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A COMPARATIVE STUDY OF CERTAIN CHARACTERISTICS OF THE COMMON VEGETABLE FIBRE TWINES FOR FISHING NETS*

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INTRODUCTION

TWISTED twines are essential components for fabrication of fishing nets and other similar snares. Selection of twines for the different gear depends on the one hand upon the dynamic characteristics and on the other, the extent of availability of the raw materials. The degree of twist and the uniformity in the distribution of the material, as denoted by the diameter and the mass per unit length, are important traits in selecting suitable twines. The softness of twist is of particular significance in gill-nets. Strength and elongation or stretch are other indispensable qualities of twines contributing in large measure to the catch efficiency and life of the concerned gear. Resistance to abrasion is yet another important characteristic particularly for those used for trawl nets and other towed gear, where rubbing and resultant friction are general features than the exception. Evaluation of the above indicated inherent properties, their concomitance and inter-relationship are basic essentialities in the programme for improvement of the existing fishing nets in vogue and introduction of their relatively modern counterparts.

Although man made fibre (synthetic) twines are becoming increasingly popular in other countries, from the economic standpoint and other related considerations, the mainstay of fishing nets in India will continue to be fibres of vegetable origin, at least till such time cheap synthetic equivalents are produced within the country. The majority of the vegetable fibres are procured from indigenous sources; a few varieties are, however, imported. The present paper deals with the initial study conducted by the authors for a comparative evaluation of certain characteristics of the common vegetable fishing net twines. The work was undertaken at the suggestion of Dr. H. Miyamoto, F.A.O. Gear Technologist. To him the authors' grateful thanks are due, for the painstaking guidance during the course of experiments and the criticism offered for the preparation of this paper.

* Contribution No. 19.

MATERIALS AND METHOD

In the present study, which as indicated earlier is only an initial attempt, seven varieties of common vegetable fibre twines were subjected to the preliminary tests. Table I presents the list of materials; the known trade specifications are noted against each.

TABLE I

Showing the specification of materials

Serial No.	Material Common name	Trade specifications
(i)	Madras sann hemp	Number 31, 10 ply
(ii)	Italian hemp	2×4 ply
(iii)	Flax	Not known
(iv)	Indian sisal	2 mm. (in diameter)
(v)	Manila	2 mm. (in diameter)
(vi)	Indian cotton	Count No. 20, 3 ply, 63 threads
(vii)	Malabar coir	Superior Angengo

Italian hemp, flax and Manila are imported into the country. Apart from flax all the other materials are extensively used in the Indian fishing industry. In choosing the different materials the diameter of the twines was taken as the approximate standard base of equity.

The diameter in millimetres, the mass per metre length in grams, the dry and wet (48 hours immersion) breaking strength in kilograms and the percentage stretch both in dry and wet conditions were recorded. The results are based on 100 tests and subsequent statistical analysis of the data. The mean (arithmetic mean) and the standard deviation were calculated employing the conventional formulæ (Waugh, 1952) for grouped data and they are:

Arithmetic mean

$$X = X' + Ci \frac{\Sigma(fd)}{N},$$

TABLE II

The analysed data of the tests conducted

Sl. No.	Name of material	Diameter in mm.				Mass in gm./metre					Breaking strength in kgm.				Percentage breaking stretch			
		U.L.	L.L.	'X'	σ	U.L.	L.L.	'X'	σ		U.L.	L.L.	'X'	σ	U.L.	L.L.	'X'	σ
(i)	Sann hemp	2·90	1·91	2·26	0·228	3·86	2·44	3·31	0·300	D	44·5	26·5	32·75	3·510	7·66	4·00	5·81	0·910
										W	50·5	28·0	37·15	3·722	13·66	9·33	11·60	1·024
(ii)	Italian hemp	2·38	1·89	2·08	0·095	3·79	2·92	3·39	0·175	D	77·5	51·5	67·50	4·845	9·00	6·60	7·97	0·515
										W	80·0	53·0	69·45	5·405	18·20	11·6	16·02	1·274
(iii)	Flax	2·48	2·05	2·21	0·110	3·88	2·52	2·93	0·263	D	60·0	31·5	44·60	5·595	10·66	6·66	8·78	0·952
										W	62·5	36·5	50·95	5·625	19·33	14·00	16·66	1·126
(iv)	Sisal	2·66	2·04	2·38	0·111	4·30	2·60	3·28	0·329	D	53·0	25·0	36·05	5·375	12·33	7·00	9·57	0·995
										W	53·0	25·0	38·95	5·740	18·00	11·00	14·55	1·351
(v)	Manila	2·99	2·20	2·66	0·167	4·56	3·02	3·90	0·380	D	65·0	34·0	50·25	6·400	11·33	7·33	9·09	0·910
										W	74·5	37·5	53·70	5·675	18·00	13·00	15·89	1·246
(vi)	Cotton	2·40	2·07	2·21	0·069	2·48	2·16	2·34	0·071	D	31·5	21·5	27·02	1·732	25·23	15·66	21·1	1·702
										W	35·0	25·0	30·74	2·184	29·33	24·00	26·74	0·982
(vii)	Coir	3·17	2·02	2·57	0·238	3·03	1·31	2·04	0·362	D	13·5	4·0	9·06	1·979	28·33	12·33	21·20	3·68
										W	12·5	4·0	8·38	2·062	35·33	13·33	25·95	4·21

U.L. = Upper limit; L.L. = Lower limit; 'X' = Arithmetic mean; σ = Standard deviation; D = Dry and W = Wet.

where X' is the assumed mean, Ci the class interval, $\Sigma(fd)$ the sum of the deviations and N the number of observations, and
Standard deviation

$$\sigma = Ci\sqrt{\frac{\Sigma(fd)^2}{N} - \left(\frac{\Sigma(fd)}{N}\right)^2},$$

where Ci is the class interval; $\Sigma(fd)^2$ the summation of the squares of deviation; $\Sigma(fd)$ the summation of deviation and N the number of observations.

RESULTS

The results of the observations (arithmetic mean) are tabulated in Table II.

(*a*) *Diameter*.—Figure 1 shows the range of variation of the diameter of the different twines compared. It will be observed that while cotton and Italian hemp are fairly uniform in thickness, Madras sann hemp and coir twines appear considerably coarse.

(*b*) *Mass*.—Figure 2 shows the range of variation in the mass per unit length. Italian hemp and cotton twines studied have fairly uniform mass as evidenced by the Text-Figure, and sann hemp and coir fall far below the above standards, having apparently no uniformity in the distribution of the fibres in the twines.

(*c*) *Breaking strength*.—Figure 3 depicts the dry and wet breaking strength of twines. The deviation in the strength appears to be high in all the twines studied.

(*d*) *Breaking stretch*.—Figure 4 shows the variations in dry and wet breaking stretch (percentage to the tested length) of the twines. In all the materials compared cotton and coir exhibit relatively high properties of stretch.

DISCUSSION

(*a*) *Diameter and mass*.—Diameter of the twines is an important characteristic to determine the effect of currents on a given piece of webbing, the pull on the net by the moving fish and the power required or speed attained in the case of a towed gear (Carrothers, 1957). Similarly the mass of twine is another important factor to be reckoned while designing a net (Reuter, 1957). Apart from economic considerations of cost and amount of material used, the mass of twine also helps to determine the total weight of the gear which in turn is indicative of the buoyancy and gravitational forces necessary to keep the net in the concerned fishing position.

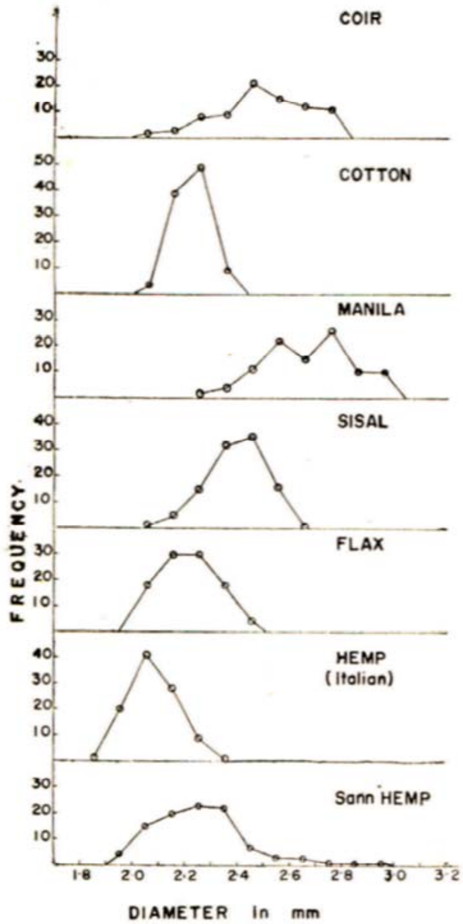

FIG. 1

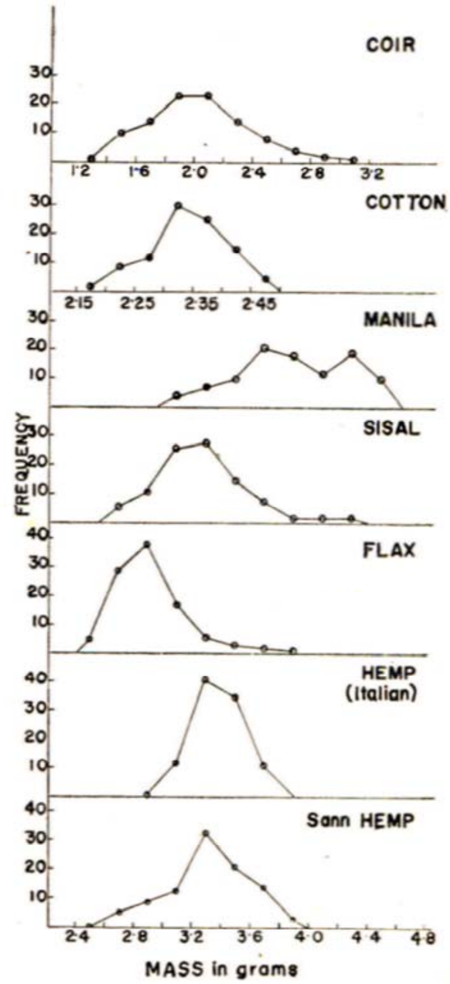

FIG. 2

FIGS. 1-2. Fig. 1. Frequency polygon showing the range of variation of the diameter of the twines. Fig. 2. Frequency polygon showing the range of variation in the mass per unit length of the twines.

Both these essential characteristics severally and conjointly denote the uniformity in the thickness and the distribution of the material in the twines. Netting twines should be uniform in thickness. It will be observed from Table I that cotton twine is most even in thickness; that the Italian hemp is the most evenly twisted among hemp twines and that the Madras sann-hemp twine exhibit rather high percentage of deviation both in its diameter and mass per unit length. The non-uniformity in the thickness of these sann hemp twines is suggestive of some defect in the procedure or process

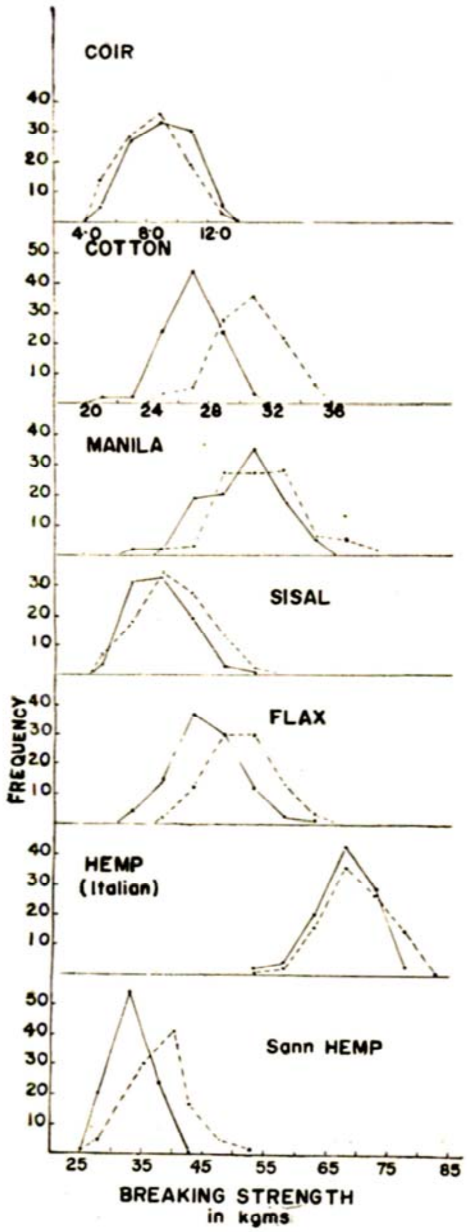

FIG. 3

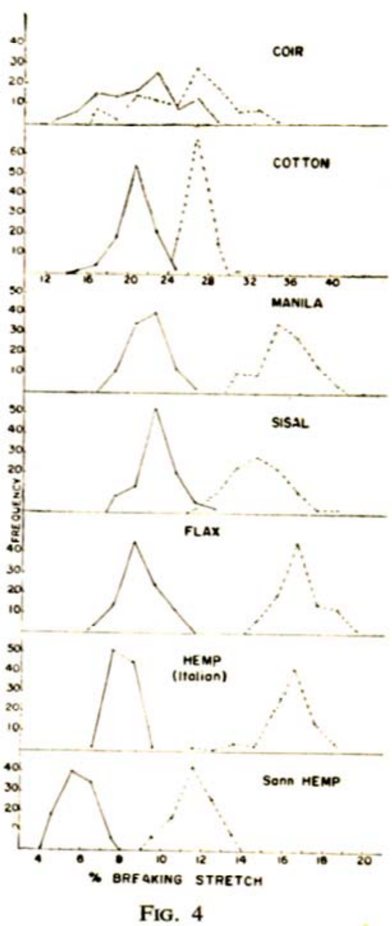

FIG. 4

FIGS. 3–4. Fig. 3. Frequency polygon showing the range of variation of dry and wet breaking strength of twines. Fig. 4. Frequency polygon showing the range of variation of dry and wet breaking stretch of twines.

of its manufacture. Miyamoto and Shariff (1959) in their studies have also indicated the poor quality of Madras sann hemp twines used for fishing nets.

In an earlier communication (Kuriyan and Cecily, 1959) it has already been propounded that mass per unit length of the twine is directly proportional to the square of the diameter of the twine. Therefore,

$$W = KD^2,$$

where W is the mass per unit length, D, the diameter and K the constant.

When W represents mass in grams per metre length of twine and D, the diameter in mm., the constant K in this relationship for the different twines compared are:

	(i) Madras sann hemp ..	0·65
	(ii) Italian hemp	0·78
	(iii) Flax	0·60
	(iv) Sisal	0·58
	(v) Manila	0·56
	(vi) Cotton	0·48
and	(vii) Coir	0·31

As the above indicated values of K show mass of twine in grams per mm.^{2} of D^2, they would serve as an index to denote the relative mass of the concerned material. In the present instance Italian hemp is more heavy than the other materials of the same thickness with sann hemp, flax, sisal, manila, cotton and coir following in that order. Coir is the lightest among the materials compared.

(*b*) *Strength*.—As indicated elsewhere in this communication strength is an essential characteristic governing the catch efficiency and the life of the concerned gear. Breaking strength is proportional to the mass per unit length of the twines. This relationship is represented in the following formula

$$S = KW,$$

where S is the breaking strength, W, the mass per unit length and K, the constant in this relationship.

The values of K for the dry and wet twines of the materials under comparison is tabulated in Table III. Since S is in kgm. and W in grams per metre length of twine, the values of K denote the breaking strength in kgm. per one gram metre of twine.

TABLE III

The values of the constant K *in the strength-mass relationship*

Sl. No.	Material	Value of K		Percentage increase in strength of wet twines
		In dry	In wet	
(i)	Sann hemp	9·92	11·26	13·5
(ii)	Italian hemp	20·25	20·61	1·8
(iii)	Flax	15·19	17·35	14·2
(iv)	Sisal	11·00	11·90	8·2
(v)	Manila	12·88	13·77	6·9
(vi)	Cotton	11·50	13·20	14·8
(vii)	Coir	4·45	4·12	− 7·5

The constant K would serve as reference figure indicating the relative strength of twines of the same mass. In the present comparative study, Italian hemp is observed to be nearly twice stronger than Madras sann hemp.

The percentage increase in breaking strength is shown in the last column of Table III. Except in the case of coir, the strength of all the twines increase in the wet condition. Coir lose their breaking strength when wet and this fact corroborates the view of Gopalan Nayar (1959).

That the strength of twines is proportional to the square of the diameter has already been indicated elsewhere (Kuriyan and Cecily, *op. cit.*). The formula depicting the above relationship is

$$S = KD^2,$$

where S denotes the strength; D the diameter and K the constant.

Founded on the above hypothesis of strength-thickness relationship, the calculated constant K for materials compared is tabulated in Table IV. Here S is in kgm., D in mm. and the values of K would therefore be breaking strength in kgm. per one mm.^{2} of D^2.

TABLE IV

The values of the constant K *in the strength-thickness relationship*

Sl. No.	Material	Values of K		Percentage increase in strength of wet twines
		In dry	In wet	
(i)	Sann hemp	6·4	7·42	16·1
(ii)	Italian hemp	15·64	16·10	2·9
(iii)	Flax	9·13	10·43	14·2
(iv)	Sisal	6·35	6·86	8·1
(v)	Manila	7·16	7·65	6·9
(vi)	Cotton	5·55	6·30	13·5
(vii)	Coir	1·21	1·12	− 7·5

Cotton and sann hemp are the main net webbing materials produced in India. Fairly large quantities of Italian hemp twines are being imported for 'Dara' gill-nets in Bombay State primarily due to extra strength of these twines. When compared with the Italian hemp of the same mass, the Madras sann hemp studied appear to be only half as strong. It must be admitted that the sample of sann hemp analysed was of poor quality being badly twisted, and non-uniform in thickness. These characteristics, if improved, could apparently increase the strength property of the twine. Similar studies on the sann hemp twines produced in other Indian States also appear necessary prior to attempting to suggest an alternative indigenous twine to replace the imported Italian hemp twine.

Coir and Sisal are indigenous fibres used for making ropes essential for fishing nets. Coir appear to be weak. On the contrary Sisal is almost as strong as Manila, a view already established earlier (Anon 1933).

(*c*) *Breaking stretch*.—The breaking stretch of materials is of particular importance in fishing net fabrication. The relation between strain and stretch is the factor by which the resilience of the twine can be represented.

In all the materials studied the stretch when wet appears to be more than when dry. Table II shows the stretch property of each twine and in general cotton and coir twines possess large percentage of stretch when compared with hemps and flax.

SUMMARY

Certain characteristics of the common vegetable fibre twines used for fabrication of fishing nets are presented. The interrelationships of these characteristics are indicated.

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