WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Comparison of Strength and Suitability of Quality Requirements for Type J Hook Non-Tuna Hand Line (Case Study: Coastal Fishing Port Tawang, Kendal Regency, Central Java)

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A B S T R A C T

The frequency of changing fishing hooks is often one of the factors contributing to increased production costs for fishermen. The brand selection of fishing hooks by fishermen has so far been based solely on their own experience, without considering the quality of the fishing hooks. This research aims to analyze the comparison of the strength of new fishing hooks before and after five fishing trips and to assess the suitability of the quality requirements of fishing hook brands available in the hand line fishing market in Coastal Fishing Port Tawang. The method used in this research is the quantitative descriptive method. The collected research samples consist of three fishing hook brands, each of which includes fishing hooks of sizes number 8 and 9. Strength testing of fishing rods is conducted through tensile testing using the Universal Testing Machine (UTM) connected to the Trapezium II software to display the test results. Data analysis is conducted using normality test, homogeneity test, and test of differences in fishing hook strength to determine the comparison of fishing hook strength before and after operation. The research findings indicate that fishing hooks number 8 (brands A3, G7, and Q9) and fishing hooks number 9 (brands G7 and Q9) do not show significant differences between the hooks before and after five fishing trips. Furthermore, the brand in question appears to not meet the quality requirements for fishing hooks. For brand A3 Number 9, there is a significant difference between new fishing hooks and those used after five fishing trips (P value < 0.05). Brand A3 Number 9 also complies with the quality standards for fishing hooks according to SNI 9312:2022.

Keywords: Hand Line, Hook, SNI, Tensile Strength Test, UTM

1. Introduction

The Kendal Regency is located on the North Coast of Central Java Province, directly bordering the city of Semarang and Batang Regency. Kendal Regency is one of the most potential fisheries production centres in Central Java Province. The significant fisheries potential, such as shrimp, demersal fish, and pelagic fish commodities, can be optimally utilized by the local community with adequate support of facilities and infrastructure, such as the Tawang Coastal Fishing Port. As the centre of fishing activities in Kendal, the Coastal Fishing Port Tawang plays an important role in sustaining the operations of the fisheries sector. Apriliani (2014), Kendal Regency ranks 8th out of 17 coastal areas in Central Java in terms of size. Thus, it can be said that the coastal area of Kendal has great potential for the development of its fisheries sector. However, the production of marine capture fisheries in Kendal Regency tends to be lower compared to some other regencies with smaller coastlines.

Fishing gear is one of the fishing gear that has quite good selectivity compared to other fishing gear. This fishing gear is very famous among fishermen and coastal communities. In practice, fishing gear is operated by small fishermen because this fishing gear does not require large capital costs and does not require special fishing boats. Hand line business activities are one of the people's fisheries businesses that have a simple construction and an easy and simple way of operating (Olii et al., 2023). Fishing gear is made and assembled by fishermen themselves with materials that are easy to obtain, such as monofilament PA ropes, fishing rods, swivels, baits and sinkers. The bait used can be artificial bait such as chicken feathers, gold thread, and rubber (Asprila et al., 2023). The fishing hooks are the most important part of the hand line fishing. Small fishing hooks have a better chance of catching larger fish, but large fishing hooks have a small chance of catching small fish (Dewi et al., 2020).

The existence of a hand line used by fishermen in catching fish in the waters of Kendal Regency indicates that there has not been optimization of fishery production activities based on this fishing gear. This is due to the lack of information related to this fishing gear. Generally, hand-line fishing is only used as a side business by the fishermen there. The low catch results and the influence of weather make the fishermen in Coastal Fishing Port Tawang reluctant to switch to using hand-line fishing gear. In addition, the frequent replacement of fishing hooks itself increases production costs. Based on the annual report from the Fisheries and Marine Affairs Office (2020), there were only about 3 hand-line fishing units in Fish Auction Bandengan and 5 units in

Fish Auction Sikucing in Kendal. This is in contrast to the absence of any hand-line fishing gear recorded in the annual report of Coastal Fishing Port Tawang for the same year. This is also one of the reasons why there has been no significant progress in the development of hand-line fishing in Kendal compared to other fishing gear.

On the other hand, the selection of fishing hooks with various sizes and types, as well as modifications of various kinds and shapes of artificial bait, is relatively underutilized by hand-line fishermen. Therefore, to improve the efficiency and productivity of hand-line fishing catches, new knowledge and information related to the development of fishing gear that can be useful in the future are needed. The choice of fishing hook brand also affects production costs and fishermen's income. The higher the intensity of hook replacement, the higher the production costs incurred by fishermen. Generally, on average, fishermen use non-tuna J hooks because their target catch consists of mackerel and squid. In addition, among the fishing community, especially in Coastal Fishing Port Tawang, there are many brands of non-tuna J hooks available. Based on these factors, the author is interested in conducting further research to compare the strength of fishing hooks from three commonly used brands by hand-line fishermen in Coastal Fishing Port Tawang. Research on the comparison of fishing hook strength before and after capture operations in the Kendal District needs to be conducted to provide new information for the development of fishing technology, especially for hand-line fishing, and to determine whether the fishing hook brands used meet the quality standards for non-tuna J fishing hooks according to applicable standards. This research aims to analyze the differences in the strength of new fishing hooks compared to fishing hooks after five operational trips and to assess whether the quality requirements for fishing lines have been met according to the applicable standards in Indonesia.

2. Materials and methods

The method used in this research is a quantitative descriptive method. Data collection was carried out through observation and direct testing of the tensile strength of fishing lines. This study was conducted from February 03 to June 27, 2024, at two locations: PPP Tawang and the Laboratory Testing Center of the Fishing Technology Development Center (BBPI), Ministry of Marine Affairs and Fisheries in Semarang.

The hand-line fishermen at CFP Tawang are generally one-day fishing fishermen. In one fishing trip, they can do as many as 10-25 settings. According to the fishermen themselves, three brands of fishing hooks are often used by fishermen: brands A3, Q9, and G7. As for the size of the fishing hooks, the majority of longline fishermen only use hooks with sizes 8 and 9. Each size has a different lifespan. The fishermen tend to use fishing hooks with size 9 for single use per trip. However, some fishermen use them up to five times for fishing trips. This is based on their acknowledgement that size 9 hooks tend to lose their sharpness quickly, rust easily, and allow fish to escape after one use. Additionally, these hooks are more prone to breaking compared to size 8 hooks. Therefore, this study aims to determine the strength of different brands and sizes of fishing hooks before and after five fishing trips.

The required sample size for this study is a total of 240 fishing hook specimens, which will be used to test the strength of the fishing hooks, and 120 fishing hook specimens will be used to assess their compliance with quality standards. The samples to be tested for strength for each brand consist of 10 new fishing hook specimens (before use) and 10 fishing hook specimens that have been used for 5 fishing trips. The hook sizes used in this study are size 8 and size 9.

According to Indonesian National Standard (SNI) Number 8956 of 2021 regarding the Strength Testing Method for Fishing Hooks, to determine the maximum tensile strength of fishing hooks, testing is conducted using a Universal Testing Machine (UTM) connected to Trapezium II software. The fishing hook is clamped between the UTM grips and gradually pulled with a specified load. The applied tensile force is 25 mm/minute, as per the research conducted by Varghese et al. (1997). The results will be monitored through the Trapezium software linked to the UTM machine. The tensile strength of the fishing hooks, measured in Newtons (N) or kilogram-force (kgf), is calculated as an average using the following formula:

$$\bar{X} = \frac{\sum X_i}{n} \qquad (1)$$

The standard deviation calculation is done using the following formula:

$$\bar{X} = \sqrt{\frac{\sum(X_i - \bar{X})^2}{n-1}} \qquad (2)$$

or

$$\bar{X} = \sqrt{\frac{\sum {X_i}^2 - \frac{(\sum X_i)^2}{n}}{n-1}} \qquad (3)$$

Information :

S = standard deviate

$\bar{X}$ = average of fishing hook tensile strength;

X_i = fishing hook tensile strength ;

n = Number of specimens (replicates), n $\geqslant$ 10

2.1 Data Analysis

The data analysis to be used in this study is statistical data analysis. Statistical tests assist researchers in formulating and proving hypotheses present in the research. The statistical tests used in this study are the Normality Test, Homogeneity Test, and non-parametric tests. This statistical analysis is employed to determine whether there is a difference in the strength of the three fishing hook brands under the two conditions. The sequence of analyses used in this study to analyze the comparison of fishing reel strength is as follows.

1. Normality Test

The normality test is one of the steps in assessing whether the standardized residuals in a regression model are normally distributed or not. This test is necessary because all parametric statistical calculations rely on the assumption of normal distribution. In this study, the Kolmogorov-Smirnov test is used for testing normality. If the research data follows a normal distribution based on the Kolmogorov-Smirnov test, then further parametric statistical tests can be applied. However, if the data does not follow a normal distribution, non-parametric statistical tests are used instead.

- H_o = The research data is normally distributed, if the P Value $\geqslant$ 0,05

- H_1 = The research data is not normally distributed, if the P value < 0,05.

2. Homogeneity Test

The homogeneity test is a classical assumption test procedure intended to demonstrate that two or more sample data groups originate from populations with equal variances. According to Sianturi (2022), the homogeneity test is used to determine whether several population variances are homogenous or not.

- H_o = Homogeneous variant

- H_1 = There is at least one variant that is not homogeneous

The criteria for this homogeneity test is that H_o is rejected if the sig value or P value > α = 0.05. Meanwhile, H_o is accepted if the sig value or P value < α = 0.05. Then further testing can be seen based on the results of this homogeneity test, whether the data is homogeneously distributed or not.

3. Wilcoxon Test

To determine the comparison of fishing hook strength between the conditions before (new) and after five fishing trips, further testing is necessary after conducting normality and homogeneity tests. If the obtained data is not normally distributed, the next step is to perform the Wilcoxon test. The Wilcoxon test is a suitable alternative for analyzing data that is not always normally distributed. This is because this method allows for the analysis of differences between two related data groups without assuming normal or homogenous distribution, making it suitable for comparing before and after contexts. The conditions for making a decision are:

- Significance level or probability > α (0,05), then accept H_o;

- Significance level or probability < α (0,05), then reject H_o.

2.2 Quality requirements for fishing hooks

The National Standardization Agency of Indonesia has issued SNI Number 9132 of 2022 regarding Fishing Gear – Tensile Strength of J Hook Fishing Hook - Ring-shaped Hook. Through this SNI, we can check the compliance of the quality requirements for fishing hook brands circulating among fishermen, especially hand-line fishermen in CFP Tawang, Kendal Regency.

Table 1 - Quality requirements for J-hook

Nomor	Total Length (mm)	Gap (mm)	Shank Diameter (mm)	Tensile Strength Minimum (kgf)
9	36,56 – 38,44	12,67 – 13,32	1,51 – 1,59	22,63
8	39,00 – 41,00	13,65 – 14,35	1,71 – 1,79	27,50

3. Results and discussion

The Kendal Regency area has a total area of 1,000,230 km^2, divided into 19 districts with 265 villages and 20 urban areas. The waters of Kendal Regency hold significant potential for fisheries resources, supporting fishing activities. One of them is CFP Tawang, which serves as the capture fisheries sector in Kendal Regency. CFP Tawang provides facilities and infrastructure that support capture fisheries activities in Kendal Regency.

Based on the interview with hand-line fishermen in CFP Tawang, it is stated that hand-line fishing is only used as a supplementary business. The fishermen there prefer to rent out their boats to transport customers to fishing spots rather than engage in capture operations. This is due to uncertain catch results,

increased production costs, and unpredictable weather, which discourage fishermen from using this fishing method. This is supported by the annual report data from the Kendal Marine and Fisheries Office, which shows that in 2020, there was no hand-line fishing production activity in CFP Tawang, whereas, in the 2020 annual report for Bandengan Fish Auction, there were 3 hand-line fishing.

3.1 The Difference in Dimensions of Fishing Hooks

The fishing hook is one of the important factors supporting the success of fishing activities using the hand-line fishing gear by fishermen in CFP Tawang. The non-tuna J hook type is the preferred choice. Each brand has different hook sizes, even if they fall under the same numbering category, depending on the standards of each company. According to Anon (2002), the fishing hook brands circulating among fishermen do not have the same physical and mechanical properties, and there is a high level of variability in the quality of different brands. This variability can be attributed to differences in materials and manufacturing processes.

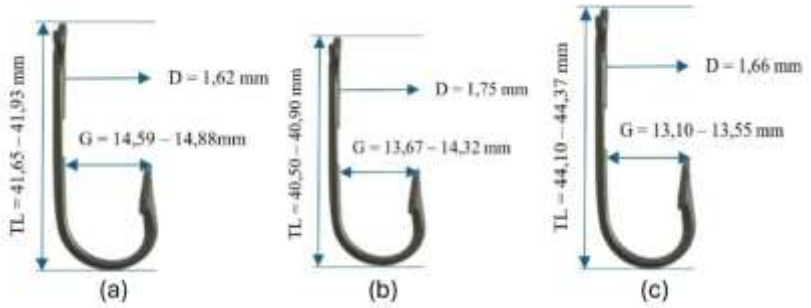

Fig. 1 - The difference in size of fishing hooks number 8 :(a) A3; (b) G7: (c) Q9.

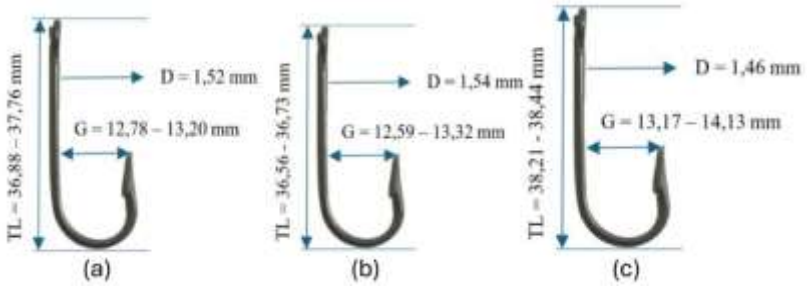

Fig. 2 - The difference in size of fishing hooks number 8:(a) A3; (b) G7: (c) Q9.

(TL: Total Length; G: Gap; D: Diameter)

Based on Fig. 1 and Fig 2, fishing hooks number 9 and 8 of the Q9 brand tend to have a larger length compared to the other two brands. Each specimen within a population has different sizes. The visual similarity of fishing hooks is used by fishermen to distinguish or compare different brands. The size of fishing hooks is largely determined by varying ownership standards among different fishing hook manufacturers as well (Edappazham, 2010).

The Q9 fishing hook tends to have a larger size compared to other brands. Meanwhile, the G7 brand has a smaller size compared to other brands. In terms of colour, the G7 has a shinier colour compared to the other two brands. The Q9 does not have a shiny colour like the G7, while the A3 has a slightly shiny finish. The hook holder on the A3 brand is more downward and straight, whereas the Q9 has a slight bend before the hook holder, similar to the G7. Physically, the A3 has better construction and is less prone to breakage at the hook holder, although each fishing reel's construction has been carefully designed and considered by their respective companies. The standard measurements of gap, total length, and so on from different companies often vary even though they fall under the same numbering category (Edappazham, 2010). Differences in materials, manufacturing processes, design, and other factors used by companies can result in variations in quality and performance (Anon, 2002). Certainly, each brand has its own positive and negative aspects. A3 may have less strength compared to brand Q9, or vice versa.

3.2 Comparison of Fishing Hook Strength

The test results for the breaking force of fishing hooks for three commonly used brands by fishermen are presented in Table 2.

Table 2 - Testing the strength of fishing hook no 8

The Specimen-	Break Force (kgf)					
	A3N	A3S	G7N	G7S	Q9N	Q9S
1	45,2754	38,0673	27,2455	26,0028	33,5168	42,2035
2	44,1665	43,4399	25,7415	14,6266	37,9526	36,7735

3	46,0721	44,1856	26,7102	23,7913	37,8888	32,5353
4	35,3013	45,1856	24,0207	27,0161	32,4843	36,2700
5	42,9301	44,5680	22,6504	28,1314	29,7693	41,2093
6	38,0354	45,9510	26,8185	25,8243	37,7741	42,2163
7	35,6008	48,8635	24,9703	30,8273	41,3559	41,0181
8	50,1318	47,1045	26,1047	26,9779	38,4879	45,9828
9	49,3351	47,3849	27,2774	33,3957	38,3477	40,9352
10	44,6827	42,3628	26,4489	27,8000	39,7179	39,9015
Max	50,1318	48,8635	27,2774	33,3957	41,3559	45,9828
Min	35,3013	38,0673	22,6504	14,6266	29,7693	32,5353
Average	43,1531	44,7330	25,7988	26,4393	36,7295	39,9015
Standard deviation	5,25187	3,04956	1,50664	4,94530	3,60190	3,78446

Table 3 - Testing the strength of fishing hook no 9

Spesimen ke-	**Break Force (kgf)**					
	A3N	**A3S**	**G7N**	**G7S**	**Q9N**	**Q9S**
1	26,6273	27,3794	17,3352	19,6996	26,8631	28,3672
2	25,4547	33,8482	18,9731	18,2338	25,0914	29,4634
3	24,3903	29,5335	17,4626	19,3874	26,7930	26,6592
4	24,9767	29,9223	18,3039	24,2884	30,9739	32,2868
5	24,7727	25,7415	17,2778	18,8201	30,3812	27,5770
6	31,4710	31,8789	17,3415	19,8781	26,4170	29,9733
7	27,7235	31,8725	19,6104	17,1504	22,4975	27,3794
8	27,2137	28,9536	18,8329	19,0814	29,4379	32,6947
9	24,5114	28,1569	18,6289	19,7570	32,1083	27,3794
10	27,5706	32,0446	18,1191	22,0195	30,4130	24,4604
Max	31,4710	33,8482	19,6104	24,2884	32,1083	32,6947
Min	24,3903	25,7415	17,2778	17,1504	22,4975	24,4604
Average	26,4712	29,9331	18,1885	19,8316	28,0976	28,6241
Standard deviation	2,17749	2,48772	0,82101	2,00555	3,04010	2,53789

Based on the average strength comparison of fishing lines, both brand A3 numbers 8 and 9 exhibit greater maximum strength compared to the other two brands. The fishing hook strength of brand A3 demonstrates the highest maximum strength. However, in practical field conditions, during testing, brand G7 had more samples with acceptable results (with fewer repetitions in testing) compared to brands A3 and Q9. The results of the G7 fishing hook testing show that there were fewer retested specimen samples to obtain passing results. Therefore, based on the number of accepted test results or the limited retesting, the G7 brand is better than A3 and Q9.

Based on the results of fishing hook strength testing, as seen in Tables 2 and 3, it is evident that the fishing hook exhibits greater strength after five fishing trips compared to the new fishing hook. This applies to all tested samples. It can be concluded that there is an increase in fishing hook strength after repeated use during five fishing trips. Further study is needed to determine the factors contributing to this strength improvement post-operation. The possibility of an increase in strength after this operation is due to the interaction between the fishing line material and the duration of immersion in seawater, which allows for such occurrences. On average, the raw material used is a high-carbon steel wire with a carbon content of 0.7%, noting that the

carbon limit for high-carbon steel is 0.6% to 2.0%. Although there is an increase in strength in the fishing hook after five operation trips, the difference between new and old fishing hooks for each specimen is not significant.

Based on the results of the testing of the new fishing hooks and after five operational trips, there was not a significant difference in strength between the fishing hooks before and after the five trips. However, there was an increase in strength after the five trips. Only brand A3, number 9, showed a significant difference in strength between the fishing hooks before and after the five trips. Therefore, it can be concluded that both fishing hooks number 8 and 9 experienced an increase in strength after the five trips, and brand A3 is the best brand with greater strength in all strength test results for both fishing hooks number 8 and 9. It is not impossible that, during operation, there may be no changes in the fishing hook and the steel content in the fishing hook that interacts with seawater, resulting in an increase in the strength of the fishing hook after five operational trips. However, over time, as usage increases, there will be changes and decreases in the shape and strength of the fishing hook. The tensile strength test method using UTM is considered very appropriate for assessing the performance of the fishing hook in the field during fishing activities. Edappazham (2010), this tensile strength test method helps analyze the mechanical strength of the fishing hook according to its original performance in the field. Therefore, it can be determined which brand has very good quality.

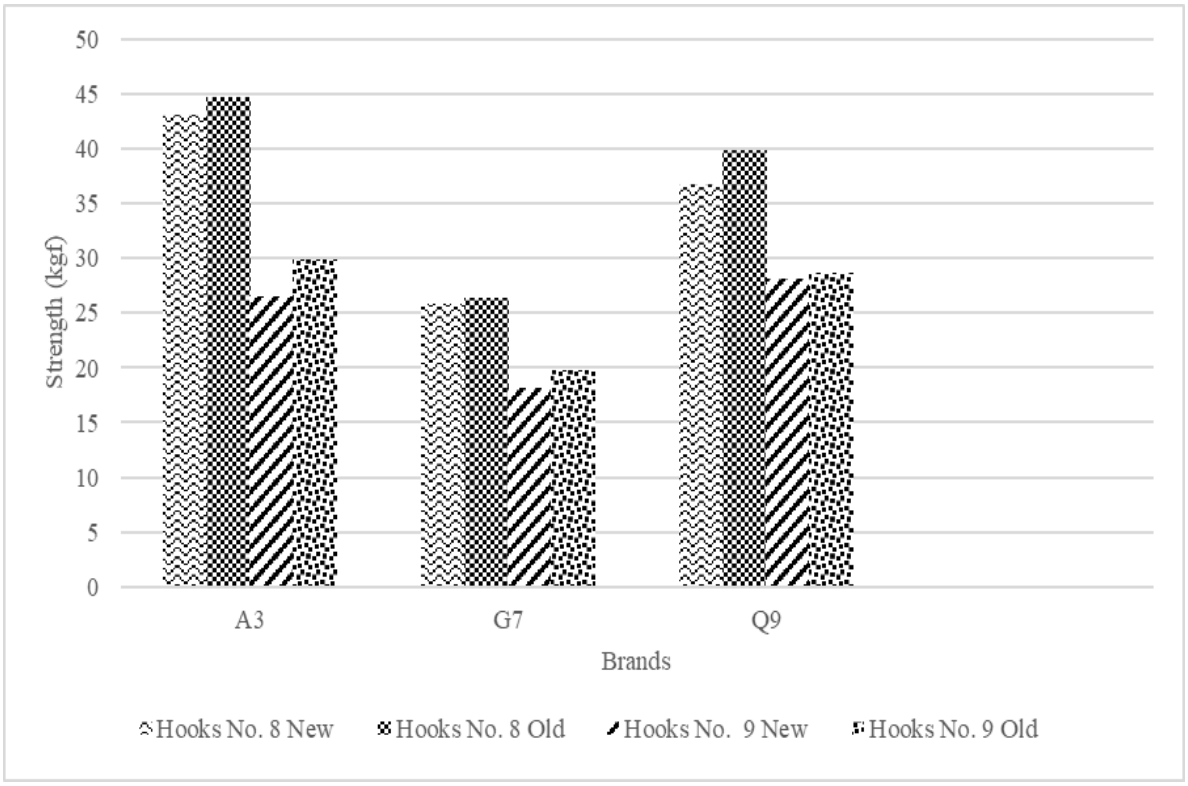

Fig. 3 - Fishing hook strength comparison graph

The Fig. 3 shows the average maximum tensile strength of fishing hooks. It can be observed that there are differences between brands for a given fishing hook number. The highest maximum strength for fishing hooks number 8 and 9 is held by brand A3. The average strength for brand A3 fishing hook number 8 is 43.1531 kgf for new fishing hooks and 44.7330 kgf for old lines. Fishing line number 9 has a maximum strength of 26.4712 kgf for new lines and 29.9331 kgf for old lines. The variation in maximum strength can be attributed to differences in materials used by each company. After five operational trips, fishing lines tend to have higher average strength compared to new ones, and this applies to all brands. The shape, size, and tensile strength of fishing hooks directly influence the performance of the fishing hook (Edappazham, 2010). The fishing hooks available among fishermen do not possess the same physical and mechanical properties, and there is a high level of variability observed in the quality of different brands. This variability may occur due to differences in materials and manufacturing processes.

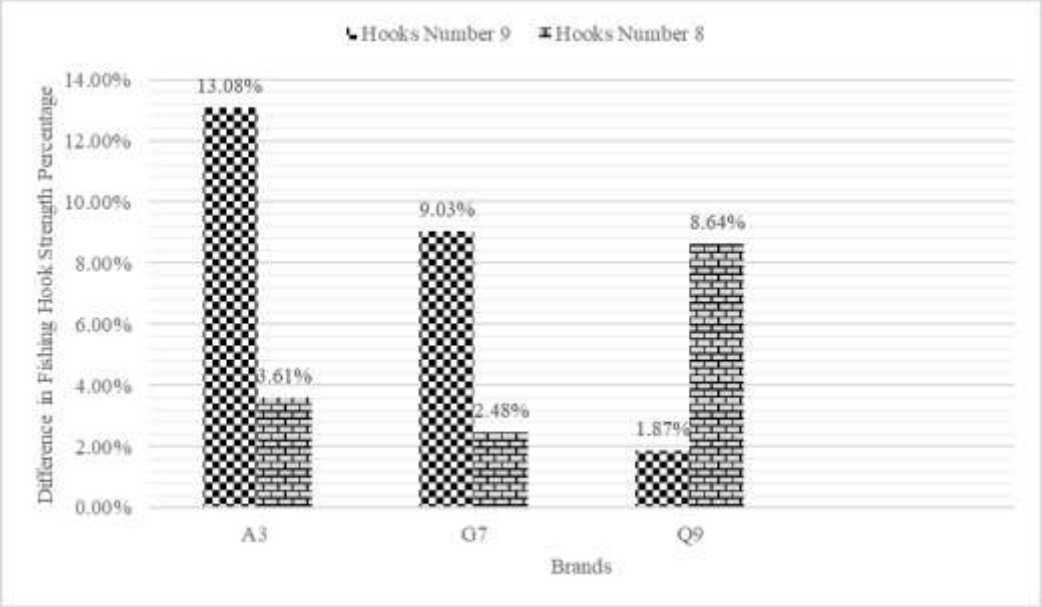

Fig. 4 - Comparison graphic of the strength percentage between new fishing hooks and after five fishing trips.

Based on Fig. 4, shows that there has been an increase in strength between the new fishing hook and the fishing hook after five operational trips. Fishing hook brand number 9 experienced a significant increase in both A3 and G7 compared to fishing hook number 8. For brand A3, there was a 13.08% increase for fishing hook number 9 and a 3.61% increase for fishing hook number 8. Based on the data above, it can be concluded that the fishing hook, after being used for five fishing trips, experienced an increase in strength compared to before the fishing operation. This increase was significant, with a magnitude of 8.64%, which is greater than the other two products in the same numbering category.

This research was conducted to determine whether there is a difference in the performance of new fishing hooks or not, as well as to identify the brands that are considered good. There are many imported fishing hook brands and models available in the market, which makes it increasingly difficult to determine which fishing hook brand is best to use (Edappazham, 2010). Based on the analysis of the data, it was found that there was only one sample that showed a difference in strength between the new fishing hook and the one used after five trips, specifically in sample number 9 of brand A3. For sample number 9 of brands G7 and Q9, there was no significant difference in strength between the new and used fishing hooks. The variability in the design of fishing hooks can be attributed to differences in material composition and manufacturing processes employed by different manufacturers to produce their respective fishing hook brands (Edappazham, 2010). This also holds for all samples of brand number 8, as there was no significant difference observed between new fishing hooks and those that had been used. It can be concluded that, on average, the brand samples do not exhibit significant differences. However, for brand A3 fishing hooks (P-value < 0.05), there is a significant difference between hooks before and after five fishing trips.

3.3 Comparison of Fish Catch

The catch data obtained by fishermen indicates differences based on both the brand and size of fishing hooks. The characteristics of the fishing hooks and the biological aspects of the target fish can also influence the fishing operation process (Lokkeborg and Bjordal, 1992). Brand A3 fishing hooks have been proven to be more successful in attracting fish due to their attractive colour and superior material quality. The slight shimmer in the colour of the fishing hook, along with its strong durability, can attract various types of fish in both clear and murky waters. Compared to brand G7 and Q9 fishing hooks, brand A3 hooks are also equipped with sharp hooks and are more resistant to rust, making them more effective and long-lasting. The good strength of the fishing hook and consistent catches make the A3 brand more effective in catching fish. With all its advantages, the A3 fishing hook is the right choice for achieving satisfying fishing results in various water conditions. The accumulated catch results during the study show that the A3 brand yields 8-20 kg per trip, while the G7 brand yields 5-16 kg per trip. Meanwhile, the Q9 brand yields 5-10 kg per trip. This indicates that the catch results with the A3 fishing hook are more effective. The size, shape, and design of the fishing hook are important factors that can influence its performance in achieving the fishermen's target catches (Edappazham, 2010).

Based on the size of fishing hooks, smaller hooks tend to catch more fish compared to larger ones. The results of this study indicate that size 9 hooks from all brands contribute to larger catches than size 8 hooks. Catch results with size 8 hooks are typically dominated by mackerel. The main catches for handline fishermen in Coastal Fishing Port Tawang are mackerel and squid. According to Susanto et al. (2015), mackerel is one of the fish species caught using handline fishing gear. Knowing the appropriate bait for the target fish and the timing of operations is essential for optimal catch results with this fishing gear. Ekaputra (2017), the results of this study indicate that the difference in size of the Hand Line fishing hooks has an impact on the quantity of fish caught by fishermen. Fishing hook number 2 yielded a total catch of 63 fish, while fishing hook number 8 yielded a total catch of 44 fish. Muandri et al. (2013) showed that fishing hook number 6 resulted in a catch of 95 fish, whereas fishing hook number 9 resulted in a catch of 85 fish. This suggests that using smaller fishing hook sizes increases the likelihood of catching fish. Therefore, the larger size of fishing hook number 8 compared to size number 9 leads to a higher catch.

3.4 Quality requirements for fishing hooks.

The National Standardization Agency of Indonesia has issued the quality requirements (SNI) for a non-tuna J hook with a ring-shaped eye in 2022. To determine the compliance of tested fishing hook brands with the quality requirements, it is necessary to check the parameters according to SNI Number 9132 of 2022. Based on Table 3.4, for fishing hook number 9, the length should range from 36.56 to 38.44 mm, the gap from 12.67 to 13.32 mm, the diameter from 1.51 to 1.59 mm, and the minimum strength should be 22.63 kgf. According to the quality requirements, only brand A3 meets the criteria for fishing hook number 9 as per SNI 9132:2022. Meanwhile, brand G7, does not meet the quality requirements due to the fishing hook's strength being below the specified minimum limit. However, brand Q9, does not meet the quality requirements in terms of diameter size according to the national standard, but the strength of the fishing hook meets the applicable standard. As for brand number 8 fishing hooks, none of the three brands meet the quality requirements of the national standard. This can be seen from the strength test results for brands A3 and Q9, which indicate that the values obtained still meet the minimum strength requirements of the national standard, but the size of both brands does not comply with the standard. In conclusion, out of the six samples, only one sample meets the quality standards for fishing hooks, which is brand A3, number 9.

Table 7 – Suitability of quality requirements for fishing hooks number 9

Parameter	**SNI**	**A3**	**G7**	**Q9**
Total Length (mm)	36,56 – 38,44	37,30	36,63	38,29
Gap (mm)	12,67 – 13,32	12,99	13,00	13,37
Diameter (mm)	1,51 – 1,59	1,52	1,54	1,46
Break Force (kgf)	22,63	26,47	18,18	28,09
Information		**Suitable**	**Not Suitable**	**Not Suitable**

Table 8 - Suitability of quality requirements for fishing hook number 8

Parameter	**SNI**	**A3**	**G7**	**Q9**
Total Length (mm)	39,00– 41,00	41,82	40,67	44,23
Gap (mm)	13,65 – 14,35	14,75	13,92	13,34
Diameter (mm)	1,71 – 1,79	1,62	1,75	1,66
Break Force (kgf)	27,50	43,15	25,79	36,72
Information		**Not Suitable**	**Not Suitable**	**Not Suitable**

Based on the data table above, it is evident that only brand A3 meets the applicable quality standards for fishing hook number 9. However, for brand G7, the strength of the fishing hook is still below the minimum quality standard that has been set, thus it can be considered as not meeting the standards. As for brand Q9, in terms of strength, it exceeds the minimum standard for fishing hook number 9. However, its diameter still falls below the applicable SNI standard.

The suitability of the quality requirements for fishing hook number 8 from the three tested brands can be seen. None of them meet the standard quality requirements for fishing hooks, as some parameters are either below or exceed the established standard range in the Indonesian National Standard (SNI). There is a need to improve the strength of the G7 brand to ensure it does not fall below the minimum strength limit for fishing hook number 8 according to the SNI. However, in terms of numbering, the fishing hooks have met the standard size numbering applicable in Indonesia.

Quality assurance of fishing hook brands is crucial for fishermen to easily select a good brand. This aims to reduce the risk of physical damage or work accidents experienced by fishermen due to faulty fishing hooks. Fishermen rely on their experience when choosing fishing hooks, and they must take risks if they want to try a new brand (Edappazham, 2010). Therefore, this testing can provide valuable information for fishermen in selecting fishing hooks. From the six samples, it was found that brand A3, size 9, had the best quality and met the applicable national standard (SNI). However, it is important to note that brand A3 is significantly more expensive than brands G7 or Q9.

3.5 Statistical Analysis

The comparison of the strength of this fishing hook is conducted by performing statistical analysis. In this study, classical assumption tests (Normality test - Kolmogorov Smirnov), homogeneity test, and Wilcoxon test are carried out. The Wilcoxon test is performed when the data is not normally distributed.

1. Normality Test

The normality test is conducted to determine whether the data is normally distributed or not. If the data is normally distributed, further advanced tests or parametric tests appropriate for the research can be conducted. If the research data is not normally distributed, the non-parametric test will be used. The results of the normality test for the strength of fishing hooks number 8 and 9 are presented in the table 4 and table 5.

Table 4 - The normality test results for fishing hook number 8

Tests of Normality

		Kolmogorov-Smirnova			Shapiro-Wilk		
	Brands	Statistic	df	Sig.	Statistic	Df	Sig.
Strength	A3N	.183	10	.200*	.913	10	.305
	A3O	.136	10	.200*	.943	10	.581
	G7N	.185	10	.200*	.882	10	.137
	G7O	.251	10	.075	.865	10	.088
	Q9N	.314	10	.006	.885	10	.149
	Q9O	.208	10	.200*	.939	10	.544

Table 5 - The normality test results for fishing hook number 9

Tests of Normality

	Brand	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	Df	Sig.
Strength	A3N	.183	10	.200*	.855	10	.067
	A3O	.182	10	.200*	.972	10	.908
	G7N	.212	10	.200*	.908	10	.269
	G7O	.291	10	.016	.886	10	.152
	Q9N	.174	10	.200*	.941	10	.570
	Q9O	.160	10	.200*	.950	10	.663

Based on Tables 4 and 5, the normality test results for fishing hook number 8 indicate that there is non-normally distributed data, specifically in the strength data for the new Q9 brand. Q9N has a Sig value of 0.006, which is less than 0.05. Therefore, it can be concluded that the P value of $0.006 < 0.05$, indicates non-normal distribution of the data. Similarly, the normality test for fishing hook number 9 shows non-normally distributed data in the strength data after five capture operations for the G7 brand. G7O has a Sig value of 0.16, also less than 0.05. Consequently, further analysis using non-parametric tests is recommended. Due to the non-normal distribution of the data, parametric tests cannot be conducted to assess the differences in fishing hook strength. Therefore, the alternative test that can be performed is the non-parametric test. This non-parametric test is used to determine whether there is a significant difference between the new fishing rods (before) and the fishing rods after five fishing trips.

2. Homogeneity Test

The homogeneity test was conducted to determine whether the data was distributed homogeneously or not. Based on the results of the Homogeneity test, fishing hook number 8 shows that the data is homogenous. Each brand A3, G7, and Q9 has a Sig value of 0.098, 0.125, and 0.957, respectively. It can be concluded that the P value $\geqslant 0.05$, indicates that the data is distributed homogeneously. Similarly, for fishing hook number 9, where each brand A3, G7, and Q9 has a Sig value of 0.583, 0.177, and 0.370, it can be concluded that the P value $\geqslant 0.05$, indicating that the data is distributed homogeneously.

Due to the non-normal distribution of the data obtained, it is not possible to conduct further parametric tests to assess the differences in fishing hook strength. Sianturi (2022), the homogeneity test is used to determine whether several population variants are equal or not. This test is conducted as a

prerequisite for independent sample t-tests and ANOVA analysis. The underlying assumption in variance analysis (ANOVA) is that the population variances are equal. Based on the normality and homogeneity tests, the results indicate that the data is homogenous but not normally distributed. Therefore, the follow-up test that can be carried out is a non-parametric test, where the non-parametric test used in this study is the Wilcoxon test.

3. Wilcoxon Test

The Wilcoxon test assumes that if the P value is greater than 0.05, then H_o is accepted or there is no significant difference between the strength of the new fishing hook and the fishing hook after five trips of the fishing operation. The results of the Wilcoxon test results of fishing hook strength test numbers 8 and 9 are presented in Table 6.

Table 6 - Results of wilcoxon test of fishing rod number 9 and 8

No.	Sample	Wilcoxon Test Result	Information
Fishing Hook Number 9			
1.	A3S – A3N	0,005, P value < 0,05	H_0 rejected
2.	G7S – G7N	0.059, P value > 0,05	H0 accepted
3.	Q9S – Q9N	0,646, P value > 0,05	H_0 accepted
Fishing Hook Number 8			
1.	A3S – A3N	0,878, P value > 0,05	H_0 accepted
2.	G7S – G7N	0.445, P value > 0,05	H_0 accepted
3.	Q9S – Q9N	0,114, P value > 0,05	H_0 accepted

Based on the Wilcoxon test results table, it can be observed that each sample A3, G7, and Q9 has a Sig value of 0.005, 0.059, and 0.646, respectively. It can be seen that the p-value (Asymp Sig. (2-tailed)) for sample A3 is 0.005. Since the p-value is less than 0.05, there is a significant difference between the new and old fishing hook strength data, and the H_o is rejected. However, for samples G7 and Q9, the p-values are greater than 0.05, indicating that there is not a significant difference, and the H_1 is rejected. According to Kadir (2015), reject H_o if the Asymp Sig. the (2-tailed) result is $\leqslant$ 0.05, and accept H_o if the Asymp Sig. (2-tailed) result is > 0.05. Therefore, for the G7 and Q9 sample data, it is concluded that H_o is accepted or there is no significant difference in strength between the new and old brands. Meanwhile, for fishing gear A3, H_o is rejected or there is a significant difference in strength between the fishing hook brands before and after five capture operations.

For the sample of fishing hook strength, number 8 indicates that all the paired brand samples show a p-value > 0.05. It can be concluded that there is no significant difference between the paired brand samples. Due to the p-value > 0.05, H0 is accepted, meaning there is no difference between the new and old fishing hook strength. According to Kadir (2015), the Wilcoxon test not only considers the direction of difference but also determines the magnitude or existence of a real difference between paired data taken from a related sample. This test can be used for both sequentially measured data and paired data. To determine the difference in fishing hook strength, if the Asymp.Sig (2-tailed) value is > 0.05, H_o is accepted and H_1 is rejected.

4. Conclusion

The research findings indicate that there is not a significant difference based on the strength testing results of fishing hooks from the three brands. However, in sample A3 number 9, the Wilcoxon test result shows a P-value of 0.005 < 0.05, which means there is a significant difference between the strength of the new fishing hook and the fishing hook after five operational trips. The fishing hook after five trips produces greater strength compared to the new fishing hook. Both fishing hooks number 8 and 9 from brand A3 are considered to have sufficiently good strength and are higher than the other two brands. The A3 brand number 9 indicates that the brand has met the quality standards for fishing hooks, both in terms of size and maximum strength. However, the G7, Q9, and the three brands from number 8 do not meet the quality requirements for fishing hooks, as one of the parameters does not reach the minimum limit. Fishermen are advised to use the A3 brand number 9 fishing hooks, which meet the quality standards and have better strength compared to other brands. Additionally, A3 fishing hooks yield a higher total catch of fish.

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