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Preparation and application of different size materials on the cotton yarn and investigating the effect of sizing on the tensile properties of cotton yarn

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Abstract

Sizing of the cotton yarn is essential to reduce breakage of the yarn due to abrasion during weaving process. The sizing agent on the woven fabric after weaving needs to remove completely before the next textile production process of dyeing and finishing. So, water soluble sizing agent is easy to handle and easy to desizing for pre-treatment of woven fabric. In this work, different types of water soluble tamarind seed kernel based sizing formulations (assigned by A, B and C) were made and applied on cotton yarn to investigate the effect on the tensile properties of sized and unsized cotton yarns. Cotton yarn treated with size B formulation shows the better tensile properties than the application of size A and size C formulation. The effect of lubricant has also been investigated and shows that the addition of lubricant decreases the tensile properties of the cotton yarn.

Keywords: Cotton yarn; Tamarind kernel; Sizing; Desizing; Tensile properties.

Introduction

Sizing plays a very important role in the production of fabric during weaving process. It improves the physico-mechanical parameters of warp threads (Schwarz *et. al.,* 2011). Sizing agents are used to improve or increase the stiffness, strength, and smoothness of yarns, fabrics, papers and other products. Sizing agents are applied as an aqueous solution to yarns in order to strengthen and lubricate them, thereby increasing the efficiency of the weaving process and improving the quality of the resulting fabric. Because breaking of yarn during weaving process causes loom stoppages that decreases the productivity and creates fabric defects. The important reasons for applying sizes to warp yarns are to protect them from breaking during weaving and to decrease their surface hairyness so that the tendency for adjacent warp yarns to entangle will be reduced (Maatoug *et. al.,* 2007). Sizing on warp yarns are provided with necessary strength, elasticity, smoothness, and acquire resistance to abrasion and static charge. Deep sizing is the quality sizing, where fibres are fixed in the position in which they were before sizing. It is also important to apply size on the surface of the thread in the form of a film to provide outer protection of the threads (Kovacevic *et. al.,* 2004). The sizing agents which are applied on the yarns in weaving mills have to be removed or desized completely before further processing of this woven fabric in the textile dyeing and finishing. Water insoluble sizing agents have to be degraded during desizing but water soluble sizing agents can be simply washed out with or without detergents. During desizing of cotton yarn, aquous sizing agent dissolves in water with elimination from the yarn and it is assumed that the yarn will behave in the similar way after the weaving (Djordjevic *et. al.*, 2012). So, an ideal sizing agent should form a film on the surface of yarn to improve tensile performance and must not penetrate into the center of the yarns to enable easy removal after weaving. Keeping this idea in mind the objectives of this research was to prepare an aqueous sizing agent which has better tensile properties and has easy desizing characteristics.

Textile sizing agents are mainly three types based on starch, PVA and acrylic. PVA belongs to refractory biodegradable organic substances, and could cause serious pollution to environment. So in recent years, researchers have developed different green size instead of PVA to protect environment from pollution (Xiao e*t al*., 2009). Starch based sizing agents have been used in the sizing of cotton yarns for many years. Major drawback of the starch is brittleness of the film. So synthetic binder is added to starch based size mixture or modified starch is used to eliminate this drawback. Starches are generally obtained from three sources, seed, root and pith

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of a plant. Requirements for size materials vary with different types of yarns. So size mixtures are composed of ingredients which have different characteristics for different types of yarns because they are required to fulfill many different conditions. Cotton sizing agents are mainly composed of many different substances in which the starchy substances are mainly wheat flour, corn starch, potato starch, or sago flour. Film strength of tamarind kernel powder is better than these starches. Tamarind seed kernel based sizing agent has two major advantages over the above mentioned starches as it is cheaper and it can be applied in smaller amounts to obtain better results. Its use can replace the use of food starches in the textile industries. In this work, water soluble tamarind kernel based sizing formulations were prepared and used for cotton yarn. An appropriate size mix selection is another important aspect in sizing. Many researchers have already reported that the starch/acrylic size mix is the best one for cotton yarns (Behera *et al.*, 2006). Therefore, in this work acrylic polymer was selected to prepare tamarind kernel/ acrylic size mix formulations for cotton yarns.

Material and methods

Tamarind seed and 100% cotton yarn were collected from local market in Dhaka. Industrial grade acrylic polymer, gum acacia, tallow and other additives were used. Tamarind seed kernel was analyzed for physical and chemical properties and summarized in the Table I. Three types of sizing materials were prepared from tamarind seed in laboratory and applied on 100% cotton yarn. The purpose of using these different sizing agents was to compare their effects on tensile properties of treated cotton yarns against each other and unsized cotton yarn.

Preparation of tamarind seed kernel solution and size mixtures

Tamarind seeds were dried in an oven at 100°C for 1-2 h and decorticated to remove husks (33% approx.) from endosperm or white kernels (67% approx.). Aqueous solution of tamarind seed kernel was prepared and other additives were added into the aqueous solution to prepare, by cooking, the following three types of size materials:

Size A: Tamarind seed kernel solution (3.5%) with acrylic polymer and other additives.

Size B: Tamarind seed kernel solution (3.5%) with acrylic polymer, gum acacia and other additives.

Size C: Size B with addition of tallow.

Application of size mixtures on cotton yarns and determination of size add-on

Prepared tamarind seed based three type size materials (size A, B and C) were applied on cotton yarn separately by diluting 30, 50 and 70 percent for 3 minutes only. The sizing process temperature was 30°C for size A, B and 70°C for size C. Each sized yarn was dried in air. The percent (% of size add-on) was measured using oven dried sized and unsized yarn by the following equation:

% of size add-on = [(weight of sized yarn - weight of unsized yarn)/ weight of unsized yarn] x 100

Physico-chemical analyses of tamarind kernel and tamarind kernel based sizing agents

Different parameters of physico-chemical properties of tamarind seed kernel and tamarind kernel based sizing agents of Size A and Size B have been studied and reported in Table I and Table II respectively.

Determination of linear densities

The linear densities of sized and unsized cotton yarn were measured as per ASTM D 1577 (Anonymous).

Evaluation of tensile properties

Sized and unsized cotton yarns were conditioned before to measure tensile properties using a tensile testing machine (Karl Kolb, Germany) following ASTM D-3822 (Anonymous) standard test method. Tensile properties were measured five times for each sample.

Results and discussion

The physico-chemical properties of tamarind seed kernel were analyzed and the results are shown in Table 1. It can be seen that tamarind seed kernel is rich in polysaccharide and protien content. The results of the physico-chemical analyses of size A and size B formulations are given in Table 2. It is found that the polysaccharide content of tamarind seed ker

Table I. Physico-chemical properties of tamarind seed kernel

S. No.	Parameter	Tamarind seed kernel
1	Physical state	Solid
2	Color	Off white/ Creamy white
3	Solubility	78% part of TKP is soluble in hot water in all proportions
4	Moisture content	7 % MAX
5	Ash Content	3.5 % MAX
6	*Polysaccharide content	62 % MAX
7	Protein content	15.5 % MAX
9	Fat/oil content	9.5 % MAX
8	Crude fiber and other constituents	2.5 % MAX

*Polysaccharide content was calculated by difference

nel is 62 % approximately which is the active ingredient in the prepared size material of A, B and C.

Figure 1 shows the results of size add-on percent on the cotton yarn by comparing the applied diluted concentration of size materials. It is found that the size add-on percent on cotton yarn increases with increasing concentration of size materials. It is also found that the addition of lubricant decreases the size add-on percent on cotton yarn. Howard *et. al.* reported that addition of lubrication caused both increases and decreases in add-on level comparing with the respective unlubricated samples. Fig. 2 shows that the linear density of sized yarn increases than unsized yarn.

The results of the tensile properties of sized and unsized cotton yarn are shown in Figs. 3-4. It is observed that application of size B on the cotton yarn shows the better tensile properties than the application of size A and C. The effect of

Table II. Physico-chemical properties of tamarind seed kernel based sizing agents

S.No.	Parameter	Size A	Size B
1	Physical state	Thick liquid	Thick liquid
2	Color	Off white	Off white
3	Solubility	Soluble with water	Soluble with water
4	Ash Content	2.5 % MAX	0.8 % MAX
5	pH at 29 ^{o}C	6.5-7.0	7.0-8.0
6	Density at 29 ^{o}C	1.036 g/cc	1.037 g/cc
7	Viscosity at 29 ^{o}C (Falling ball viscosity method)	267.52 mPa.s	215.05 mPa.s

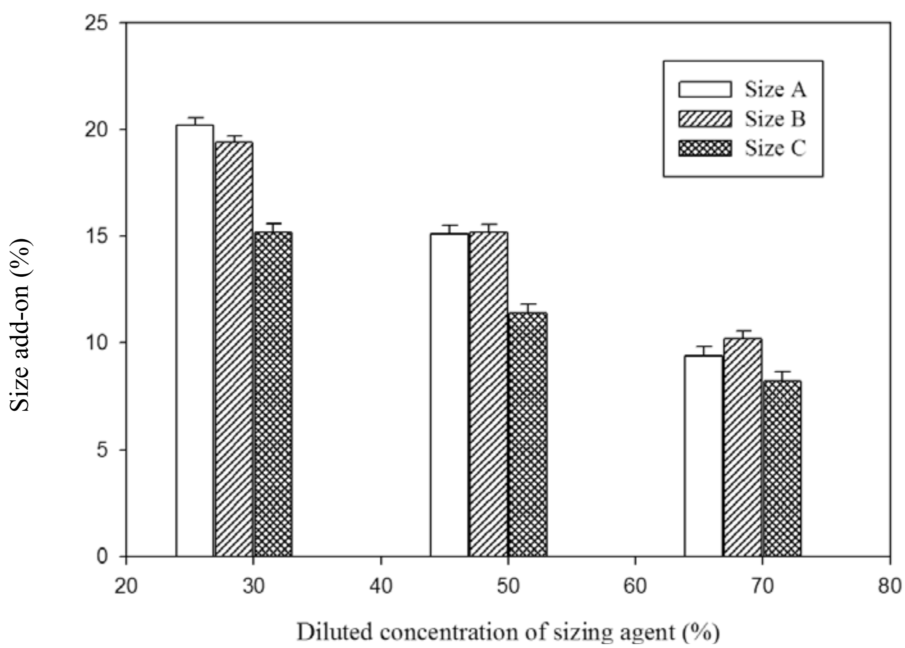

Fig. 1 . Diluted concentration of sizing agent (%) vs size add-on (%) of cotton yarn

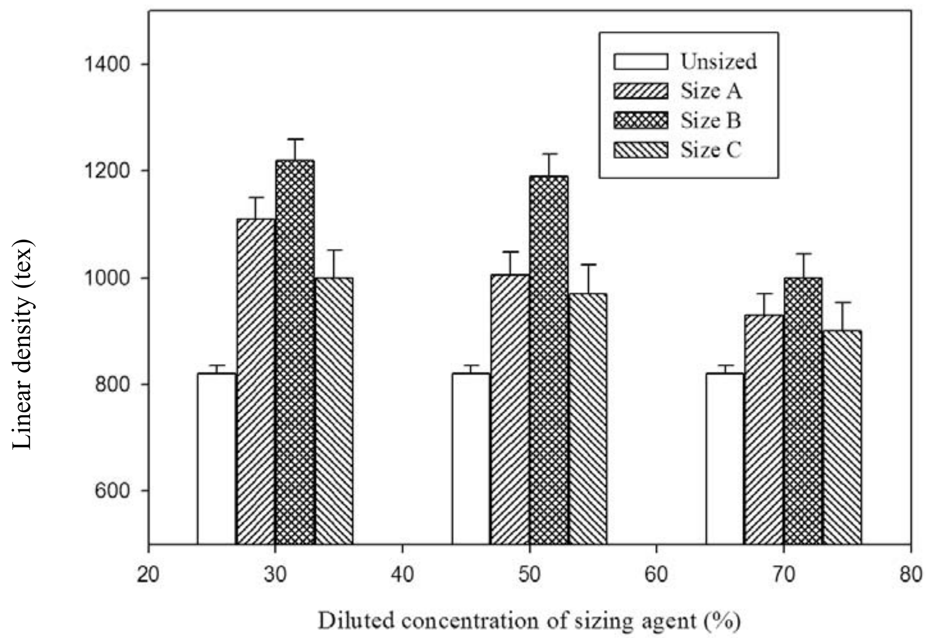

Fig. 2 . Diluted concentration of sizing agent (%) vs linear density (tex) of cotton yarn

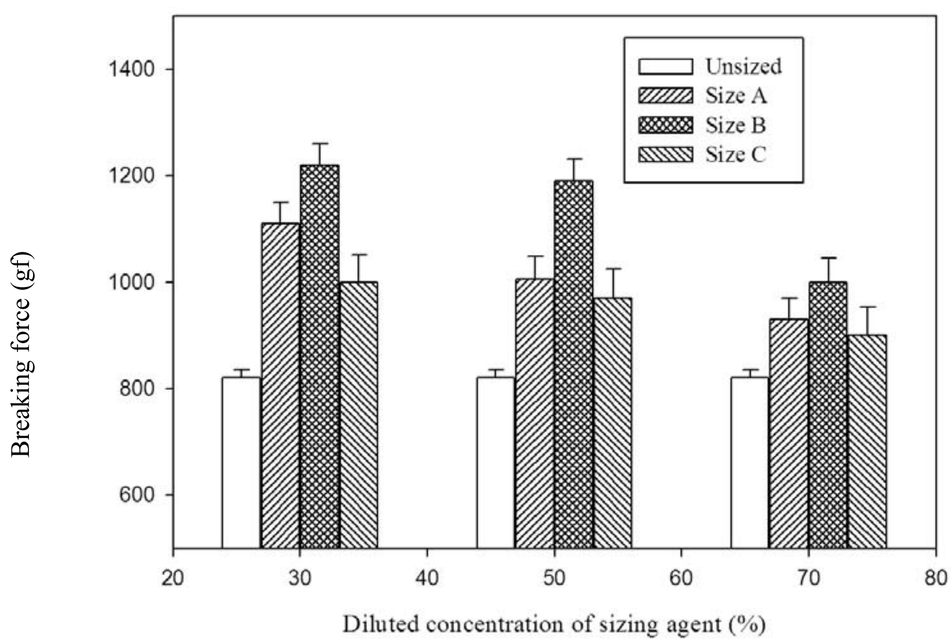

Fig. 3. Diluted concentration of sizing agent (%) vs breaking force (gf) of cotton yarn

lubricant on the tensile properties of sized yarn compared with unsized yarn is also shown in the Figs. 3-4. From the results of Figs. 3-4, it is observed that addition of lubricant decreases the tensile properties of size C application than the size A and size B application on the cotton yarn. Howard *et al*. (2000) also reported similar result that application of lubricant in either solid or liquid form, in the size bath or after drying caused a decrease in yarn tensile strength. It is also found from Table I that the tamarind kernel contains

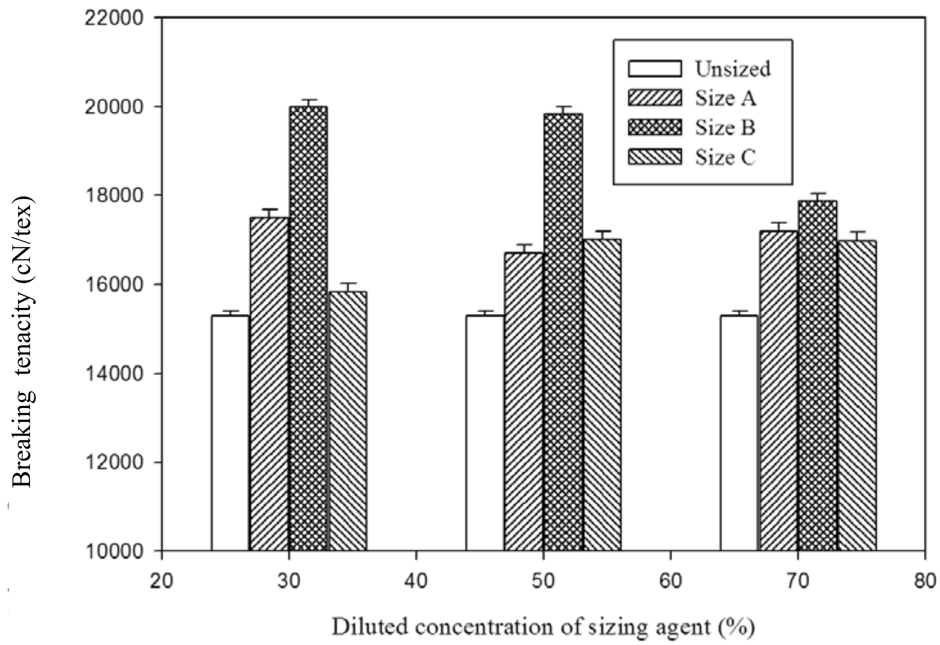

Fig. 4. Diluted concentration of sizing agent (%) vs breaking teancity (cN/tex) of cotton yarn

approximate ly 9.5% fat/oil which may act as a lubricant in the size formulation. So addition of lubricant may increases the amount of softening resulting the decreases of the tensile properties.

Conclusion

This research investigated on the tensile properties of sized and unsized cotton yarns by applying the prepared tamarind seed kernel based different size materials. From this investigation it may be concluded that tamarind seed kernel based size materials are suitable sizing agents for cotton yarns. Size formulation B gives better results, in respect to an improvement in tensile properties of sized cotton yarns, in comparison with other size formulations; size A and size C. Addition of lubricant in the size formulation C decreases the tensile properties of the cotton yarn.

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