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Research Article

Effect of Coconut Leaves, Coconut Palm (*Cocos nucifera*) as Artificial Bait on the Catch of Fish Traps at Telaga Batin Water, Terengganu

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Abstract

Fish trap is one of the most frequently used fishing devices by people around the world. The purposes of this study are to determine fish species and bycatch species in traps with different baits such as coconut leaves, regular fish bait, and without bait at Telaga Batin waters. Coconut leaves from coconut palm, (*Cocos nucifera)* were used as artificial fish bait, replacing normal live bait. Nine traps with the size of 4 m x 2 m x 6 m of steel structure framed with galvanized wire mesh of 1.5 inches were immersed for 48 hours at different depth (15m, 20m and 25m). The whole procedure was repeated four times with a total of 20 types of species and 132 individuals in total were caught. One-way ANOVA was chosen to analyze data collected. The value calculated was not significant for fish traps with coconut leaves (P >0.168) compared to fish traps with normal live bait (P <0.022), the devices with artificial bait were able to catch several cuttlefishes. Individually, traps with normal bait were able to get more species, but in terms of species value, traps with coconut leaves have the advantage as cuttlefish being more valuable in the market compared to certain demersal fishes.

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1. Introduction

Ever since man's first fishing tool, technologies in fisheries have witnessed changes, which have greatly improved fishing efficiency, and helped fishers for better economic returns (Singh, 2012). Effort in developing fishing strategies have also increased over time, that would significantly improve both fisheries sustainability and reducing bycatch without affecting the income source of the fishers (Mbaru and Mcclanahan, 2013). The fish trap is not an exception from the development of fishing gears. Fish traps are the type of fishing devices where fishes are attracted to enter either by bait or shelter factor and their escape is made difficult (Chakravartty and Sharma, 2013).

Fish traps are usually deployed by the artisanal fleet which has less efficient technology and mostly uses passive gears, other than the fish trap itself (Bañón *et al*., 2018). Fish traps are not only used for marine fishing, but also inland such as a river, lakes, and ponds. Different kinds of traps and methods are highly dependent on the characteristics of the areas (James *et al*., 2017) and types of targeted species. Crab fishing, in Australia for example, most commercial fishers would use netted round traps with a stretched mesh opening of 50 mm to 60 mm (Broadhurst *et al*., 2018). In Norway, to reduce fish mortality, they have designed a trap that is capable to capture all sizes of sea trouts and other species of coastal fish (Barlaup *et al*., 2013) which enables them to catch more fish at once. In 2017, there are about 1,163 units of licensed fish traps in entire Malaysia and about 3,654 tons of fish caught by the trap at Terengganu, with a total of 13,908 tons caught for the entire country (Department of Fisheries, 2018).

Fish traps are widely used around the world, by both large scale and small scale fishermen, and Malaysia is not an exception. However, poor and small scale fishermen are facing difficulties in maximizing their catch from a fish trap. This is because regular fish baits which are usually effective are expensive. In today's market, mackerels would cost RM16 per kg, sea bream at RM12 per KG, and squid for RM28 per KG. Coconut leaves, on the other hand, would cost nothing since people can simply pick them anywhere. So by using the coconut leaves, we can find out whether they can replace regular fish baits or not. And so the objectives of this study were to determine targeted fish species trapped from the fish trap with coconut leaves (*Cocos nucifera*), regular fish bait, and without bait and to determine bycatch species trapped from the fish trap with coconut leaves (*C.nucifera*), regular fish bait, and without bait.

Fisheries bycatch is the unnecessary product influenced by fishing effort and the species distribution which is at a vulnerable stage base on its ecological characteristics (Lewison *et al*., 2013). Bycatch is often considered a concern due to its contribution to the overfishing problem which has affected the effort in sustainable fisheries management (Melstrom, 2015) and is critical enough that it is considered one of the biggest threats to marine life (Kappel, 2005). The uncontrolled level of bycatch has the potential of closing major fisheries and affecting the market of seafood regardless of the economic importance and status of commercial fish stocks (Kirby and Ward, 2014). The significance of this study is first and foremost, we would be able to help reduce the cost for bait used for fishing traps. Using coconut leaves is cheaper and they are readily available almost all the time. This study can also help sustain fisheries resource as the fishermen would not have to spare some of their catch for bait but instead, they can use them for their consumption.

2. Materials and Methods

2.1 Study location

The area of study, which was the Telaga Batin waters, was located around three kilometers away from Universiti Malaysia Terengganu, northeast of Peninsular Malaysia, within six to seven kilometers from the coastline as shown in Figure 1. Several bottom FADs have been recorded around the sampling site which would help with the project. Fish aggregating devices or FADs are objects that are capable of aggregating (Moreno *et al*., 2016) or forming fishes in an area. Naturally, fish are attracted and would associate with the FADs (Ghazali *et al*., 2013) in both the offshore environment and coastal environment (Sinopoli *et al*., 2015).

2.2 Design study

Nine fish trap with a size of 4x2x6 m which were made out of steel structure and framed with galvanized wire mesh with a size of 1.5 inches was used in this study. Three of the fish traps acted as 'regular' traps with mackerels as baits. The other three fish traps were given the study role as coconut fronds were added to each of the three 'study' traps replacing mackerels where they were put rest on the trap floor respectively. The last three fish traps had no bait but deployed also so that they can be studied either fish will still get trapped even without bait or not and acted as control traps.

The study was conducted during mid-January until mid-February 2019. The whole procedure was run for three days, where all nine traps were deployed at three different depths (10m, 20m, and 25m) of bottom FADs or artificial reefs, during the first day at early morning. The traps were then left for two days, and on the third

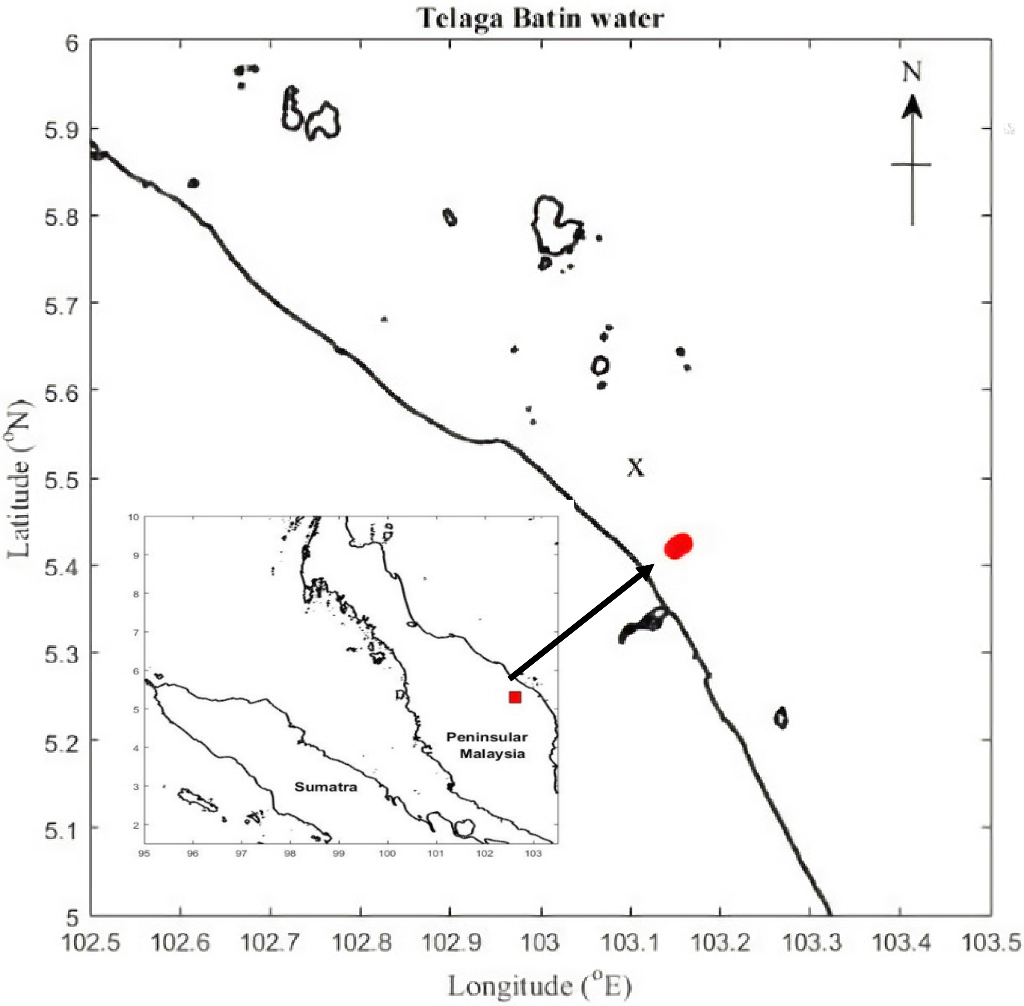

Figure 1. Location of sampling site marked with three different coordinates

day, fish caught were collected from all nine traps and brought to the laboratory for the next step of the whole procedure. The whole procedure was repeated three times more with the same coordinates.

Data collection was classified based on the type of baits used in this experiment. Identification of fish was done by using the reference book to distinguish the targeted and non-targeted species based on Terengganu locality species demand. Samples were then brought to the laboratory where formalin was applied for photographing.

2.3 Analysis data

The one-way ANOVA was used to determine if there were any statistical differences between means of two or more independent groups. It tested the null hypothesis with the type of baits used as the manipulated variable with the duration of traps rest as a constant variable. Catch per unit effort (CPUE) was used to measure the abundance of caught species from three different fish traps.

3. Results and Discussion

A total of 132 individuals belonging to the 20 species were caught by all nine fish traps from three different habitats. Generally, *Sepia* sp. was the highest bycatch (47.62%) out of 21 individuals caught at 15 meters habitat. While both 20 meters and 25-meter habitat recorded *Pentapodus setosus* as the highest catch, (34.21%) out of 38 individuals and (38.36%) from a total of 73 individuals respectively (Table 1). One-way ANOVA (Analysis of Variance) was used to calculate the data collected with three different fish traps and three different habitats as the finding factors (Table 2). Species caught by fish traps with coconut leaves recorded not significant ($P>0.168$) compare to fish traps with regular live bait ($P<0.022$) which was considered significant. As for species entangled by empty fish traps which acted as control traps, they recorded the least significant ($P>0.680$). Catch Per Unit Effort (CPUE) where a total number of fish caught divided by period of fish traps rest was also used as shown in Table 3.

Table 1. General species composition between different habitats

Area	Targeted species	Bycatch species
15 meters	9 (42.86%)	12 (57.14%)
20 meters	25 (65.79%)	13 (34.21%)
25 meters	61 (83.56%)	12 (16.44%)

Table 2. ANOVA on three different types of fish traps

Type of fish trap	Abundance			
	f	df	MS	P- Value
Fish traps with coconut leaves	1.9	32	69.4	0.168
Fish traps with regular live bait	4.04	69	173.3	**0.022**
Empty fish traps	0.39	28	12.5	0.68

Table 3. Catch Per Unit Effort (CPUE) of three different fish traps

Type of fish traps	CPUE
Fish traps with coconut leaves	0.172
Fish traps with regular live bait	0.365
Empty fish traps	0.151

Table 4. Species composition including targeted and bycatch species

Species (Common name)	Scientific name	Percentage (%)
Chordata		
Grey bamboo shark	*Chiloscyllium griseum*	3 (2.27)
Forktail threadfin bream	*Nemipterus furcosus*	33 (25)
Blue spotted stingray	*Dasyatis kuhli*	1 (0.76)
Pink ear emperor	*Lethrinus lentjan*	6 (4.55)
Big eye snapper	*Lutjanus lutjanus*	5 (3.79)
Monocle bream	*Scolopsis monogramma*	2 (1.52)
Long spine porcupine fish	*Diodon holocanthus*	10 (7.58)
Shortnose boxfish	*Ostracion nasus*	2 (1.52)
Yellow boxfish	*Ostracion cubicus*	5 (3.79)
Starry toadfish	*Arothron stellatus*	1 (0.76)
Brownstripe snapper	*Lutjanus vitta*	1 (0.76)
Painted cardinalfish	*Archamia fucata*	1 (0.76)
Bulleye cardinalfish	*Apogon fleurieu*	5 (3.79)
Remora	*Remora remora*	1 (0.76)
Redspine threadfin bream	*Nemipterus nemurus*	2 (1.52)
Butterfly whiptail	*Pentapodus setosus*	41 (31.06)
Yellowstripe scad	*Selaroides leptolepis*	1 (0.76)
Pinspotted spinefoot	*Siganus fuscescens*	1 (0.76)
Slender scad	*Decapterus russelli*	1 (0.76)
Mollusca		
Cuttlefish	*Sepia* sp.	10 (7.58)

Table 5. Targeted species composition between different habitat and fish trap type

Area	Fish traps with coconut leaves	Fish traps with regular live bait	Empty fish traps
15 meter	Grey bamboo shark 1 (4.35%)	Forktail threadfin bream 1 (1.64%)	Big eye snapper 2 (18.18%)
	Brownstripe snapper 1 (4.35%)	Pink ear emperor 3 (4.92%)	Pink ear emperor 1 (9.09%)
20 meter	Grey bamboo shark 1 (4.35%)	Pink ear emperor 1 (1.64%)	Slender scad 1 (9.09%)
	Forktail threadfin bream 3 (13.04%)	Forktail threadfin bream 1 (1.64%)	Forktail threadfin bream 5 (45.45%)
	Butterfly whiptail 2 (8.70%)	Butterfly whiptail 9 (14.75%)	Butterfly whiptail 2 (18.18%)
25 meter	Big eye snapper 3 (13.04%)	Monocle bream 2 (3.28%)	
	Redspine threadfin bream 1 (4.35%)	Pink ear emperor (1.64%)	
	Butterfly whiptail 5 (21.74%)	Redspine threadfin bream 1 (1.64%)	
	Forktail threadfin bream 6 (26.09%)	Butterfly whiptail 23 (37.70%)	
		Forktail threadfin bream 17 (27.87%)	
		Yellowstripe scad 1 (1.64%)	
		Grey bamboo shark 1 (1.64%)	

For targeted species, fish traps with coconut leaves were able to catch forktail threadfin bream as the most abundant species (39.13%), especially from the 25-meter habitat. Fish traps with regular live bait caught Butterfly whiptail as the most abundant (51.62%) species and Slender scad (50%) from empty fish traps (Table 5). A number of bycatch were also recorded (Table 6), where 15-meter habitat had *Sepia* sp. as the higest valuable bycatch from fish traps with coconut leaves (70%). Meanwhile, fish traps with regular live bait recorded cuttlefish and yellow boxfish both as the most abundant bycatch (22.22%) and empty fish traps had Bulleye cardinal fish as the highest bycatch species entangled (27.78%).

Table 6 . Bycatch species composition between different habitat and fish trap type

Area	Fish traps with coconut leaves	Fish traps with regular live bait	Empty fish traps
15 meter	Cuttlefish 7 (70%)	Cuttlefish 2 (22.22%) Painted cardinalfish 1 (11.11%)	Cuttlefish 1 (5.56%) Pinspotted spinefoot 1 (5.56%)
20 meter	Blue spotted stingray 1 (10%) Yellow boxfish 1 (10%)	Long spine porcupine fish 1 (11.11%) Remora 1 (11.11%) Yellow boxfish 1 (11.11%)	Long spine porcupine fish 3 (16.67%) Bulleye cardinalfish 5 (27.78%)
25 meter	Long spine porcupine fish 1 (10%)	Long spine porcupine fish 1 (11.11%) Yellow boxfish 2 (22.22%)	Long spine porcupine fish 4 (22.22%) Shortnose boxfish 2 (11.11%) Yellow boxfish 1 (5.56%) Starry toadfish 1 (5.56%)

It was found that fish traps designed and exploited by the fishermen of Terengganu, Malaysia were able to catch primary target species, especially *Nemipterusfurcosus* and *P. setosus*, excluding the bait type factor. However, species habitat also played a role in this study, with different depth having different species diversity. With the help of Fish Aggregating Devices (FADs) aggregating or forming groups of fish around an area, had increased the chance of fish to enter the fish traps. Non-targeted species or bycatch also happened to drawn into the fish traps willingly since fish traps are passive fishing gears.

At species habitat of 15 meters, *Sepia* sp. had the highest catch rate, with a total of ten individuals (47.62%) out of 21 individuals, seven of the species were caught by fish traps with coconut leaves as artificial bait. This is considered a great finding since the other two fish traps, one with regular live bait, were only able to catch two *Sepia* sp.and the empty fish trap caught one. Based on the data analyze, *Sepia* sp. was only able to get entangled by fish traps at a 15-meter habitat since no cuttlefish were caught by fish traps from the other two habitats. Apart from cuttlefish, one Blue-spotted stingray (*Dasyatis kuhli*) was also caught by fish trap with the artificial bait at the habitat of 20 meters. Even though fish traps were not meant to catch cuttlefish and stingray, locals would usually keep them since they are considered as valuable bycatch or keep bycatch. Moreover, the use of coconut leaves as artificial bait can be seen as efficient and able to replace regular live baits to catch valuable species such as the cuttlefish which could help fishermen to sustain the fish resources. In Thailand, the squid trap which was introduced in 1977 uses coconut leaves to cover the top and bottom of the trap (Chotiyaputta, 1982).

Other bycatch species, on the other hand, are not as valuable as cuttlefish or stingray. Hugely depend on its distribution, pufferfish are considered as non-valuable bycatch or discarded bycatch in Malaysia since they are not highly demanded in the local market (Azman *et al*., 2014). In this study, all four types of pufferfish species, *Diodon holocanthus, Ostracion nasus, Ostracion cubicus,* and *Arothron stellatus* were found trapped at the fish habitat of 20 meters and 25 meters but not found from the 15-meter habitat. One remora fish (*Remora remora*) was also trapped inside the fish trap with regular live bait from the 20-meter habitat and was classified as non-valuable bycatch as well. Unlike puffer fish which has a market value elsewhere such as Japan (Kanazawa *et al*., 1980), remora fish is known as trash fish and are recommended as non-edible in most countries. The other three species of bycatch caught were Painted cardinalfish (*Archamia fucata*), Bulleye cardinalfish (*Apogon fleurieu*) and Pinspotted spinefoot (*Siganus fuscescens*).

Most targeted species, on the other hand, were caught by fish traps with regular live bait and empty fish traps. Traps with live bait trapped the most targeted species, mainly Forktail threadfin bream (*N. furcosus*) and Butterfly whiptail (*P. setosus*) at both habitats of 20 meters and 25 meters respectively. The significant difference between these three habitats tells there were different species diversity were in this study, cuttlefish were only able to be caught at 15-meter habitat while Forktail threadfin bream and Butterfly whiptail were mostly caught at the other two habitats.

However, traps with artificial bait also managed to catch a small number of targeted species mainly Forktail threadfin bream, Butterfly whiptail, and Big eye snapper (*Lutjanus lutjanus*) from all three habitats. This showed that coconut leaves are not only able to potentially be used to attract cuttlefish but also able to completely replace regular live bait and still manage to catch targeted species.

4. Conclusion

Based on the study conducted, we can conclude that coconut leaves from Coconut palm (*Cocos nucifera*) have the potential of replacing regular live bait and able to catch more valuable species in the market, even though fish traps with coconut leaves showed no significance ($P>0.168$) compared to fish traps with regular bait ($P<0.022$), which was significant. Since coconut leaves are cheaper, it would greatly help fishermen especially those who rely on fishing traps to compete with other fishermen who run large scale fishing. The fish they caught can be utilized completely for consumption and also for live baits in their fishing activities. Fishermen can use their standard fish trap yet still able to catch cuttlefish and perhaps stingray as the two species are valuable bycatch and they can still catch the targeted species without using specific fishing gear.

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Authors' Contributions

Mohd Fazrul Hisam Bin Abd Aziz designed the experiment, collected the data, drafted the manuscript. Muhammad Azfar Bin Azahari collected the data. All the authors discussed the analysis of data and contributed to final manuscript.

Conflict of Interest

The authors declare that they have no competing interests

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