EPA and DHA exhibited antibacterial activities against two Gram-positive bacteria (*Listeria monocytogenes* ATCC 7677 and *Staphylococcus aureus* ATCC 29213) and six Gram-negative bacteria (*Pseudomonas aeruginosa* ATCC 27853, *Escherichia coli* ATCC 25922, *Klebsiella pneumoniae* ATCC700603, *Enterococcus faecalis* ATCC 29212, *Aeromonas hydrophila* NCIMB 1135 and *Salmonella paratyphi* A NCTC 13). Inhibition zones and MIC value of bEPA and bDHA against bacterial strains ranged from 7 to 12 mm and from 350 to 2350 µg/mL, respectively. Our results suggested that the crude extracts of bioconversion of EPA and DHA by *P. aeruginosa* PR3 can be considered as promising antimicrobials in improving food safety by controlling foodborne pathogens.

Keywords: High performance liquid chromatography (HPLC), docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA), minimum inhibitory concentration (MIC), *Pseudomonas aeruginosa* PR3

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ÖZET

Bu çalışmada alabalık yağlarından HPLC tekniği ile esansiyel yağ asitleri olan EPA ve DHA ω-3 yağ asitlerinin elde edilmesi ve bu yağ asitlerinin P. *aeruginosa* PR3 suşu tarafından biyodönüşümleriyle üretilen ekstraktların inhibisyon zonu ve MIC değerleri ile gıda kaynaklı patojen bakterilere karşı antimikrobiyal etkileri incelenmiştir. Ham alabalık yağında %11.1 oranında EPA ve %15.9 oranında bulunan DHA yağ asitleri, HPLC optimizasyonu sonucu %58.64 (EPA) ve %40.33 (DHA) seviyelerine yükseltilmiştir. Bu şekilde gıda ve farmasötik amaçlar için değeri yüksek destek maddesi olarak kullanılabilecek EPA ve DHA'ca zenginleşmiş ürünler elde edilmiştir. Biyodönüşümlü EPA ve DHA (bEPA, bDHA) 2 gram pozitif bakteri (*Listeria monocytogenes* (ATCC 7677) ve *Staphylococcus aureus* (ATCC 29213)) ve 6 gram negative bakteriye (*Pseudomonas aeruginosa* (ATCC 27853), *Escherichia coli* (ATCC 25922), *Klebsiella pneumoniae* (ATCC700603), *Enterococcus faecalis* (ATCC 29212), *Aeromonas hydrophila* (NCIMB 1135), *Salmonella paratyphii* A (NCTC 13)) karşı antibakteriyel aktivite göstermiştir. Her iki bEPA ve bDHA büyüme inhibisyonu gram pozitif bakterilere karşı benzer sonuçlar gösterirken, bDHA ekstraktı minimum inhibitor konsantrasyonu (MIC) olarak tanımlanan gram negative bakterilere karşı bEPA'dan daha etkili olmuştur. Sonuç olarak, *P. aeruginosa* PR3 tarafından EPA ve DHA'nın biyodönüşüm ekstraktları gıda kaynaklı patojenlerin kontrolü için gıda güvenliğinin geliştirilmesinde gelecek vaad eden antimikrobiyal ajanlar olarak düşünülebilir.

Anahtar sözcükler: HPLC; DHA; EPA; MIC; *Pseudomonas aeruginosa* PR3; büyüme inhibisyonu.

1. INTRODUCTION

During the last years, interest in the nutritional and pharmacological effects of dietary polyunsaturated fatty acids and specifically of n-3 polyunsaturated fatty acids has increased (Simopoulus, 1991; Uauy et al., 1992). The ω-3 polyunsaturated fatty acids (PUFA), especially eicosapentaenoic acid (20:5, EPA), docosahexaenoic acid (22:6, DHA) are attracting increasing attention because of their importance to human health (Uauy & Valenzuela, 1992). EPA is the precursor of prostaglandins, tromboxanes and leukotrienes, which are effective anti-aggregatory substances. EPA ingestion can has effects on cardiovascular diseases through a variety of mechanisms (Glosmet, 1985) and DHA in essential for the development of the neural and vision function, mainly in neonates (Uauy et al., 1992). DHA is a main component of membrane phospholipids of brain and retina cells. Clinical studies show that DHA is essential for the growth and development of the brain in infants and for maintenance of normal brain functions in adults. Recently it has been shown that EPA and DHA supplementation has positive health effects including attenuation of coronary heart disease risk factors (hypertension, hyperlipidemia, platelet aggregation, glucose tolerance); modulation of eicosanoid synthesis (cellular immune system, dermal integrity) and tumoricidal activity. Some studies indicated that the PUFA concentrates, devoid of more saturated fatty acid, are much better than oils themselves since they

allow the daily intake of total lipid to be kept as low as possible.

Samples enriched in these fatty acids are needed to further investigate their nutritional, health and biochemical effects and to serve as secondary analytical standards. The PUFA concentrates can be produced by several methods, including fractional crystallization, urea fractionation, molecular distillation, supercritical fluid extraction, silver ion complexation and enzymatic hydrolysis and esterification reactions. Different procedures for the obtention of EPA and DHA concentrates at laboratory scale, including urea complexation and interesterification with specific lipases allowing the obtention of concentration up to 90% for both fatty acids, have been developed (Haagsma et al., 1982; Ackman et al., 1988; Haraldsson et al., 1989). However, the nutritional and pharmacological research on these fatty acids needs pure forms of either EPA and DHA.

Microbial conversion of unsaturated fatty acids has been widely exploited to produce new, value-added hydroxy products. The bioconversion reactions by *Pseudomonas aeruginosa* PR3 have been cited extensively among microbial systems that produce mono-, di- and trihydroxy fatty acid derivatives from unsaturated fatty acids (Hou and Bagby, 1991; Kuo et al., 1998, 2001; Kim et al., 2000). Strain PR3, isolated from a wastewater stream on a pig farm in Morton, Illinois, was found to convert oleic acid to a novel compound, 7,10-dihydroxy-8(E)-octadecenoic acid (DOD) (Hou and Bagby, 1991), and to convert ricinoleic acid to a novel compound, 7,10,12-trihydroxy-8(E)-octadecenoic acid (TOD) (Kuo et al., 1998).

Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are formed in animal (including fish and shellfish) tissues, but not plant tissues. DHA is a component of membrane structural lipids that are enriched in certain phospholipid components of the retina and nonmyelin membranes of the nervous system in animal. EPA is a precursor of the ω-3 eicosanoids, which have been shown to have beneficial effects in prevention of coronary heart disease, arrhythmias, and thrombosis (Kinsella et al., 1990). Although microbial bioconversion of EPA and DHA was reported by Hosokawa et al. (2003), the antimicrobial activity of bioconversion products has not been investigated so far.

In this study we describe two comparative procedure for the obtention of almost pure fractions of EPA and DHA by HPLC starting from a concentrate containing up 11.1% and 15.9% in trout oil increased in 58.64% and 40.33% after HPLC optimization (Nieto et al., 1997) and antibacterial availability of bioconversion extracts of EPA and DHA produced by *P. aeruginosa* PR3 strain as determining the inhibition zone and MIC values against a range of foodborne pathogenic bacteria. This concentrate could be used as valuable supplement for food and pharmaceutical purposes.

2. MATERIAL AND METHOD

2.1. Materials

2.1.1. Fish Oil

The rainbow trout oil used in this study was obtained from a commercial company from Adana.

2.1.2. Microorganisms

P. aeruginosa PR3, kindly provided by Dr. Hou in USDA/ ARS/NCAUR, Peoria, IL, USA, was grown at 28°C aerobically at 200 rpm on screening medium (SM) containing per liter 4 g dextrose, 2 g K_2HPO_4, 2 g $(NH_4)2HPO_4$, 1 g NH_4NO_3, 0.5 g yeast extract, 0.014 g $ZnSO_4$, 0.01 g $FeSO_4 \cdot 7H_2O$ and 0.01 g $MnSO_4 \cdot 7H_2O$.

Eleven strains of foodborne pathogenic and spoiling bacteria including *Bacillus subtilis* (ATCC 6633), *Enterobacter aerogenes* (KCTC 2190), *Escherichia coli* (ATCC

8739), *E. coli* O157:H7 (ATCC 43888), *E. coli* O157:H7 (human), *Listeria monocytogenes* (ATCC 19166), *Pseudomonas aeruginosa* (KCTC 2004), *Salmonella enteritidis* (KCCM 12021), *S. typhimurium* (KCTC 2515), *Staphylococcus aureus* (ATCC 6538) and *S. aureus* (KCTC 1916) were obtained from the Korea Food and Drug Administration, Daegu, Korea. The stock cultures were maintained on Luria broth (LB) agar medium at 4°C. Active culture for experiments were prepared by transferring a loopful of cells from stock cultures to flasks and inoculated in the LB and incubated at 37 °C for 24 h. The cultures were diluted with fresh LB to achieve optical density of 10^5 CFU/ml for the test organisms.

2.1.3. Chemicals

EPA and DHA as substrates were purchased from Sigma-Aldrich (Germany). The purity of substrate fatty acids was over 95%. All another chemicals used in this study were purchased from Merck.

2.2. Methods

2.2.1. Purification of EPA and DHA Fractions

The mobile phase for the purification of fatty acids in rainbow trout oil was ethanol and HPLC grade ultra pure water. The separation time of total fatty acids was 20 minute. The program takes 1 minute to return to the initial condition after separation. The injection level was 5 µl and the determination was at 254 nm (Nieto, 1997).

2.2.2. Fatty Acids Analysis of Fractions

Samples were converted to their constituent fatty acid methyl esters by the method of Ichihara et al. (1996), by using 2M KOH in methanol and n-heptane with minor modifications. Twenty mg of sample was dissolved in 2 ml n-heptane followed by 4 ml of 2 M methanolic KOH. The tube was then vortexed for 2 min at room temperature. After centrifugation at 4000 rpm for 10 min, the n-heptane layer was taken for gas chromatography analyses.

2.2.3. Bioconversion reactions

Bioconversions were carried out in 50 ml of SM which was containing (per liter) 4 g dextrose, 2 g K_2HPO_4, 2 g $(NH_4)2HPO_4$, 1 g NH_4NO_3, 0.5 g yeast extract, 0.014 g $ZnSO_4$, 0.01 g $FeSO_4 \cdot 7H_2O$ and 0.01 g $MnSO_4 \cdot 7H_2O$. EPA and DHA (each 0.5 g) as substrates were added to 24 h old cultures separately followed by continued incubation for an additional 72 h and then continuously shaken at 200 rpm in a Psycro Therm controlled environment shaker (New Brunswick Scientific, Edison, NJ) for specified temperature and duration and bioconversion was allowed to proceed. At the end of the bioconversion the culture broth was acidified to pH 2.0 with 6 N HCl and extracted twice with an equal volume of ethyl acetate/diethyl ether (1:1 vol/vol). The solvent was then evaporated from the combined extract with a rotary evaporator and the crude lipid extracts were obtained with the yield of 95%.

2.2.4. Antibacterial assay

Antibacterial tests were carried out by disc diffusion method (Murray et al., 1995), using 10 ml of suspension containing 10^5 CFU/ml of bacteria and poured on LB agar. The discs (6 mm in diameter) separately were impregnated with 1.5 µl (1500 µg crude lipid extracts) of bioconverted eicosapentaenoic and docosahexaenoic acids respectively and placed on the inoculated agar. The inoculated plates were incubated at 37 °C for 24 h. Antibacterial activity was evaluated by measuring the diameter of inhibition zones against the test microorganisms. Each assay for EPA and DHA in this experiment was performed in triplicate. Non-bioconverted EPA and DHA as substrates were used as negative control.

2.2.5. Minimum inhibitory concentration (MIC)

Minimum inhibitory concentrations of the crude lipid extracts of the bioconverted eicosapentaenoic and docosahexaenoic acids were tested by the two-fold dilution method (Murray et al., 1995). A loopful of the bacterial culture from the LB slant was inoculated in the Luria broth and incubated at 37 °C for 24 h, and two-fold serial dilution method was followed as below. The crude extract was first dissolved in 5% dimethyl sulfoxide (DMSO). This solution was further diluted with 5%DMSO and was added to LB to final concentration of 0, 125, 250, 350, 500, 650, 800, 1000, 2000, 3000, 4000, 5000 µg/ml. The bacterial suspensions of tested strains were inoculated in LB medium in 25 ml of cap tube and incubated for 24 h at 37 °C. The minimum concentration at which no visible growth was observed in the tube was defined as MIC, which is expressed in µg/ml. A set of tubes containing only seeded liquid medium was kept as control and 5% DMSO control was also maintained. All the tests for MIC determinations were performed in triplicate.

2.2.6. Statistical analysis

Analysis of variance was conducted with SAS program (Cary, NC, USA). Comparison of means was performed using Duncan's multiple test with significance level of α=0.05 using the same program.

3. RESULTS AND DISCUSSION

The chromatographic profile of the EPA + DHA concentrate obtained from rainbow trout oil subjected to HPLC elution has been given in Figure 1. The retention time of the desired omega-3 fatty acids was found in the peak between 3.5 and 4.7 minutes. The fraction in this range was then esterified to be injected in a gas chromatography (GC) apparatus for yield analysis after collection with HPLC fraction collector.

Table 1 shows the EPA and DHA composition of the concentrate, expressed as percentage of the total fatty acids present in the sample, compared to the original fatty acid composition of rainbow trout oil before the concentration procedure. Individual concentrations of EPA and DHA in the concentrate are 58.64% and 40.33% respectively.

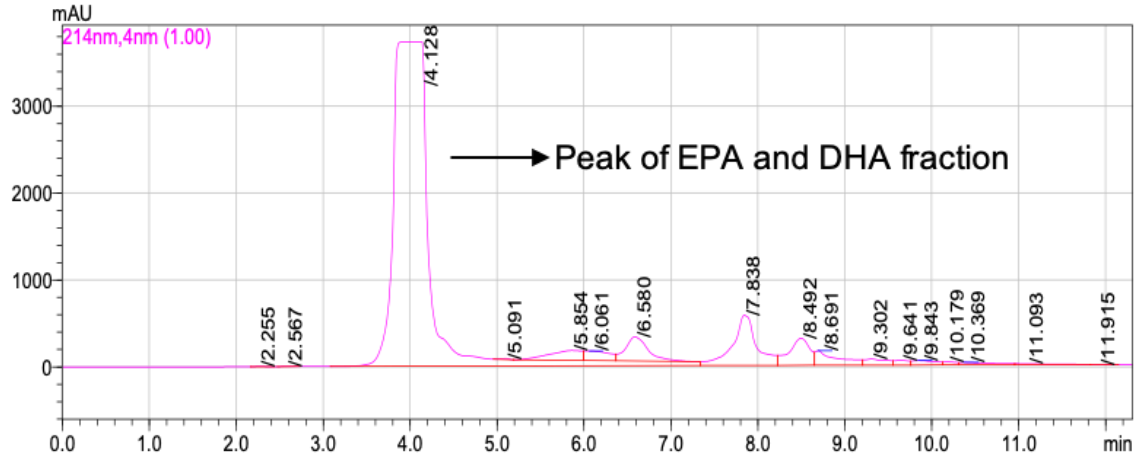

Figure 1. Peak of EPA and DHA fraction after HPLC purification

Table 1. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) composition (% methyl esters) of rainbow trout oil before and after the concentration procedure

	Before concentration procedure	**After concentration procedure**
EPA	11.1	58.64
DHA	15.9	40.33
EPA + DHA	27.0	98.97

* Results represent a typical concentration procedure.

As a result of bioconversion of EPA and DHA, total of 44 biotransformation components have been identified after GC-MS analysis. The components of this extract are carbonochloridic acid, methoxymethane, hydrazine, L-prolin, oxalic acid, luprisol, propionaldehyde, caproaldehyde, propanoic acid, valeric acid, 1,1-dimethoxyoctane, cyclooctane, sulfurous acid, butyric acid, 1,2,3,4-undecanetetrol, 2-propenoic acid, butanedioic acid, 2,2,3- triethyloxirane, acrolein, tetrahydropyrrolo, thaizole, cyclohexanecarboxylic acid, diethyl carbinol, cyclohexanone, butanoic acid, decanoic acid, 4-pentenyl butyrate, 1-heptene, cyclohexanol, silane, 1-butyne, birnenoel, trifluoroacetic acid, dodecane, pentalene-1,5-dione, 3-decen-1-ol, cyclopentaneundecanoic acid, ethyl isohexanoate, 1-pentanol, propylphosphonic acid, 4-heptenoic acid, hex-4-enoic acid, butyldimethylsilanol and 4-methylhexyl acetate. As a major components are 15,18-dihydroxy-14,17-epoxy-5 (Z), 8 (Z), 11 (Z) -eicosatrienoic acid (18.2), 17,19-dihydroxy-16,18-epoxy-4 (Z),7(Z),10(Z),13(Z)-docosatetoraenoic acid (11.96), carbonochloridic acid (2.99%), methoxymethane (40.6%), caproaldehyde (7.85%), 2-propenoic acid (8.13 %) and cyclohexanone (2.07%).

In-vitro antibacterial activities of EPA and DHA biotransformation products against foodborne pathogenic bacteria were determined qualitatively and quantitatively by inhibition zone and MIC values. According to the results given in table 2 and 3, the crude extracts of bEPA and bDHA showed high antibacterial activity against two gram positive (*L. monocytogenes* (ATCC 7677) and *S. aureus* (ATCC 29213)) and six gram negative (*E. faecalis* (ATCC 29212), *E. coli* (ATCC 25922), *P. aeruginosa* (ATCC27853), *K. pneumonia* (ATCC700603), *A. hydrophila* (NCIMB1135) and *S. paratyphii* A (NCTC13)) pathogenic bacteria. Although eicosapentaenoic acid, which is not bioconverted and used as negative control, exhibit very low antimicrobial activity, non-bioconverted doxahexaenoic acid did not showed any antibacterial effect. The inhibition zone diameters and MIC values for bacterial strains varied between 7-12 mm and 350-5000 μg/ml for crude bEPA extract and 7-12 mm and 250-4800 μg/ml for crude bDHA extract, respectively (Table 1 and 2). Control group as applied 5% DMSO used in this study did not inhibit any test bacteria. Gram-positive bacteria were more sensitive to bEPA and bDHA than gram-negatives and showed relatively higher antimicrobial activity than other strains against *L. monocytogenes* and *S. aureus* (ATCC 7677) strains (Table 2). *P. aeruginosa* (ATCC 27853) from gram negative bacteria appears to be the most sensitive bacteria to DHA.

Table 2. Growth inhibition zone produced by bacteria against bEPA and bDHA extracts

Bacteria	Inhibition Zone (mm)	
	EPA	**DHA**
Listeria monocytogenes ATCC 7677	12	13
Staphylococcus aureus ATCC 29213	10	11
Pseudomonas aeruginosa ATCC 27853	10	12
Escherichia coli ATCC 25922	8	7
Klebsiella pneumoniae ATCC700603	7	8
Enterococcus faecalis ATCC 29212	7	7
Aeromonas hydrophila NCIMB 1135	7	7
Salmonella paratyphii A NCTC 13	7	8

In the antibacterial susceptibility studies, many essential oils have been reported using against *P. aeruginosa* (Deans and Ritehie, 1987; Knobloch et al., 1989; Paster et al., 1990). These results have been substantially similar to those reported by other researchers for essential oils (Cosentino et al., 1999; Lambert et al., 2001; Karaman et al., 2003). Other gram-negative organisms had been less sensitive to the effect of antimicrobial compounds than *Pseudomonas aeruginosa*. This is probably due to the fact that their cell wall perimeter has an outer membrane (Ratledge and Wilkinson, 1988), which limits the diffusion of hydrophobic compounds along the lipopolysaccharide cover (Vaara, 1992).

The growth inhibition of bEPA and bDHA crude extracts was similar to gram positive bacteria, but DHA's bioconversion extract was more effective than EPA as the minimum inhibition concentration against gram negative bacteria (Table 3). This was closely related to experimental findings that oxidative activity of DHA's crude biotransformation extract was higher than that of EPA (Kim et al., 2006). As a result, the antibacterial properties of crude extracts converted by the biotransformation of ω-3 fatty acids such as EPA and DHA were produced by *P. aeruginosa* PR3 bacterial strain.

Table 3. MIC values of bEPA and bDHA extracts which inhibit the growth of bacteria

Bacteria	MIC (µg/mL)	
	bEPA	**bDHA**
Listeria monocytogenes ATCC 7677	350±10.00[a]	350±9.50[a]
Staphylococcus aureus ATCC 29213	500±5.00[a]	500±5.80[a]
Pseudomonas aeruginosa ATCC 27853	350±7.20[a]	250±6.30[b]
Escherichia coli ATCC 25922	2350±27.00[a]	1800±30.50[b]
Klebsiella pneumoniae ATCC700603	1800±28.60[a]	1650±29.90[b]
Enterococcus faecalis ATCC 29212	5000±32.00[a]	4800±23.50[b]
Aeromonas hydrophila NCIMB 1135	2350±18.30[a]	1650±11.80[b]
Salmonella paratyphii A NCTC 13	1800±16.40[a]	1650±12.40[b]

[a] and [b] shows statistically significant differences between bEPA and bDHA against test bacteria.

4. CONCLUSION

The results showed that *P. aeruginosa* PR3 may suggest that EPA and DHA's bioconversion extracts are promising antimicrobial agents for improving food safety for control of foodborne pathogens. In order to produce and bioprocess extruding extracts of a wide range of EPA and DHA, it is necessary to isolate the active new compounds from the crude extracts and to define their chemical structures to make them feasible and practical. As a result of this study, bEPA and bDHA extracts significantly inhibited bacterial growth.

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CONFLICT OF INTEREST

The authors declare there are no conflicts of interest.

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Research Article
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Do Commodity Prices Matter for Second Hand Values? An Empirical Research on Capesize Market

Emtia Fiyatları İkinci El Değerler için Önemli midir? Capesize Piyasası Üzerine Bir Uygulama

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 5 Sayı: 1 (2019) 44-52

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ABSTRACT

In this study, it is aimed to investigate the relationship between second hand values of Capesize ships and iron ore prices which is the basic loads of Capesize type ships. In this respect, the asymmetric causality test has been used to determine the causal relationships between the shocks contained in the series. This test examines the nonlinear relationships by separating the positive and negative shocks in the series. Considering that the reactions of the agents in the market may also change according to the type of shock (news), this method provides great advantage. The data set used in the study consists of 227 monthly observations covering the dates between July 1999 and May 2018. According to the results, positive shocks in iron ore price are the cause of positive shocks in the value of 5-year-old Capesize vessel. Furthermore, the negative shocks in the iron ore price are the cause of negative shocks in the value of 5 years old Capesize vessel. These results are hoped to bring a different perspective to the literature and open a new window to the researchers. In addition, iron ore prices for those who plan to invest in this sector can be said to be the leading indicator for second hand Capesize vessel values. Increasing shocks in commodity prices trigger shocks which increase the ship value, therefore, realizing the investment strategies by following the commodity prices can reduce the risks caused by uncertainty and even lead to significant profit opportunities.

Keywords: Capesize ship, Second hand value, Commodity price, Asymmetric causality.

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ÖZET

Bu çalışmada Capesize gemilerinin ikinci el değerleri ile bu gemilerin en temel yükü olan demir cevheri fiyatı arasındaki ilişkinin incelenmesi amaçlanmaktadır. Bu doğrultuda serilerin içerdikleri şoklar arasındaki nedensellik ilişkisini tespit etmek için asimetrik nedensellik testi kullanılmaktadır. Bu test değişkenlerdeki pozitif ve negatif şokları ayrıştırarak doğrusal olmayan ilişkileri tespit edebilmektedir. Piyasadaki ajanların gelen şokun (haberin) türüne göre farklı tepkiler verebilecekleri düşünüldüğünde, bu yöntem önemli bir avantaj sağlamaktadır. Çalışmada kullanılan veri seti 227 aylık gözlemden oluşmaktadır ve Temmuz 1999 ile Mayıs 2018 tarihleri arasını kapsamaktadır. Elde edilen sonuçlara göre, demir cevheri fiyatındaki pozitif şoklar 5 yaşındaki Capesize gemisinin değerindeki pozitif şokların nedenidir. Ayrıca demir cevherindeki negatif şoklar da 5 yaşındaki Capesize gemi değerindeki negatif şokların nedenidir. Bu sonuçların literatüre farklı bir bakış açısı kazandırması ve araştırmacılara yeni bir pencere açması umulmaktadır. Ek olarak, demir cevheri fiyatlarının sektöre yatırım yapacak olanlara Capesize gemi değerleri için öncü gösterge oldukları söylenebilmektedir. Emtia fiyatındaki arttırıcı şoklar gemi değerindeki arttırıcı şokları da tetiklemektedir, bu yüzden yatırım stratejilerini gerçekleştirirken emtia fiyatlarını takip etmek belirsizlikten kaynaklı riskleri azaltabilir ve hatta çok önemli kar fırsatları da sağlayabilir.

Anahtar sözcükler: Capesize gemi, İkinci el değer, Emtia fiyatı, Asimetrik nedensellik.

1. INTRODUCTION

Dry bulk shipping one of the most convenient and cost-effective method of global transportation of large volume cargoes (Dai et al., 2015), which are generally composed of five major bulks that are iron ore, coal, grain, bauxite/alumina, and phosphate (Wright, 1991). The bulk market is directly affected by the changes in the demands of these cargoes, since the structure of the market is derived demand (Branch, 2012:1). One of the most important factors affecting the demand for commodities is the prices of them.

Changes in commodity prices are related to the state of global economic activities in general. Sudden rise in the demand for commodities may not be met by the supply at the same rate, and this situation causes sudden increases in their prices. But also declines in commodity supply can also lead to price increases. If the increase in commodity prices is due to the demand-side shocks rather than supply-side ones, this is considered to be a sign of strong global economic activities (Tsioumas and Papadimitriou, 2018).

It is clear that commodity prices have a possible relationship with freight rates, given that they may be indicative of the demand for maritime transport, and this relationship is confirmed by many studies in the literature (Kavussanos et al., 2010; Kavussanos et al., 2014; Yu et al., 2007; Chou et al., 2015; Tsioumas and Papadimitriou, 2018). Considering the close relationship of the freights with the ship values, it is likely that the commodity prices may have an impact on ship values as well. Especially the second hand ship market is very liquid compared to the shipbuilding market, and prices are very

volatile in this market (Adland and Jia, 2015; Açık and Başer, 2018). The delivery of a ship ordered in the shipbuilding market can be made after 2 years, therefore the prices are not as volatile as the second hand prices (Başer and Açık, 2018). However, as Tsioumas and Papadimitriou (2018) have stated, changes in commodity prices are not generally demand-driven and may also be supply-driven. Therefore, examining the relationship between commodity price and ship value in a linear way causes some points to be overlooked. In addition, the maritime market is a very volatile and risky market (Jing et al., 2008) since it is exposed to many unexpected events, shocks and crisis. However, a study examining this possible relationship with this approach has not been found in the literature. In this context, this study aims to examine the possible relationship between commodity prices and second-hand ship values through the Capesize ships and iron ore prices. The iron ore commodity has been chosen since iron ore is a type of commodity mostly transported by Capesize vessel types (Stopford, 2009: 69).

The asymmetric causality analysis developed by Hatemi-J (2012a) is preferred in this study, which is a nonlinear method and allows to determine the asymmetrical causality relationship between the shocks in the series in four possible combinations; from positive to positive, from positive to negative, from negative to negative, from negative to positive. When the financial series are thought to be subject to too many unexpected events and shocks, it is inevitable that their structures become non-linear. In addition, the reactions of players in the market may vary depending on the type of shocks (news) they are exposed to. The variables that are subject to this study are also affected by many macro factors. Considering all these evaluations, it can be said that the asymmetrical causality test is quite suitable for the spirit of this study. As a result of the study, the unidirectional causal relationship between the iron ore price and the 5-year-old ship value is examined and two significant causalities are determined. The findings reveal that positive shocks in iron ore price are the cause of positive shocks in the ship value, and negative shocks in iron ore prices are the cause of negative shocks in ship value. Thus, it is hoped that this study provides important contributions to the maritime literature by approaching the subject from a different viewpoint with its novel method. Moreover, it is expected that these results will benefit the stakeholders who are interested in the Capesize shipping market in terms of reducing the risks of investment and being one step ahead in the market.

The remainder of the study is organized as follows; the relevant literature is reviewed in the second section; the method used in the study is introduced in the third section; the findings obtained from the analyzes are presented in the fourth section; and finally, evaluations are made in the last section.

2. LITERATURE REVIEW

Any similar study has not been found in the literature. Instead, there are several studies investigating the relationship between commodity prices and freight indices, and some other studies examining the second-hand values of the ships.

The main subjects of the commodity price and freight rate related studies are; economic spillover effect (Kavussanos et al., 2010, Kavussanos et al., 2014) and linear causality relation (Yu et al., 2007;

Chou et al., 2015; Tsioumas and Papadimitriou, 2018). The general results of these studies are as follows; there are return and volatility spillover effect between Panamax freight and commodity derivatives markets; commodity futures lead the FFAs in both in returns and volatilities; Baltic Capesize Index is a leading indicator for Asian Steel Index; there are some unidirectional and bidirectional causalities between freight rates and commodity prices. These studies confirm the relationship between the freight rates, which are the main determinants of ship values, and commodity prices.

The subjects of the second hand ship related studies that can be reached in the literature are; second hand ship valuation (Strandenes, 1984; Alizadeh and Nomikos, 2003), ship sale & purchase volume and second hand price volatility (Dai et al., 2015), price dynamics in different sizes of ships (Kavussanos, 1997), and volatility analysis compared with newbuilding prices (Adland and Jia, 2015). The general results of these studies are as follows; increasing sale & purchase volume reduces the second hand price volatility; price fluctuations in larger vessels are more volatile than smaller ones; volatilities in newbuilding prices are lower than volatilities in second hand prices.

As Lun and Quaddus (2008) have stated, the second hand values are based on the probability to profit now and in the future. Therefore, the second hand values of the vessels are directly related to the freight rates in the market, and it is quiet natural that there is a relationship between the commodity prices and the second hand values as the relationship between commodity prices and freight rates is confirmed by many studies in the literature. The fact that it has not been found any study examining this relationship in a nonlinear way constitutes the motivation of this study.

3. METHODOLOGY

The asymmetric causality test used in this study has been developed by Hatemi-J (2012a). This method determines the asymmetric causality by using the cumulative sums of the positive and negative shocks (Tugcu and Topcu, 2018). In this way, it can differentiate the causal impacts of negative and positive shocks (Shahbaz et al., 2017). This feature makes it possible to achieve very overlapping results with real-life problems, since agents in the markets may react differently according to the type of the shock (Hatemi-J, 2012a), and thus asymmetric positive and negative shocks may produce different causal impacts (Hatemi-J, 2012b).

Since the asymmetric causality test involves the Toda and Yamamoto (1995) process in its structure, the series do not have to be stationary, however, the value of the maximum degree of integration must be known (Umar and Dahalan, 2016). The unit root tests are used to determine this value, and if there is a unit root, extra lag(s) is added to the unrestricted VAR equations (Hatemi-j, 2012a). Then, some initial values such as the maximum number of lag, the number of bootstrap simulation repetition and the type of information criteria are determined, and analyses are carried out.

4. FINDINGS

The data set used in the study consists of 227 monthly observations covering the dates between July 1999 and May 2018. The iron ore price and the 5-year old Capesize vessel value are visually

presented in Figure 1. According to the graph, they mostly follow a parallel course, which may be due to the fact that the iron ore price also includes transportation costs.

Descriptive statistics for the variables used in the study are presented in Table 1 as raw data, logarithmic data and return data. According to the statistics of the ore data, the lowest price is observed as $ 27, while the highest price is observed as $ 82 in the covered period. The same statistics for the 5 years-old Capesize vessel are minimum $ 21 million and maximum $ 153,5 million. In the asymmetric causality test, the logarithmic forms of the series are used. By doing so, the discrete series become continuous and the processability of the data increases. In addition, better distribution properties can be obtained (Shahbaz et al., 2017).

Return series are obtained by using $R_p=ln_p-ln_{p-1}$ and are important since they provide information about the shocks and non-linearity of the series. If the Kurtosis values are significantly higher than 3, the sign of Skewness indicates the types of news (shocks) that the series are mostly affected. For instance, the Kurtosis values of both variables are very high, and the Skewness value of the vessel value is negative while the value of the ore price is positive. This situation shows that ore variable is more exposed to positive news while ship value variable is more exposed to negative news in the covered period.

Another most important information provided by the return series is related to non-linearity. Since the financial series are exposed to many unexpected events and shocks, this distracts their distribution from normal distribution characteristics due to the tail effects. Therefore, the lack of normal distribution characteristics of the series can be interpreted as a sign that non-linear methods can be used (Shahbaz et al., 2017). Jarque-Bera statistics in the return series test normal distribution, and the null hypothesis of this test indicates that the series are normally distributed. When the probability values of this test are examined, it is seen that the null hypothesis is rejected for both variables. In other words, variables are suitable to be examined by a non-linear method. The following step is to apply the unit root tests to the series in order to determine the maximum order of integration.

Augmented Dickey-Fuller (1979) and Phillips-Perron (1988) tests are applied to determine the maximum degree of integration in the series, and the results are presented in Table 2. According to the results obtained, both tests indicate that the series become stationary when first differences of them are taken. According to these results, both series are I (1) and the maximum degree of integration is determined as 1. After determining this value, asymmetric causality test is applied.

Some initial values must be determined before the asymmetric causality test is applied. The maximum number of lags for the VAR equations in the test determined as 12 since the frequencies of the series are monthly. The maximum number of bootstraps for the calculation of critical values is selected as 1000. Finally, the AICc information criteria, which is the corrected version of the Akaike Information Criteria (AIC), is used to select the best model. After these values are determined, analysis is performed by using GAUSS codes written by Hatemi-J (2012a). The results of the test are presented in Table 2. According to the results, positive shocks in ore price are the cause of positive shocks of second-hand ship value, and negative shocks in ore price are the cause of negative shocks of second-hand ship value.

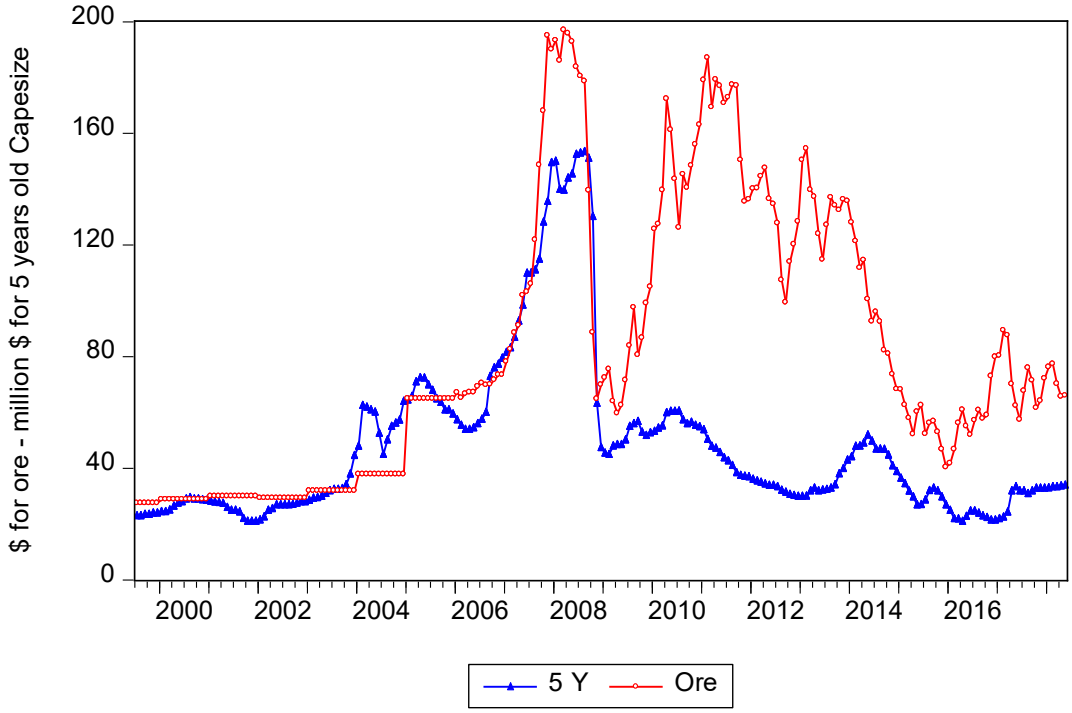

Figure 1. Graphical display of the variables (Bloomberg, 2018; Worldbank, 2018).

Table 1. Descriptive statistics of the variables

	Ore	5 Y	Ln Ore	Ln 5 Y	R Ore	R 5 Y
Mean	82.2	48.1	4.22	3.73	0.00	0.00
Med.	67.3	36.5	4.20	3.59	0.00	0.00
Max.	197.1	153.5	5.28	5.03	0.53	0.27
Min.	27.5	21.0	3.31	3.04	-0.45	-0.72
Std. D.	49.1	29.9	0.61	0.49	0.09	0.07
Skew.	0.73	2.03	0.00	0.85	0.14	-3.67
Kurt.	2.39	6.94	1.77	3.21	10.8	40.5
J.B.	23.9	304.3	14.1	28.1	573	13757
Prob.	0.00	0.00	0.00	0.00	0.00	0.00
Obs.	227	227	227	227	226	226

Table 2. Unit root test results

		Level		First Difference	
	Variable	Intercept	Trend and Intercept	Intercept	Trend and Intercept
ADF	Capesize 5 Y	-2.1764	-2.2060	-8.5843*	-8.6044*
	Ore	-1.8857	-1.6840	-10.879*	-10.909*
PP	Capesize 5 Y	-1.8778	-1.8898	-8.5495*	-8.5660*
	Ore	-1.7242	-1.3902	-10.725*	-10.738*

Critical values:-2.57 for 10%, -2.87 for 5%, -3.45 for 1% at Intercept; -3.13 for 10%, -3.42 for 5%, -3.99 for 1% at Trend and Intercept.

Table 3. Asymmetric causality for 5 years old ship

		Commodity => Capesize			
		$C^{+}5^{+}$	$C^{+}5^{-}$	$C^{-}5^{-}$	$C^{-}5^{+}$
Opt. Lag; VAR(p)		2	3	3	3
Additional Lags		1	1	1	1
Test Stat (MWALD)		5.02	3.04	306	3.39
Asym. chi-sq. p-val.		0.08***	0.38	0.00*	0.33
Critical Val.	1%	15.6	0.00	0.00	0.38
	5%	6.49	0.00	0.00	0.00
	10%	5.52	0.00	0.00	0.00

5. CONCLUSIONS

In this study, the effect of the shocks in the commodity price on the second hand price of the ships is examined by a non-linear method through Capesize vessel and iron ore prices, and significant results are obtained. Capesize ships are one of the largest ship types used in dry bulk transport and are mostly used in transoceanic distances for iron ore transportation. Therefore, it is inevitable to be affected by the changes in iron ore price.

In the literature, any similar study examining the relationship between ship value and commodity prices has not been found. Only the studies examining the relationship between freight market and commodity prices have been found. The fact that this study is examining this issue and approaching the subject from a different angle makes it distinctive.

As a result of the study, it is determined that the positive shocks in the iron ore price are the cause of the positive shocks in the second hand price, and the negative shocks in the iron ore price are the cause of the negative shocks in the second hand prices. This results may be attributed to two reasons; demand-driven impact and cost-driven impact. Demand-driven impact can be explained as: the increase in commodity prices is stem from increased demand for commodity, and this demand growth the increases in ship values due to the increasing freight rates. Just the contrary, decrease in demand for commodity results in decrease in its price and demand for transportation. Then a depreciation in ship values occurs due to the falling freight rates. Cost-driven impact can be explained as: since the iron ore is the raw material of steel production, an increase in the price increases the new construction prices, which leads to an appreciation of the second-hand ship values. On the contrary, when the iron ore prices decrease, it is reflected negatively on the ship's values as production costs decrease.

Further studies may examine the targeted relationship by increasing commodity and ship types in order to make the possible relationship more generalizable. Moreover, if the relationship between ship value and commodity prices is analyzed by including the data after May 2018, it may be possible to reveal the impact of the recent shocks experienced in the financial markets of Turkey and the World due to the foreign trade restrictions on the commodity prices and second hand values of the ships. Also newbuilding prices may be included in the model and the results can be more generalized. The relationship can also be examined for another type of maritime markets such as crude oil transportation or LNG transportation. In addition, the subject can be approached from different perspectives by using methods such as time-varying or lagged causalities.

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Research Article
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Investigation of performance characteristics using Stochastic Reactor Model in a biodiesel pilot-fueled natural gas engine

Biyodizel pilot yakıtlı doğalgaz motorunda performans karakteristiklerinin Stokastik Reaktör Model kullanılarak incelenmesi

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 5 Sayı: 1 (2019) 53-63

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ABSTRACT

In this study, the effects of different biodiesel pilot fuel injection pressures on performance characteristics of a natural gas engine were investigated using 'Kinetics & SRM Engine Suite' software which is based on stochastic reactor model (SRM). This advanced software uses chemical kinetic mechanisms of fuels to simulate combustion process of the engine. 'Methyl decanoate/methyl-9-decenoate/n-heptane' reduced chemical kinetic mechanism including 71 species and 217 reactions were defined as a biodiesel surrogate fuel chemical kinetic mechanism to represent biodiesel fuel in this study. Theoretical model set by the way of software tools was validated by experimental data. Then, simulation was run in three different stochastic particle numbers (50, 100, and 150) to investigate engine performance characteristics of a biodiesel pilot-fueled natural gas engine. It is observed that as pilot fuel injection pressure increases, engine torque and brake power enhance, but brake specific fuel consumption decreases. Furthermore, various stochastic particle numbers used in the simulation did not dramatically affect data of engine performance characteristics simulated.

Keywords: Dual fuel engine, Natural gas, Biodiesel pilot fuel, Stochastic Reactor Model, Engine Performance.

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ÖZET

Bu çalışmada, bir doğalgaz motorunda farklı biyodizel pilot yakıt püskürtme basınçlarının performans karakteristiklerine etkileri stokastik reactor modele (SRM) dayanan 'Kinetics & SRM Engine Suite' yazılımı kullanılarak incelenmiştir. Motorun yanma işleminin benzetimini yapmak için bu gelişmiş yazılım yakıtların kimyasal kinetik mekanizmalarını kullanır. Bu çalışmada, biyodizel yakıtı yansıtmak için 71 bileşen ve 217 reaksiyon içeren 'Metil dekanoat/metil-9 dekenoat/n-heptan' kimyasal kinetik mekanizması biyodizelin yerini tutan yakıt kimyasal kinetik mekanizması olarak tanımlanmıştır. Yazılım araçları vasıtasıyla ayarlanan teorik model deneysel veri aracılığıyla doğrulanmıştır. Sonrasında, biyodizel pilot yakıtlı doğalgaz motorunun motor performans karakteristiklerini incelemek için benzetim işlemi üç farklı stokastik parçacık sayısında (50, 100 ve 150) gerçekleştirilmiştir. Pilot yakıt püskürtme basıncının artmasıyla motor döndürme momenti ve efektif gücün arttığı fakat özgül yakıt tüketiminin azaldığı gözlemlenmiştir. Buna ek olarak, simülasyonda kullanılan çeşitli stokastik parçacık sayılarının benzetimi yapılmış motor performans karakteristik verilerini önemli ölçüde etkilemediği saptanmıştır.

Anahtar sözcükler: Çift yakıtlı motor, Doğalgaz, Biyodizel pilot yakıt, Stokastik Reaktör Model, Motor Performansı

1. INTRODUCTION

Internal combustion engine (ICE) researchers have primarily focused to develop reformer engines (HCCI, PCCI and RCCI) being innovative, eco-friendly and having high fuel economy because of increasing environmental concerns and status of fossil fuels depletion (Namasivayam *et al.*, 2010; Papagiannakis *et al*., 2010). There have been numerous experimental and simulation studies to investigate reformer type of engines (Bissoli *et al.*, 2016; Wang *et al.*, 2016; Li *et al.*, 2016; Park and Yoon, 2016). Primary data have been obtained by the way of experimental studies in research activities. However, experimental studies are of some challenges and restrictions. Simulation-based approaches are briefly an important alternative used by ICE researchers. A Computational Fluid Dynamics (CFD) based engine simulation approaches are widely used in engine research activities. One Dimensional (1D) CFD and Three Dimensional (3D) CFD are called as first and second generation simulation methods (Dizy *et al.*, 2016). However, 3D CFD approach is highly time-consuming during engine simulation due to above expressions (Anetor, 2013; Pasternak *et al.*, 2014; Pasternak *et al.*, 2016). Consequently, Zero Dimensional (0D) 'Kinetics & SRM Engine Suite' Software has been developed to meet this challenge. Aforementioned software is based on Probability Density Function (PDF) methods and called as a third generation simulation method at the same time (Dizy *et al.*, 2016; Maurya and Akhil, 2017). 0D means that position of the stochastic particles have no information. 'Kinetics & SRM Engine Suite' software has been validated by experimental data related to low temperature combustion, direct injection compression ignition and direct injection spark ignition modes for twelve years and are proved oneself (Dizy

et al., 2016; Maurya and Akhil, 2017; Bhave *et al.*, 2004; Bjekborn *et al.*, 2012; Lundgren *et al.*, 2013; Pehlivan *et al.*, 2016).

One of the developed engine types is dual fuel engine to supply better combustion. In these engines, two different fuels (gas+liquid) are concurrently conceded in combustion chamber. The dual fuel engines can be served both current liquid fuels (diesel and biodiesel) and gaseous fuels (natural gas, biogas, producer gas, hydrogen) (URL-1, 2016; URL-2, 2016; Supee *et al.*, 2014; Bora and Saha, 2015; Korakianitis *et al.*, 2010; Carlucci *et al.*, 2013). Diesel fuel has generally used as a pilot fuel in the dual fuel engines, but recently biodiesel has been widely utilized because of high cetane number compared to diesel fuel. Natural gas as a main fuel has generally used in the dual fuel engines in that it has lower C/H ratio and higher auto-ignition temperature compared to other hydrocarbon fuels. In available literature, biodiesel pilot fueled natural gas engines are investigated with experimental studies to display the effect of pilot injection parameters (pilot injection pressure, pilot injection timing, pilot injected mass etc.) on engine performance, exhaust emissions and combustion characteristics (Ryu, 2013a; Ryu, 2013b; Gharehghani *et al.*, 2015). However, it has not found any stochastic reactor model (SRM) based theoretical study related to these type of dual fuel engines.

Therefore, SRM was set to investigate the effects of different pilot injection pressures and three different stochastic particle numbers on brake power, engine torque, brake specific fuel consumption of a biodiesel pilot fueled natural gas engine in this study.

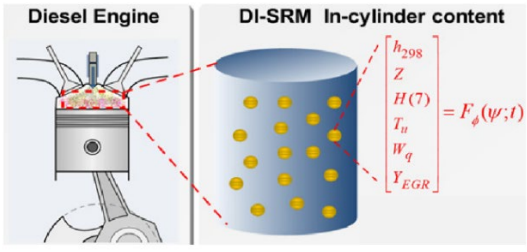
2. SRM ALGORITHM

2.1. Model Depiction

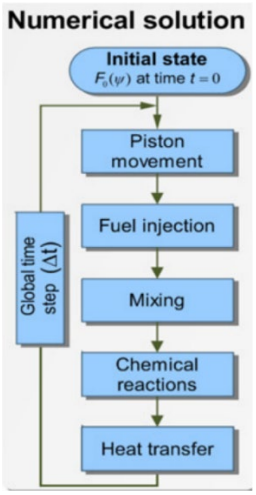
SRM is a spatially zero-dimensional model based on the opinion which real fluid particles and homogeneity inside the cylinder is switched the unreal stochastic particles and statistically homogeneity (Ahmedi *et al.*, 2014; Maurya and Akhil, 2016; Franken *et al.*, 2019). Each unreal particle has mass, chemical composition, and temperature. In addition, these particles also possess the capability of mixing with other particles next to exchange heat with cylinder walls.

Cylinder substances depend on pressure and volume changes, chemical reactions, heat transfer, mixing and fuel injection. These are independent from the space. All parameters of interest are estimated from these processes. These are subdivided as global and local parameters and obtained by solving the SRM equations using Monte Carlo particle method (Pope, 1985).

Global parameters have invariant value in the combustion chamber and include total mass, volume, mean density and pressure in the SRM model. They are assumed to remain stable spatially in the combustion chamber. If engine geometry (volume), density and equation of state (pressure) are known, global parameters can be predicted (Maurya and Akhil, 2016; CMCL, 2013; Wang *et al.*, 2016; Tunér, 2008; Tunér *et al.*, 2008). Local parameters modified in the combustion chamber are mass fractions and temperatures for each species. They can be assumed as random variables which can modify in the combustion chamber and identify the substances of the gas mixture in the cylinder. These variables are clarified using the mass density function (MDF) (CMCL, 2013). The representation of particles for diesel engines and SRM numerical solution scheme are respectively shown in Fig. 1(a) and Fig. 1(b).



(a)



(b)

Figure 1. Stochastic particles representation in Diesel-SRM model (Franken et al., 2018).

2.2. Solution Algorithm

SRM is rooted in statistical homogeneity supposed to be the same along engine cylinder of the PDF. Nevertheless, MDF has been employed rather than the PDF as the in-cylinder density changes throughout an engine cylinder. The MDF is obtained mass density multiply by PDF and given by Equation (1).

$$\mathcal{F}(\psi;t)=\rho(\psi)f(\psi;t) \tag{1}$$

In Equation (1); ρ, $\mathcal{F}$ and ψ is respectively to express the mass density, MDF and a parameter represented properties such as mass, temperature, pressure. The variation of the MDF on the time is described by the following PDF transport equation (CMCL, 2013).

$$\frac{\partial}{\partial t}\mathcal{F}(\psi;\mathrm{t})=\underbrace{-\sum_{j=1}^{N_S+1}\frac{\partial}{\partial\psi_j}\left[G_j(\psi)\mathcal{F}(\psi;\mathrm{t})\right]}_{\text{chemical reaction}}+\underbrace{\sum_{j=1}^{N_S+1}\frac{\partial}{\partial\psi_j}\left[A_j(\psi)\mathcal{F}(\psi;\mathrm{t})\right]}_{\text{turbulent mixing}}$$
$$\underbrace{-\frac{1}{V}\frac{dV}{dt}\mathcal{F}(\psi;\mathrm{t})}_{\text{piston movement}}\underbrace{-\frac{\partial}{\partial\psi_{N_S+1}}\left[U(\psi_{N_S+1})\mathcal{F}(\psi;\mathrm{t})\right]}_{\text{convective heat transfer}}+\underbrace{\frac{\mathcal{F}_C(\psi;\mathrm{t})}{\tau_{crev}}-\frac{\mathcal{F}(\psi;\mathrm{t})}{\tau_{cyl}}}_{\text{crevice flow}}+\underbrace{\frac{\mathcal{F}_f(\psi;\mathrm{t})}{\tau_f}}_{\text{fuel injection}} \tag{2}$$

In Equation (2), N_S+1 random scalar variables are to verbalize. The analysis function identifying chemical kinetic mechanisms are represented by G_j. The function defining turbulent mixing process occurred into the cylinder are by $A(\psi)$. The displacement volume is denoted by V. The function $U(\psi_{N_S+1})$ specifies the amount of heat that is transferred between the cylinder charge and cylinder walls. The MDF of the gases in the crevice and the fuel are symbolized by $\mathcal{F}_C$ and $\mathcal{F}_f$. The characteristic residence times of the in-cylinder gas, crevice gas and fuel are represented by τ_{crev}, τ_{cyl} and τ_f, respectively (CMCL, 2013). The residence time states the average amount of time that a particle in a particular system (reactor, engine etc.). The initial conditions are described by Equation (3).

$$\mathcal{F}(\psi;0)=\mathcal{F}_0(\psi) \tag{3}$$

The right-hand side of Equation (2) informs the physical in-cylinder processes of chemistry, turbulent mixing, heat transfer, piston movement, crevice flow and fuel injection (CMCL, 2013). This equation is solved by a Monte Carlo stochastic particle method (Pope, 1985; CMCL, 2013; Demir *et al.*, 2015). The PDF with ensemble average is predicated by Equation (4).

$$f(\psi;t)\approx\frac{1}{N_{par}}\sum_{i=1}^{N_{par}}\delta\left(\psi-\psi^{(i)}(t)\right) \tag{4}$$

A number of stochastic particles describing the statistical representation of the PDF is represented by N_{par}. The Dirac delta function (δ) is the PDF corresponding to discontinuous distribution function as Heaviside functions. δ is derivative of the Heaviside function (Pope, 1985). Operating splitting technique, which each term can be treated separately (Ahmedi *et al.*, 2014; Pope, 1985; Strang, 1968) is operated to solve Equation (2).

2.3. Engine Performance Algorithm

The calculations for this section are the standard definitions in engine technologies (Heywood, 1988). In the event that the simulation typifies a *closed system only* (i.e. intake valve *closed* to exhaust valve opening), the open portions of the cycle are guessed to be same to the intake ($P_{int.man.}$) and exhaust manifold pressures ($P_{exh.man.}$), respectively.

2.3.1. Indicated work per cycle

The indicated work ($W_{c,in}$) is calculated by integration of pressure and volume throughout the whole cycle.

$$W_{c,in} = \oint pdV \tag{5}$$

2.3.2. Indicated power per cylinder

The indicated power per cylinder (P_i) is determined depending on the indicated work in Equation (6).

$$P_i = \frac{W_{c,in} \times n}{n_R} \tag{6}$$

where n_R is the number of crank revolutions for each power stroke per cylinder (two stroke n_R=1, four stroke n_R=2).

2.3.3. Mean effective pressure

The Mean Effective Pressure (MEP) is given by Equation (7).

$$\text{MEP} = \frac{P \times n_R}{n \times V_d} \tag{7}$$

where V_d is the displacement volume and n the engine speed.

2.3.4. Engine Torque

The MEP can be used from Equation (8) to obtain the engine torque (T).

$$T = \frac{\text{MEP} \times V_d}{n_R} \tag{8}$$

2.3.5. Brake mean effective pressure and mechanical efficiency

The IMEP and BMEP are related via frictional losses predicted by calculating the FMEP in Equation (9).

$$\text{BMEP} = \text{IMEP} - \text{FMEP} \tag{9}$$

A mechanical efficiency (in percentages), η_m can also be gained by relating indicated, P_i and brake P_b power.

$$\eta_m = 100 \times \frac{P_i}{P_b} \tag{10}$$

2.3.6. Specific fuel consumption and emissions

Specific outputs are obtained by calculating the mass flow rate and dividing by the brake P_b power.

$$\text{Specific Emissions or SFC} = \frac{\dot{m}}{P_b} \tag{11}$$

2.4. Chemical Kinetic Model

The theory of SRM Engine Suite software depends on chemical kinetic mechanism of related fuel. Improved chemical kinetic mechanisms were put to use within software. These mechanisms were initially developed as detailed chemical kinetic mechanism, but use of these mechanisms has considerably been time-consuming. Reduced chemical kinetic mechanisms of

fuels were employed using some reduction methods to solve this problem. In the wake of disposal reduced chemical kinetic mechanism, simulations in CFD or SRM Suite have considerably been fast. 'methyl decanoate/methyl-9-decenoate/n-heptane' biodiesel surrogate reduced chemical kinetic mechanism (Brakora, 2012) was used to depict biodiesel fuel in this study.

2.5. Dual Fuel Engine Specifications and Experimental Data

Experimental data was extracted from the literature (Ryu, 2013a) related to biodiesel pilot fueled dual fuel engine and used to validate the presented SRM model. Specifications of the dual fuel engine are given in Table 1.

Table 1. Specifications of test engine (Ryu, 2013a; Ryu, 2013b).

Description	Specification
Engine model	ND 130DI
Type	Single cylinder DI engine
Bore × Stroke (mm)	95 × 95
Displacement volume (cm^3)	673
Compression ratio	18
Intake valve opening	BTDC 340°
Intake valve closing	ATDC 136°
Exhaust valve opening	ATDC 136°
Exhaust valve closing	BTDC 340°
Combustion chamber	Open chamber
Maximum horse power (ps/rpm)	13/2400
Maximum engine torque (N.m/rpm)	42/2000
Cooling water temperature (°C)	70 ± 2

3. RESULTS AND DISCUSSION

In this study, the effects of five biodiesel pilot fuel injection pressures (30, 60, 90, 120 and 150 MPa) on engine performance characteristics were investigated at three different stochastic particle numbers (50, 100 and 150) by SRM model (using Kinetics & SRM Engine Suite software). Experimental data were obtained at constant engine speed (1800 rpm) and engine load (75 %) by Ryu (2013a). Values of engine performance characteristics were calculated at the same engine operation condition in the SRM model. The simulation results were presented in Fig. 2-5. The optimum biodiesel pilot injection pressure (120 MPa) value was defined via indicated mean effective pressure (IMEP). Validation of the model, shown in Fig. 2, was performed by the cylinder pressure history at optimum biodiesel pilot fuel injection pressure. It was seen that there was modest difference for maximum cylinder pressures in between the simulation and experimental data by 6.6% at optimum case (Pehlivan, 2016).

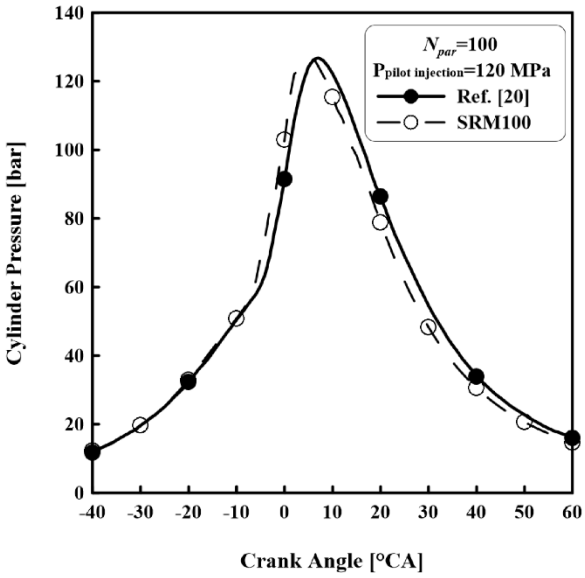


Figure 2. Model validation process for 120 MPa pilot fuel injection pressure

There have been small differences between calculated and experimental cylinder pressure data at the early stage of the combustion and the late stage of expansion process. Conceivable causes have been specified as below:

- Crevice volume (%) was roughly computed and set as an input in the simulation process.
- Initial boundary conditions (initial pressure and initial temperature) required for numerical solution was not fully known. Therefore, they

were predicted with trial and error method.

- Convenient turbulent mixing model was chosen. Its default value of the parameters (swirl ratio, tumble ratio etc.) were used in the simulation.
- Heat transfer parameters such as piston top temperature, cylinder liner temperature, etc. were approximately determined.
- Reduced chemical kinetic mechanism for biodiesel was used in terms of reducing computational time.
- The reduced chemical kinetic mechanism for biodiesel may not fully represent biodiesel fuel.

Engine performance characteristics (brake power, engine torque and brake specific fuel consumption) at three different stochastic particle numbers are given in Figs. 3-5, respectively. Due to giving better simulation results, the optimum stochastic particle number was chosen as 100. It was observed that 120 MPa pilot fuel injection pressure give the best results to brake power, engine torque and brake specific fuel consumption data for different stochastic particle numbers. Furthermore, as pilot fuel injection pressure was increased, it was observed that brake power and engine torque increased (Abd Alla *et al.*, 2000) and brake specific fuel consumption decreased.

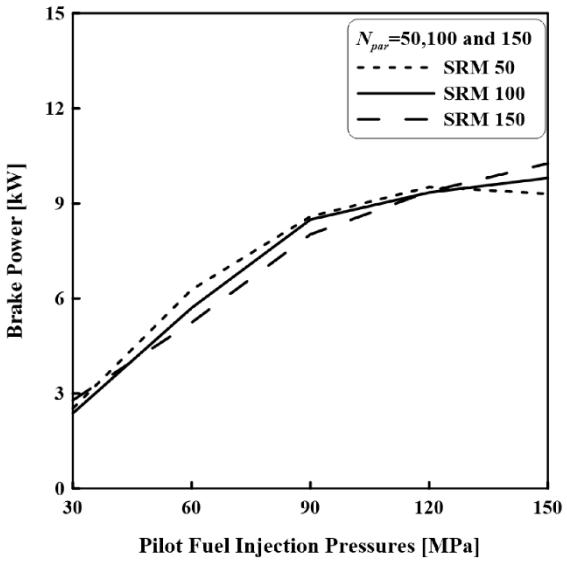


Figure 3. The variation of brake power on different pilot fuel injection pressures.

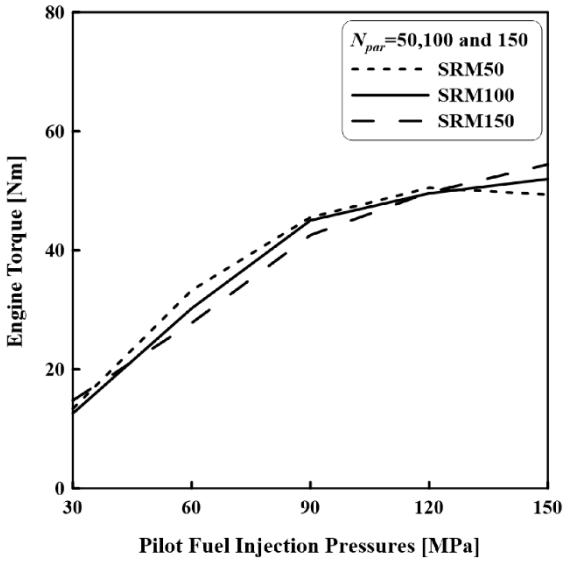


Figure 4. The variation of engine torque on different pilot fuel injection pressures.

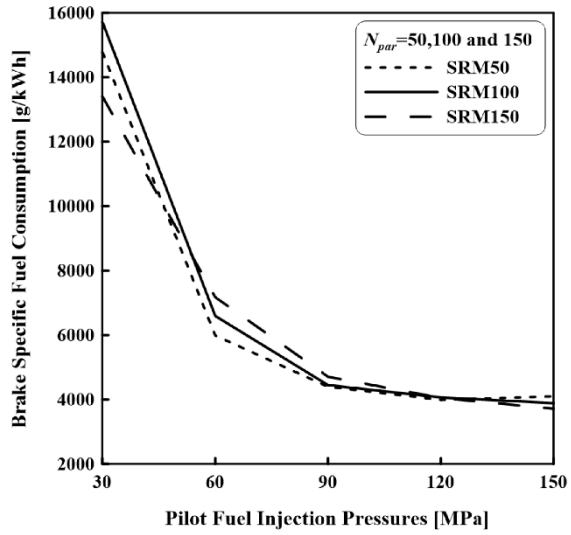


Figure 5. The variation of brake specific fuel consumption on different pilot fuel injection pressures.

4. CONCLUSIONS AND FUTURE WORK

In this study, it was investigated the variation of different biodiesel pilot fuel injection pressures on engine performance characteristics (brake power, engine torque and brake specific fuel consumption). The dual fuel engine operated natural gas and biodiesel was preliminary investigated using SRM approach with this study. It was seen that SRM Engine Suite was a good tool to predict engine performance characteristics of a biodiesel pilot fueled natural gas engine. Presented results can be improved and performed simulation process using different engine parameters such as engine speed, engine load, pilot fuel injection amounts if chemical kinetic mechanisms for each biodiesel (soy bean, canola, rapeseed methyl esters) are advanced. Presented model can be extended on dual fuel marine engines with various pilot fuels (dimethyl ether, alcohol, diesel etc.) and gas fuels (biogas, producer gas, Liquified Petroleum Gas, shale gas etc.).

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NOMENCLATURE AND UNITS

BMEP: Brake Mean Effective Pressure [bar]
CFD: Computational Fluid Dynamics
$\mathcal{F}_C$: Mass Density Function of the crevice gas
$\mathcal{F}_f$: Mass Density Function of the fuel
HCCI: Homogeneous Charge Compression Ignition
IMEP: Indicated Mean Effective Pressure [bar]
MDF($\mathcal{F}$): Mass Density Function
N_{par}: Stochastic particle numbers
N_S+1: Random scalar variable numbers
n: Engine speed [rpm]
PCCI: Premixed Charge Compression Ignition
PDF(f): Probability Density Function
P_i: Indicated Power [W]
P_b: Brake Power [W]
RCCI: Reactivity Charge Compression Ignition
SE: Specific Emissions [g/kWh]
SFC: Specific Fuel Consumption [g/kWh]
SRM: Stochastic Reactor Model
$W_{c,in}$: Indicated work [J]
0D: Zero Dimensional
1D: One Dimensional
3D: Three Dimensional
(i): Individual particle

ρ: Mass Density [kg/m^3]
ϕ: Equivalence ratio
η_m: Mechanical efficiency [%]
τ_{crev}: Characteristic residence time of the crevice gas
τ_{cyl}: Characteristic residence time of the cylinder gas
τ_f: Characteristic residence time of the fuel
ψ : Chemical and physical characteristics such as mass, pressure and temperature

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Research Article
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First record of *Gonostoma denudatum*, Rafinesque 1810 (Family: Gonostomatidae) from Mersin Bay (Northeastern Mediterranean, Turkey)

Mersin Körfezi'nden (Kuzeydoğu Akdeniz, Türkiye) *Gonostoma denudatum*, Rafinesque 1810'un (Familya: Gonostomatidae) İlk Kaydı

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 5 Sayı: 1 (2019) 64-68

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ABSTRACT

One specimen of *Gonostoma denudatum* was caught by a commercial deep trawler (Boat length: 26.15 m and Engine Power: 400 Hp) at a depth of about 595 m on 08 July 2019 from the Erdemli coast (Mersin Bay, Turkey). After the capture, the fresh specimen was identified, photographed, measured to the nearest millimetre, and weighed to the nearest gram. The present paper reports the first record of *G. denudatum* in the northeastern Mediterranean, Turkey. Although *G. denudatum* has been previously reported from the Mediterranean Sea, this species is extremely rare in the eastern part of the Mediterranean Sea. Thus, the present study is an indication of the occurrence of *G. denudatum* in the eastern Mediterranean Sea coast of Turkey. Morphometric and meristic characters of the specimen are given in the text.

Keywords: Deep Sea Fish, Bristlemouth, Report, Eastern Mediterranean Waters

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ÖZET

Erdemli açıklarından (Mersin Körfezi, Türkiye) ışıldak balığı, *Gonostoma denudatum'*un bir bireyi 08 Temmuz 2019 tarihinde yaklaşık 595 m derinlikten ticari dip trolü (Tekne Uzunluğu: 26,15 m ve Motor Gücü: 400 Hp) ile avlanmıştır. Yakalanan birey daha sonra tanımlanarak, fotoğraflanmış, ölçümleri ve ağırlığı alınmıştır. Sunulan bu çalışmada, *G. denudatum* Türkiye'nin kuzeydoğu Akdeniz kıyılarından ilk kez rapor edilmiştir. *G. denudatum* daha önce Akdeniz'den bildirilmiş olmasına rağmen, bu tür Akdeniz'in doğu kısmında oldukça nadir görülmektedir. Bu nedenle sunulan bu çalışma Türkiye'nin doğu Akdeniz sahillerinden *G. denudatum*'un varlığını işaret etmektedir. Türün morfolojik ve meristik ölçümleri metin içerisinde verilmiştir.

Anahtar sözcükler: Derin deniz balığı, Dikenağız, Rapor, Doğu Akdeniz Suları

1. INTRODUCTION

The genus *Gonotoma* is represented with two valid species around the worldwide. From this genus, only *Gonostoma denudatum*, Rafinesque 1810 is locally common in the Mediterranean Sea, characterised as native to this area (Froese and Pauly, 2019).

Gonostoma denudatum is distributed from the subtropical to temperate North Atlantic and the Mediterranean (IUCN, 2019). This species is widespread throughout the Eastern Central and Western Central Atlantic (Schaefer et al., 1986).

In Turkish waters, *G. denudatum* has been previously stated in the marine checklist of Turkey by Bilecenoglu et al. (2014). Although the occurrence of *G. denudatum* has been reported from Turkish marine waters in the Mediterranean Sea in previous year (Bilecenoglu et al., 2014), this species is extremely rare in the eastern part of the Mediterranean Sea. Besides, up to date any individual of this species was not captured data by bottom trawls from Mersin Bay.

The present paper reports the first record of *G. denudatum* in the northeastern Mediterranean, Turkey. This study also to confirm its occurrence with some morphological properties from Erdemli coast (Mersin Bay, Northeastern Mediterranean).

2. MATERIAL AND METHOD

A single specimen of *G. denudatum* was caught by a commercial trawler at a depth of 595 m on 08 July 2019 from Mersin Bay (Erdemli coast) (Coordinate; 36°12′N, 34°42′E), in the North-eastern Mediterranean coast of Turkey (Figure 1). The coordinate and depth was measured by satellite GPS and echo sounder on the boat. After the capture, the fresh specimen was identified, photographed, measured to the nearest mm, and weighed to the nearest g. The specimen was preserved in 4% formalin and were deposited in the Museum of the Faculty of Marine Sciences and Technology, Iskenderun Technical University (MSM-PIS/2019-4) (Figure 2).

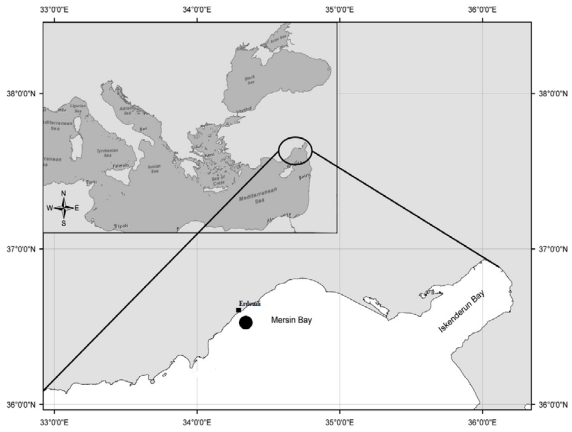

Figure 1. Map showing capture site (●) of *Gonostoma denudatum* from coast of Erdemli (northeastern Mediterranean, Turkey)

Figure 2. *Gonostoma denudatum*, 117.5 mm SL from the northeastern Mediterranean coast of Turkey (MSM-PIS/2019-4)

3. RESULTS AND DISCUSSION

The main diagnostic characters and morphometric measurements of the captured specimen of *G. denudatum* are given in millimeters: the specimen was 130.7 mm in total length and 7.89 g in total weight. Some morphometric and meristic measurements of this specimen were made and presented in Table 1. Besides, morphometric and meristic measurements of the captured specimen were compared with the measurements of previous record of *G. denudatum* which was caught from the coast of İskenderun by Bilecenoglu et al. (2014), (Table 1).

The specimen is described as follows: Body moderately elongate. Mouth large; angle of jaw extending posterior to the eye. Eyes moderate to small. Dorsal finrays 14, behind midpoint of body, followed by a small adipose fin; pectoral finrays 10; pelvic finrays 8; anal finrays 28, anal fin origin a little in advance of dorsal fin origin. Head length 25.7%, pre-dorsal length 61.2%, pre-anal length 59.5%, pre-pectoral length 24.6%, pre-pelvic length 46.8%, all of Standart length, SL. Eye diameter 15.5%, snout length 20.8%, post orbital length 68.9%, all of head length, HL. Photophores: Paired photophore near symphysis of lower jaw (SO) 1, anterior orbital (ORB), 1, opercular (OP) 3, branchiostegal (BR) 9, ventral series between pelvic-finbase and origin of anal fin (VAV) 5, ventral series posterior to anal-fin origin (AC) 19, lateral series (OA) 13.

Colour (Fresh specimen): Body transparent, dorsal side dark, head silvery gray, flanks silver, a distinctive dark gular pigment patch, finrays speckled.

Gonostoma denudatum is mesopelagic, usually associated with continental and slopes. The depth range for juveniles and adults is 700-400 m during the day and 100-200 m at night (Badcock, 1984). This species reaches a maximum size of 14 cm, SL (Quero et. al., 1990). It feeds on zooplankton. Eggs and larvae is planktonic (Golani et al., 2006).

Gonostoma denudatum has been included in the checklist of marine fishes of Turkey about 5 years ago by Bilecenoglu et al. (2014). Bilecenoglu et al. (2014) has mentioned caught one *G. denudatum* individual from Iskenderun Bay by a commercial trawler at depths of 200 m. Our specimen was obtained by a commercial trammel net at a depth of 595 m. The specimen was identified according to Harold and Weitzman (1996) and Quero et al. (1990).

Table 1. Comparison of *G. denudatum* individuals in terms of morphometric and meristic measurements

	This study		Bilecenoglu et al. (2014)	
Specimen No	n=1		n=1	
Measurements	**Size (mm)**	**Values (%)**	**Size (mm)**	**Values (%)**
Total length (TL)	130.7		-	
Standard length (SL)	117.5		118.0	
Head length (HL)	30.3	25.7	29.0	24.6
Eye diameter	4.7	15.5	5.0	17.2
Inter orbital distance	4.3	14.1	4.5	15.5
Post orbital length	20.9	68.9	17.0	58.6
Snout length	6.3	20.8	6.9	24.1
Pre-dorsal length	72.0	61.2	70.4	59.7
Pre-anal length	69.9	59.5	69.5	58.9
Pre-pectoral length	28.9	24.6	-	-
Pre-pelvic length	55.0	46.8	-	-
Meristic				
Dorsal fin rays	14		14	
Pectoral fin rays	10		11	
Pelvic fin rays	8		8	
Anal fin rays	28		-	

To date there is little information available about habitat, ecology, and population of *G. denudatum*. However, there are no species-specific threats and no species-specific conservation measures in place for this species (IUCN, 2019).

This species is listed as Least Concern (LC) in the Global Red List by the International Union for Conservation of Nature, IUCN (Harold, 2015; IUCN, 2019) and considered as Data Deficient (DD) in the Mediterranean Sea (Abdul Malak et al., 2011).

Nowadays, marine ecosystems are greatly affected by bottom trawling in Turkish coasts, which destroys benthic and pelagic fauna (Abdul Malak et al., 2011). Although *G. denudatum* is not a commercial and target species, obtained as by-catch in deep-waters during commercial bottom trawls targeting shrimp fishing, it is important for diversity of Mersin Bay and Turkish ichthyofauna.

4. CONCLUSIONS

The present paper reports the first record of *G. denudatum* from the Mersin Bay (northeastern Mediterranean, Turkey). This species could be considered as exceptionally rare in the Mediterranean. Thus, the present study is an indication of the occurrence of *G. denudatum* in the northeastern Mediterranean Sea coast of Turkey.

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