

Degradation Effects of Automotive Gas-Oil Pollution of Oyan-lake, Lagos Lagoon and Sea Waters on Elongation (cm) of Unknotted Artisanal PVA Synthetic Fishing Twine.

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ABSTRACT

This study investigated the effects of automotive gas-oil spillage of Oyan-lake (0.4ppt), Lagos lagoon (25ppt) and Sea (37ppt) waters on elongation (cm) of artisanal PVA synthetic twine of diameters 4mm, 6mm, 8mm and 10mm soaked for four months. Chemical (burning) test was carried out to identify the twine as PVA, among others six locally synthetic twines (Klust, 1973). The elongation (cm) of dry, unpolluted (control) and polluted states of PVA twines were tested with tensile-strength gauge machine (0-200kg capacity). Factorial statistics was used to analyze the treatments, twine (at four levels), water salinity (at three levels) and concentrations (at six levels), replicated in four places (288 treatments). The thicker the PVA twine diameters at lowered (0%, 20%, 40%, 60%, 80% & 100%) automotive gas-oil spillage of fresh, brackish and marine waters respectively, the higher the significant elongation was evaluated. Significant ($p < 0.05$) correlation coefficients $r = 0.989$ for dry twine 10mm, $r = 0.933$ for unpolluted 10mm twine and lowest r -value of 0.499 was obtained in twine 4mm soaked in 100% gas-oil concentration.

(Keywords: degradation, elongation, automotive gas-oil pollution, AGO, unknotted PVA twine, fishing gear, fresh water, brackish water, marine water)

INTRODUCTION

The introduction of man-made netting twine or fiber such as in the 1950s is one of the main technological revolutions in modern fishing in Nigeria (Klust, 1973). These days, fishing gear made of synthetic netting fibers are widely used in both the artisanal and industrial sub-sectors of the capture fisheries. Netting, according to the

International Organization for Standardization (ISO, 1970) is defined as a meshed structure of indefinite shape and size, composed of one yarn or of one or more systems of yarn interlaced or joined together. The raw materials of the netting consist of fiber of which two main groups may be distinguished. These are both natural fibers and manmade or synthetic fibers (Klust, 1973).

Elongation (extension) of synthetic fibers is the increase in length of a specimen during a tensile test, expressed in units of length, e.g. millimeters or centimeters. The netting yarn sample without knot of a given length is fastened to the clamps of the machine and extended under an increasing load until half of its respective knot breaking load is reached. However, because of the difficulty in measuring the extension of knotted netting twines as a result of the twine coming out of the knot, when loose knots are tightened during the test, Brandt (1959) suggested that elongation test should be carried out with unknotted materials unless there are particular reasons to the country.

There are seven synthetic locally made twines used in making fishing gears, which are Polyvinyl-alcohol (PVA), Polyamide (PA), Polyester (PES), Polyethylene (PE), Polypropylene (PP), Polyvinyl chloride (PVC) and Polyvinylidene chloride (PVD) (Klust, 1982). PVA being one of the seven synthetic fibers, is a man-made products created through a chemical process. However, ecological disaster aspect of oil spillage needs to be accessed in order to determine its implication on lives and other properties of the environment. All these spillages have caused lots of destruction to our natural ecosystem especially our aquatic resources. Ajao (1994) observed that oil spillage directly

damages the boats and gears used for catching or cultivating aquatic species.

Nigerian fishery sector is divided into three main parts, which are fresh (rivers, lakes), brackish (lagoon, estuaries) and marine (sea) water ecosystems. Oyan-lake which is owned and operated by the Ogun-Osun River Basin Development Authority (O-ORBDA) has a surface area of 40km² is located on latitude 7°15'N and longitude 3°16'E on the confluence of Oyan and Ofiki rivers about 20kilometers North West of Abeokuta, Ogun State, South Western Nigeria (O-ORBDA, 1989). Lagos lagoon is a lagoon sharing its name with the city of Lagos, Nigeria, which lies on the coordinates 6°27'N 3°23'E, the second largest city in Africa and lies on its south-western side. The lagoon is more than 50km long and 3 to 13km wide, separated from the Atlantic Ocean along sand spit 2 to 5km wide, which has swampy margins on the lagoon side. Its surface area is approximately 6,354.7km (Obafemi, 2008). The city spreads along more than 30 km of the lagoon's south-western and western shoreline pollution by urban and industrial is a major problem as a large amount of wastewater is released into the lagoon daily (Obafemi, 2008). Bar-beach, which is enclosed with marine water, is one of the many beaches scattered along Lagos coastline. The Nigerian marine fisheries ecosystem covers about 960 km coastline. The exclusive economic zone was created in 1978 and goes about 320 km into the water.

MATERIALS AND METHODS

The study was conducted from July-December, 2010 in a simulated fishery laboratory at the Department of Aquaculture and Fisheries Management, University of Agriculture, Abeokuta, Ogun state, South West Nigeria. Sea (marine) water and lagoon (brackish) water samples were collected from bar-beach and Lagos lagoon respectively, both in Lagos State, while Oyan-lake (fresh) water was collected from Oyan-Lake in Ogun State, with 20 liters keg each. The salinity of the three water bodies was measured immediately with water salinity chemical test kit of model HI3835 and recorded. Twenty five (25) liters of automotive gas oil was purchased at *Dambold* filling station, camp, Alabata area, Abeokuta, Ogun State. Artisanal PVA fishing twines of four different diameters (4mm, 6mm, 8mm and 10mm) were purchased at Adeniji Adele market, Lagos State.

In accordance with (Klust, 1973: 1982), the identification of the experimental white synthetic twine by solubility test was achieved to know the chemical group which the twine belongs as the marketers always muddle-up the seven different types of synthetic twines for profit interest. The standard safety precautions for chemical laboratories, such as putting the twine sample in the reagent and not pouring the reagent on twine sample to avoid explosion and others were observed.

The materials used for solubility test were; heat source from Bunsen burner, 2 forceps, 5 glass test tubes of 10ml each, 5 pieces of 30cm experimental synthetic white twine, and five different reagents. Each test tube contained 30cm experimental synthetic white twines mixed separately with each of these five different reagents; Hydrochloric acid; Sulphuric acid; Dimethylformamide; Formic acid and Glacier acetic acid. The two forceps were used to hold the test tube firmly into the flame and the 5 test tubes were heated simultaneously with the aid of lighted Bunsen burner to discover its solubility rate (Klust, 1973). The reactions of experimental white twine with different reagents after heating were noticed and recorded.

70cm of 72 pieces each, of diameters 4, 6, 8 and 10mm that were meant for the experiment were cut and knotted at both ends, to prevent loosening. The well-labeled eighteen experimental bowls of 4 liters capacity each, were labeled and arranged in three groups of fresh, brackish and marine water samples at 0%, 20%, 40%, 60%, 80% and 100% concentration levels. Automotive gas-oil spillage samples of fresh, brackish and marine waters were then prepared artificially using measuring cylinder (cl). Zero percent (0%) automotive gas-oil spillage of fresh water contained 3litres of non-polluted fresh water (control). 20% diesel-oil spillage concentration of fresh water contained 0.6litre of automotive gas-oil in 2.4litres of fresh water (0.6/2.4 liters). 40% automotive gas-oil concentration of fresh water contained a mixture of 1.2litre of diesel-oil in 1.8litres of fresh water (1. 2/1.8 liters) and so on. Sixteen twine pieces (4 replicates each of twine 4, 6, 8 and 10mm) were then immersed in each of the eighteen experimental bowls that contained automotive gas-oil spillage of fresh, brackish and marine water samples at 0%, 20%, 40%, 60%, 80% and 100% concentration levels and were left for duration of four (4) months. The 288 netting

twines were brought out of the eighteen experimental bowls after four months immersion and were tested using the method described by Klust (1982).

Elongation (cm) effects of all the 288 treatments (wet specimens), including 16 dry twines (control) added up to three hundred and four (304) specimens were then measured in fishing gear laboratory of Nigeria Institute for Oceanography and Marine Research (NIOMR), Lagos state. Each test specimen was fastened between the two clamps of a tensile testing machine and was stretched and extended under increasing force until it broke, and the point at which it broke was breaking load value in kilograms-force. Elongation is the increase in length of a specimen during a tensile test, expressed in units of length, e.g. millimeters or centimeters (Klust, 1973;1982) and calculated as Elongation (cm) = Final length (cm) - Original length (cm). The factorial experiment was four by three by six (4 x 3 x 6). That is, twine sizes replicated at four levels (4, 6, 8 & 10mm), water salinity replicated at three levels (0.4, 25 & 37 parts per thousand) and automotive gas-oil concentrations replicated at six levels (0, 20, 40, 60, 80 & 100% by volume).

Factorial statistics were used to analyze the data. Data collected were subjected to analysis of variance. Significant means were separated using Least Significant Difference (LSD) at 95% confidence value (P<0.05). Correlation and

Regression analysis were used to distinguish relatively among elongation (cm) of the twine diameters tests (Klust, 1982).

RESULTS AND DISCUSSION

The water salinity tested were 0.4ppt, 25ppt & 37 parts per thousand (ppt) for Oyan-lake, Lagos lagoon and Sea waters respectively. The experimental synthetic white twine was chemically identified by solubility test as PVA (Table 1). About 10ml each of these five reagents; Hydrochloric acid; Sulphuric acid; Dimethylformamide; Formic acid and Glacier acetic acid which were mixed separately with experimental twine in different five glass test tubes that were heated with the aid of lighted bunsen burner reacted differently. The twine was observed soluble in hydrochloric acid, sulphuric acid and formic acid which correlate with its attributes as discovered by (Klust, 1973). Whereas, the twine was not soluble in dimethylformamide formamide boiled for 5minutes and was decomposed by exposure to light even when stored in a brown bottle. It is therefore advised to store away from light and preferably in a cool place. Glacier acetic acid boiled for 5minutes was not also soluble, Table 1. And all these soluble reaction confirms the experimental white twine to be PVA which agrees with the findings of Klust (1973; 1982)

Table 1; Solubility (Chemical Test) Identification of PVA Synthetic Twine

Reagents/ Methods	Solubility rate
• Hydrochloric acid/ HCL (37%) + twine for 30 minutes at room temperature	+
• Sulphuric acid/ H ₂ SO ₄ (98%)+ twine for 30 minutes at room temperature	+
• Dimethylformide/HCON(CH ₃) ₂ +twineboiledfor5minutes	-
• Formicacid/HCOOH(97%)+ twine for 30minutes at room temperature	+
• Glacieraceticacid/CH ₃ -COOH+twineboiledfor5minutes	-

Key; +ve signifies soluble and -ve signifies non- soluble
Field Survey, 2010

Effects of automotive gas-oil pollution of fresh, brackish and marine waters on elongation of PVA fishing twine

Elongation (cm) was significantly highest ($p>0.05$) in twine diameter 10mm compared to other twine diameters at all concentration level of automotive gas-oil, followed by twine 8mm and 6mm, and significantly lowest in twine 4mm. Therefore, the thicker the PVA twine diameter with lowered automotive gas oil concentration, the higher the elongation (cm) and vice versa. Twine 10mm ($20.50^b \pm 1.12$) at 0% automotive gas-oil concentration had the highest significant ($p>0.05$) elongation value, followed by twine 8mm ($19.33^c \pm 1.10$) at 0% automotive gas oil concentration which was not significantly different from twine 10mm ($20.01^{bc} \pm 1.11$) soaked in 20% automotive gas-oil concentration. Twine 10mm ($19.53^d \pm 1.00$) at 40% automotive gas oil concentration had the same elongation (cm) effect with twine 8mm ($19.21^d \pm 1.06$). Twine 8mm ($19.00^e \pm 1.03$) at 40% automotive gas-oil concentration and 10mm ($18.96^e \pm 1.00$) at 60% automotive gas-oil concentration were not differed significantly ($p>0.05$) in elongation (cm) effects. Twine 4mm ($17.20^f \pm 1.05$) at 0% automotive gas-oil concentration and 6mm at 20% ($18.00^f \pm 1.13$) and 60% ($17.00^f \pm 1.08$) automotive gas-oil concentration were not differed significantly ($p>0.05$) in their elongation (cm). Thus, the lowest elongation (cm) effect was observed in twine 4mm ($17.0^f \pm 1.14$) at 100% automotive gas-oil concentration. This implies that, the bigger the PVA twine diameters (10, 8, 6 & 4mm) at no or lowered automotive gas-oil concentration (0%, 20%, 40%, 60%, 80% and 100%), the higher the elongation (cm) value, and high durability of PVA fishing gear typed could be achieved. Thus, automotive gas-oil pollution contributed a high

negative effect to the elongation (cm) of the artisanal PVA fishing twine, which in turn leads to low tensile strength of the twine that could cause wear and tear of fishing gears, and thus could inhibit the sustainability of artisanal fish production in Nigeria (Table 2).

Elongation (cm) of PVA twine diameters was significantly affected by water types at varied concentration of automotive gas-oil. Twines soaked in automotive gas-oil polluted fresh water were significantly higher in elongation (cm), than the same twines soaked in automotive gas-oil pollution of brackish and marine waters respectively. Elongation (cm) of twine soaked in 0% ($19.22^b \pm 1.05$) fresh water had the highest significant effect on twine among others. Twines soaked in brackish water at 0% ($18.28^c \pm 1.00$) automotive gas-oil concentration and freshwater at 20% ($18.19^c \pm 1.01$) automotive gas-oil concentration had no significant difference ($p>0.05$) in their elongation (cm) output. Twines soaked in fresh water at 40% ($18.03^d \pm 1.30$) and 60% ($17.88^d \pm 1.20$) automotive gas-oil concentrations were not significantly different ($p>0.05$) in elongation (cm).

Also, twines soaked in marine water at 60% ($16.13^g \pm 1.23$) and 80% ($15.19^g \pm 1.00$) automotive gas-oil concentration and brackish at 80% ($15.63^g \pm 1.21$) automotive gas-oil concentration had the same elongation (cm) effects, whereas, twine soaked in marine water at 40% ($16.3^g \pm 1.11$) and 60% ($16.13^g \pm 1.23$) automotive gas oil concentration were not significantly different in elongation (cm). Meanwhile, twine soaked in 80% ($15.19^h \pm 1.00$) automotive gas-oil of marine and 100% automotive gas oil concentration had the least elongation (cm) value (Table 3).

Table 2: Effects of Varied Automotive Gas-Oil Concentration on Elongation (cm) of Different Diameters of PVA Twine.

Twine Diameters (mm)	0% Conc.	20% Conc.	40% Conc.	60% Conc.	80% Conc.	100% Conc.
4	$17.20^f \pm 1.05$	$17.05^g \pm 1.17$	$16.50^h \pm 1.20$	$16.20^i \pm 1.05$	$15.05^j \pm 1.09$	$17.0^j \pm 1.14$
6	$18.10^e \pm 1.15$	$18.00^f \pm 1.13$	$17.63^{ef} \pm 1.02$	$17.00^f \pm 1.08$	$16.69^{gh} \pm 1.02$	$16.01^i \pm 1.07$
8	$19.33^c \pm 1.10$	$19.21^d \pm 1.06$	$19.00^e \pm 1.03$	$18.76^{ef} \pm 1.14$	$18.05^g \pm 1.21$	$17.01^h \pm 1.01$
10	$20.50^b \pm 1.12$	$20.01^{bc} \pm 1.11$	$19.53^d \pm 1.00$	$18.96^e \pm 1.00$	$18.21^f \pm 1.00$	$17.33^{fg} \pm 1.05$

Source: Field survey, 2010

Hint; b-j are ANOVA superscripts. Means (Figures) with the same letters (superscripts) have no significant difference at 5% probability ($P>0.05$)

Table 3: Effects of Varied Automotive Gas-Oil concentration of Fresh, Brackish and Marine Waters on Elongation (cm) of PVA Twine.

Water Types	0% Conc.	20% Conc.	40% Conc.	60% Conc.	80% Conc.	100% Conc.
F	19.22 ^b ±1.05	18.19 ^c ±1.01	18.03 ^d ±1.30	17.88 ^d ±1.20	16.62 ^e ±1.12	16.59 ^h ±1.15
B	18.28 ^c ±1.00	17.30 ^{de} ±1.16	16.76 ^{ef} ±1.10	16.46 ^{fg} ±1.07	15.63 ^g ±1.21	14.88 ^h ±1.02
M	17.75 ^{cd} ±1.15	16.56 ^{ef} ±1.26	16.3 ^{fg} ±1.11	16.13 ^g ±1.23	15.19 ^h ±1.00	14.75 ^h ±1.25

Source: Field survey, 2010

Hint; b-h are ANOVA superscripts. Means (Figures) with the same letters (superscripts) have no significant difference at 5% probability (P>0.05)

Correlation of Elongation (cm) of Dry PVA twine diameters (4, 6, 8 & 10mm)

Correlation of elongation (cm) of PVA twine diameters in dry state was calculated. Elongation (cm) correlated positively and highly significant with different twine diameters 10, 6, 8 & 4mm respectively, with r ranging from (r= 0.800-0.989) for dry test. Twine 4mm with the least correlation coefficient(r) of 0.800, implies that Y is significantly different from X at 80% probability level, that is, the farther the elongation value of PVA twine diameters to 1.00, the weaker and shorter the longevity of that twine diameter, followed by twine 6mm (r =0.900) & 8mm (r=0.929). Whereas, twine 10mm had the highest correlation coefficient r, 0.989, thus, this implies that Y is significantly different from X at 99% probability level, that is, the closer the correlation coefficient r-value to 1.00, the more durable and stronger the elongation (cm) of PVA twine diameters in dry state was observed. Thus, any gear made from such durable PVA twine without its usage in AGO polluted water bodies will enhance high and maximum fish yield in no time (Table 4).

It is evident that PVA twine dry test conducted was only used as control to compare the result from the PVA twines soaked in three different polluted and non-polluted water bodies for a period of four (4) months and not as a reference point, as also reported by Carrothers (1972), that the properties of netting materials and netting are usually of interest and most important to fishery in the wet condition. He further stated that the usual dry strength data, for example are normally of no value to the fishery and can even lead to incorrect decision.

Figure 1 shows the result of the significant interactive effects of elongation (cm) on PVA twine diameters soaked in different water types at varied automotive gas-oil (AGO) concentration. Elongation (cm) was significantly highest in twine 10mm (with a mean of 20.40±3.50) soaked in 0% automotive gas concentration of freshwater and lowest in twine 4mm (with a mean of 13.50±4.00) soaked in 100% of automotive gas-oil. Twine 4mm of 0% automotive gas-oil concentration of fresh water, 10mm of 80% automotive gas-oil pollution of freshwater and 8mm in 0% AGO pollution of marine water were not significantly different (p>0.05) in elongation (cm). Twine 6mm of 0% automotive gas-oil concentration of fresh water, 10mm soaked in 20% automotive gas-oil pollution of fresh water and 10mm soaked in 0% automotive gas-oil concentration of brackish and marine waters were not significantly different (p>0.05) in elongation (cm). Also, twine 4mm soaked in 20% automotive gas-oil pollution of fresh, 6mm in 40% automotive gas oil pollution of fresh water, 8mm in 80% automotive gas-oil pollution of fresh water and 4 & 6mm in 0% automotive gas-oil pollution of brackish waters were the same (p>0.05) in elongation (cm). Twine 6mm soaked in 80% automotive gas-oil pollution of fresh water, 6mm soaked in 40% automotive gas oil pollution of brackish water, 8mm soaked in 40% and 60% AGO pollution of brackish water and 8mm of 20,40 & 60% automotive gas-oil pollution of marine waters were not significantly different (p>0.05) in elongation effects. Twine 6 & 8mm soaked in 20% automotive gas-oil pollution of brackish water were not significant (p>0.05) in elongation (cm) values.

Table 4: Prediction Equation, Correlation Coefficient and Coefficient of Determination of Dry (Control) PVA Twine Diameters.

PVA Twine Diameter (Y)	Prediction Equation (r)	Correlation Coefficient (r ²)	Coefficient of Determination	Significant Level (5%)
4	0.986X ² -31.98X+ 298.4	0.800	0.640	S
6	1.125X ² -4038.8X+ 366.1	0.900	0.810	S
8	9.091X ² -353X+ 3448.7	0.929	0.863	S
10	11.79X ² -518.6X+ 5534	0.989	0.978	S

Source: Field Survey, 2010

Note: S is significant (p<0.05) at 95% confidence value

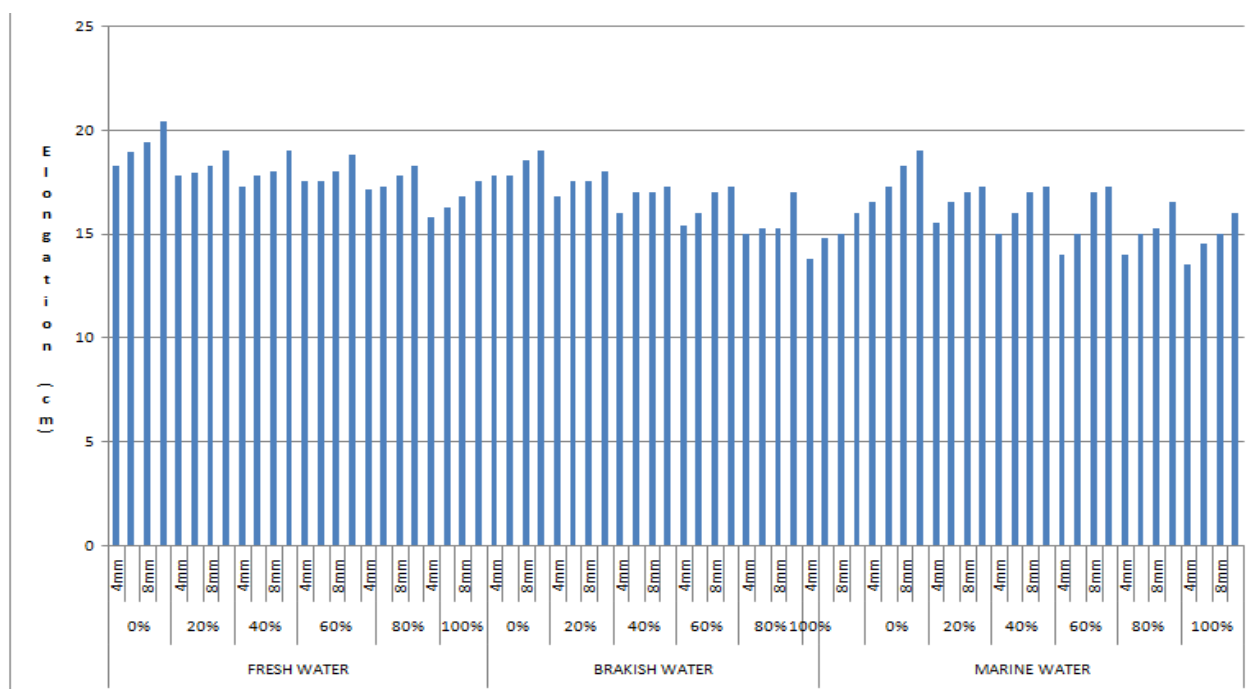


Figure 2: Effect of Different water types at varied Automotive Gas-Oil Concentration on Elongation (cm) of PVA Twine Diameters. Source: Field Survey, 2010

Twine 4mm soaked in polluted brackish water at 40% concentration of automotive gas-oil, 6mm of 60% automotive gas oil pollution of brackish and 10mm of 100% automotive gas-oil pollution were not significantly different (p>0.05) with twine 6mm soaked in polluted marine water of 40% automotive gas-oil concentration. Likewise, twine 4mm soaked in 60% automotive gas-oil pollution of brackish water was not different significantly from twine 4mm soaked in 20% automotive gas-oil pollution of marine water (p>0.05). Twine

10mm soaked in 60% automotive gas-oil concentration of brackish water and 10mm soaked in 20% & 40% automotive gas-oil concentration of marine waters were the same (p>0.05) in elongation (cm) values. Twine 4mm soaked in polluted brackish water at 80% concentration of automotive gas oil, 8mm soaked in 100% automotive gas-oil pollution and 10mm soaked in 20% & 40% automotive gas-oil concentration of marine waters were not significantly different in elongation (cm) effects.

Also, twine 6mm and 8mm soaked in 80% automotive gas-oil concentration of brackish water were not differed significantly ($p>0.05$) in elongation (cm) with twine 8mm at 80% automotive gas-oil concentration of marine water. Twine 6mm at 0% automotive gas-oil concentration of marine water and 10mm at 60% AGO concentration of marine water were not differed in elongation (cm) values. Likewise 6mm at 20% automotive gas-oil concentration of marine water and 10mm at 80% automotive gas-oil concentration of marine water were the same in elongation (cm) values. And again, twine 4mm at 60% automotive gas oil concentration of marine water and the same 4mm at 80% diesel concentration of marine water were not different significantly ($P>0.05$) in elongation (cm) values. It was therefore observed in most cases that, the thicker the twine diameters (10,8,6 & 4mm) at lowered automotive gas-oil concentration (0,20,40,60,80 &100%) of fresh, brackish and marine waters respectively, the higher the elongation values of PVA twine as illustrated below (Figure 1).

CONCLUSIONS

From this study, it is evident that when new twine materials are put on the market, manufactures usually claim that these twines are well suited for fishing gear construction. The arguments of manufacturers are not always based on exact testing, findings and controlled experiments, but are sometimes speculative. Manufacturers advertising should therefore be considered with caution, and the work of the research department for fishing gear and methods should be concerned with the following main aspects; Textile materials for the production of fishing gears: Treatment and maintenance of fishing gears: Location and detection of fish: Prevention and treatment of polluted water bodies: Design and construction of fishing gear for aquaculture, artisanal and industrial fisheries purposes.

Although, synthetic materials are known to be generally strong, but this study revealed that 10mm of PVA synthetic twine which had the highest thickness among other experimented twines such as 8, 6 and 4mm exhibited the highest elongation (cm) in most cases, which was led to increase mesh sizes of fishing nets constructed from such twines, which is in line with (Klust, 1982), that the elongation of netting yarns naturally increased with increasing thickness. In

other words, the heavier the netting yarns, the more force (load) is required to obtain elongation (cm). Fishing gears to be made of PVA are therefore suggested to be of higher diameters (starting from 10mm), in order to have a perfect fishing sustainability

In addition, the quality of the fish to be caught with automotive gas oil-polluted PVA net is likely to be of low quality and may even have residual toxins in the fish caught, if such nets are used. It is recommend that, dissemination of vital information about treatment of automotive gas-oil polluted water bodies and management of efficient fishing gears to the artisanal fishermen through the following training media be appropriately considered: safety precaution on gear maintenance, which could be formal or informal: Workshop: Bill-board: Radio message (mass media): Extension agents that follow this trend; contact farmers; community leaders; group leaders; local fishermen and so on, should as well be ensured.

In order to avoid or at least reduce the damage from water immersion, fishing gears should be generally protected from soaking in water when not in use because rot-proofness of PVA synthetic fibers, does not really mean that it is entirely unaffected in its properties when immersed in water for prolonged periods Abdulsalami, 2008 (unpublished). Investigative study should be carried out by the fisheries scientist in various test methods for fishing gear materials (twines and netting) to be used by the Nigerians artisanal fisheries for efficient and sustenance fish production.

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