EFFICIENCY OF SIZING MATERIALS ON COTTONS

Thesis submitted to the
University of Agricultural Sciences, Dharwad
in partial fulfillment of the requirements for the
Degree of

MASTER OF HOME SCIENCE

IN

TEXTILE AND APPAREL DESIGNING

By

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1. INTRODUCTION

Cotton is one of the world's most socially vital and economically important agricultural cash crops. The lint from the cotton plant forms the major source of fabric as well clothing, fabricated by various techniques like weaving, knitting, non-woven, braiding, netting, knotting and lace making. The seeds of cotton, separated during ginning is an important source of vegetable oil used as cooking oil as well as to prepare paint, varnish and soaps. The meat of the seed forms a rich and valuable supplement feed for cattle and other live stocks; a raw material for paper and other consumer products. The stalks are the inexpensive source of fuel, mostly for rural folk (Degury *et al.,* 1973).

The cultivation and utility of cotton has a great and long lasting history. This cash crop was grown and used in the manufacture of fabric since historical times in India, Egypt and China. There is evidence of cotton being existed in Middle Egypt as early as 12,000 B.C. The archeological excavations revealed that cotton fibre and its string were available in the city of Mohenjodaro during Indus Valley Civilization, indicating use of cotton in various forms as early as 3000 B.C. By this time natives of Nile Valley in Egypt had mastered in the art of spinning and weaving. The use of cotton in India is referred to, in the ancient laws of Manu as early as 700 B. C. The use of cotton undoubtedly was known to the Greeks soon after the invasion of India by Alexander and Aristobulus, a contemporary of Alexander, mentions the cotton plant under the name 'wool bearing plant'.

The word 'Quttan' or 'Kutn', meaning a plant found in conquered lands, is the origin of "cotton". "Muslin" originally applied to cotton woven in Mosel, also comes from the Arabic language. Cotton is also called as 'fabric of India', since it has played a very important role in the lives of Indians. India holds the largest area of million hectares under cotton cultivation and ranked third in world's cotton production, next to China and USA and second largest cosumer of cotton (Venugopal *et al*., 1996). Besides sustaining the country's textile industry, it earns precious foreign exchange by way of export, both yarn as well as finished goods.

Cotton is a vegetable seed fibre of genes *Gossypium,* a member of the Malvaceae or mallow family and is widely grown in tropical and subtropical regions all over the world. The fibre grows in the seed pod of the cotton plant. Each fibre is a single elongated cell, flat, twisted and ribbon like with a wide inner hollow, the lumen. It is composed of about ninety percent cellulose, about six percent moisture and the remainder is of natural impurities. The outer surface of the fibre is covered with a protective wax like coating which gives fibre a somewhat adhesive quality.

The impurities present in raw cotton are oil, wax, pectin and natural colouring matter *viz*., husks seeds, pods and thrash. These impurities do become evident in the cloth when woven from spun yarns of such raw cotton. These cotton fabrics are categorized as low grade because of the poor aesthetics and quality, hence sold at a low price. The low grade cloth is reserved for minor applications and never recommended for clothing purpose. The quality cotton, today has wide applications as clothing for children, adolescents, elderly, ignoring the gender. Bed linen, table linen, furnishing and other similar made-ups are popularly produced from quality cotton yarns. Cotton is eco-friendly and user friendly fabric mainly because of many inherent properties like good absorbency, breathability, good heat conductivity, soft, pliable, acceptable level of orientations, resistance to high temperature, alkalies and moth. However, cotton is susceptible to cold or hot acids and mildews along with poor resiliency.

A number of gray finishing where cotton undergoes are scouring, bleaching, dyeing and printing in order to improve appearance and performance for different end uses. These gray finishes may be grouped as basic or special, mechanical or chemical and either temporary or permanent. Usually the basic finishes are mechanical where rollers, cylinders, frames are used along with the application of pressure and heat; and thus these finishes are temporary and non-durable indicating the finish vanishes on subsequent washes or dry cleaning. On the contrary the special finishes are durable, since suitable chemicals are selected to perform special function and are unaltered by any wet or dry treatments. Sometimes the chemicals applied onto the textile materials are retained there either by mechanical deposition or held there in by physical forces or chemical reaction; there by having durability to various degrees to the after treatment involving washing, dry cleaning, exposure to sunlight, perspiration, heat etc, during the use of the finished fabrics.

One such physical finishing is stiffening also referred starching where the sizing material is mechanically held on the fabric surface by physical forces. The word "starch" is derived from Middle English *sterchen*, meaning to stiffen. "Amylum" is Latin for starch, from the Greek word "amylon" which means "not ground at a mill". The root amyl is used in biochemistry for several compounds related to starch. Sizing also referred as starching, is the most common rather basic finish given to cottons, to impart stiffness, improve drape and aesthetics along with to resist dust and soil. The starched clothes in fact exhibit good resiliency too.

The starch is an important carbohydrate present in all the cereals at different percentages and composed of carbon, hydrogen and oxygen. It is obtained from plant, either as cereals, tubers, bark or pith. Chemically, it is carbohydrate having the empirical formula ($C_6H_{10}O_5$). It is a polysaccharide consisting of 75-80 percent amylopectin and 20-25 percent amylase. Pure starch is a white, colourless and odourless powder insoluble in cold and hot water. Starch becomes soluble in water when heated. The granules swell and burst, the semi-crystalline structure is lost and the smaller amylase molecules start leaching out of the granule, forming a network that holds water and increasing the mixture's viscosity. This process is called starch gelatinization. During cooking the starch becomes a paste and increases further in viscosity. During cooling or prolonged storage of the paste, the semi-crystalline structure partially recovers and the starch paste thickens, expelling water. This is mainly caused by retrogradation of the amylase. Retrogradation is a reaction that takes place in gelatinized starch when the amylase and amylopectin chains realign themselves, causing the liquid to gel (D'Souza, 1998).

The starch industry extracts and refines starches from seeds, roots and tubers, by wet grinding, washing, sieving and drying. Today, the main commercial refined starches are cornstarch, tapioca, wheat and potato starch. To a lesser extent, sources include rice, sweet potato, sago and mung bean. Historically, Florida arrowroot was also commercialized. Florida arrowroot was the commercial name of an edible starch extracted from *Zamia integrifolia* (coontie), a small cycad native to North America. To this day, starch is extracted from more than 50 types of plants.

A laundry starch is the solution that penetrates into the fibre but leave it pliable and give a smooth glossy finish that resist dirt. Thus, starching is a process of adding stiffness to the cotton fabric and tends to make subsequent washing easier as soil clings to starch rather than the fabric (Dantyagi, 1987). Clothing or laundry starch is a liquid that prepared by mixing a vegetable starch in water and is used in the laundering of clothes. Starch was widely used in Europe in the 16th and 17th centuries to stiffen the wide collars and ruffles of fine linen which surrounded the necks of the well-to-do. During the 19th century and early 20th century, it was stylish to stiffen the collars and sleeves of men's shirts and the ruffles of girls' petticoats by applying starch to them as the clean clothes were being ironed. Aside from the smooth, crisp edges it gave to clothing, it served several practical purposes as well. Dirt and sweat from a person's neck and wrists would stick to the starch rather than to the fibers of the clothing, and would easily wash away along with the starch. After each laundering, the starch would be reapplied.

'Resiliency' is the bending capacity of the fibre, yarn and fabric resulting into unwanted wrinkles. In other words cotton is prone to wrinkles, that distracts the appearance and adversely affects the aesthetic appeal. The fabric texture like stiffness or limpiness is concerned with the hand feel, drape, texture and aesthetic properties of apparel fabrics.

Sizing is a process used for the application of a film forming polymer may be natural or synthetic to provide temporary protection to the warp yarns from abrasion and other types of stress and strain generated on the weaving machines in order to reduce the warp breakages. Sizing helps in forming a coating which encapsulates the yarn, embeds the protruding fibres and also causes some inter-fibre binding by penetration. The performance of the warp yarn largely depends on the nature of the protective coating and its interaction with fibre substrate.

The weavability of sized yarn is greatly influenced by adhesion power of size material and is important parameter for selecting the size material for any application (Behera *et al.,* 2008).

Sizing is a necessary operation by means of which cotton warps have to be provided with the ability to meet the requirement of weaving and to be given a certain amount of protection against any adverse influence to the material. It is achieved by the application and uniform distribution of the sizing ingredients on the threads. The threads must acquire a certain amount of stiffness, suppleness and smoothness depending on the character of the yarn and the final fabric. Hence, the warp yarns of thin, fine goods must not be sized in the same way as that for thick, coarse fabrics. (Shenai, 1991)

Cotton dresses and saris are a favourite of many Indian populations; it is often not preferred due to maintenance problems. Cotton is always comfortable and cool. The colourful cotton especially saris in just a single wash loose its rich crispness and stiffness that directly affects it's the drape quality. Hence, maintaining crispness of cotton clothes need smart thinking.

Starching is the basic finish given to cottons, which is temporary. The sizing materials available in the market are either natural or synthetic in origin thus the quality of stiffness varies with the source. The raw cotton materials on dresses do contain some percent of size, which will be washed off during laundering, resulting into soft, pliable, fabrics with poor drape, resiliency and aesthetic appeal. Therefore, it becomes imperative to starch the cotton especially saris, ladies dresses as well as gents shirts/kurtas after laundering.

Hence, the present study was taken up with the following objectives:

1. To study the different sizing agents used on cotton fabric
2. To assess the impact of natural and synthetic sizing agents on structural, performance, durable, comfort properties and aesthetic appearance
3. To examine the effect of washing on structural, performance, durable, comfort properties and aesthetic appearance of sized fabrics

2. REVIEW OF LITERATURE

This chapter presents the relevant research articles pertaining to the present study on "Efficiency of sizing materials on cottons" and the review is presented under the following headings:

2.1 Cotton sizing

2.2 Composition of starch

2.3 Impact of sizing materials on physical parameters of cotton fabric

2.1 Cotton sizing

Sizing is the application of various materials to a fabric to produce stiffness and firmness. Starch is sizing agent that give weight to a fabric and make an inferior product to look attractives, improve texture, fineness and drape of the fabric. Starching is a basic finish given to cotton materials.

Mishra et al. (2007) conducted a study on 'Standardization of stiffening procedure for white cotton fabric'. White cotton fabric and arrowroot powder was selected for the study. Sample of three different materials to liquor ratio i.e 1:20, 1:30 and 1:40 were selected and the test sample was sized with sizing agent. Results revealed that the material to liquor ratio and concentration of stiffener made a significant difference in air permeability, bending length, crease recovery and drapability of white cotton fabric stiffenied with arrowroot powder. On sizing there was improvement in the appearance of cottons and help in stain removal, keep clothes clean for longer time which might prove beneficial for day to day use of cotton fabric.

Zahram et al. (2007) carried out a study on 'Synthesis and application of reactive stiffening agent based on the methlyolated products of (polyacrylamide) guar gum polyblends'. Polyacrylamid-guar gum polyblends have been prepared via graft copolymerization of acrylamide onto guar gum using $KBrO_3$/thiourea redox system. The feasibility of utilization of the obtained reactive polyblends as permanent stiffening agents for cotton fabrics was studied. The results obtained indicated that reactive polyblends, the cotton fabrics under the optimum pad-cure conditions arrived at (3%Nmethylol-PAam- GG, 0.5% $(NH_4)2SO_4$; curing temperature 140^0C, and curing time, 5 min) produced fabric having excellent permanent stiffness, superior tensile strength as compared with that of untreated fabric.

Das et al. (2011) conducted a study on 'Jackfruit seed- A source of natural sizing agent'. Mercerized cotton both white and coloured fabrics were starched with varying concentrations of starch range from 10–30 per cent. The result of the study revealed that the starch prepared from seeds could be effectively used for cotton materials. From the physical properties and visual results, 20gpl-25gpl concentrations were accepted as a standard concentration for starching cotton material both white and coloured.

Mostafa and El-Sanabary (2012) revealed about the 'Harnessing of novel tailored modified pregelled starch-derived products in sizing of cotton textiles', while harnessing of the newly tailored pregelled starch-derived products as sizing agent of cotton textiles was studied. The result of the study reveal that the extent of carbamoylethylation increase by increasing the extent of hydrolysis and duration; the graft yield monomer/100 g sample of different monomers onto carbamoylethylated pregelled starch and carbamoylethylated hydrolyzed pregelled starches increased by increasing the extent of carbamoylethylation and the degree of hydrolysis, and follows the order: methacrylamide - methacrylonitrile - methacrylic acid; and cotton fabrics sized with grafted carbamoylethylated hydrolyzed pregelled starch acquire higher mechanical properties, i.e., tensile strength, elongation at break, and abrasion resistance values than hydrolyzed pregelled starches, carbamoylethylated pregelled starch, and carbamoylethylated hydrolyzed pregelled starches.

2.2 Composition of starch

Starch is highly organized mixture of two carbohydrate polymer, amylase and amylopectic, which are synthesized by plant enzymes and simultaneously pack into dense water soluble granules. Starch granules vary in size and shape, which are characteristic of their specific plant origin.

Starch is the major energy reserve for plant, it is located mainly in the seeds, tubes, pith and fruit. Starch amylase is primarily a linear chain of glucose units. Amylase chains can coil into double helices and become insoluble in cold water. Amylopectic also is composed of chains of glucose units, the chain are branched. This branched structure renders amylopectic soluble in cold water. Both the appearance of granules and their functional properties vary with the plant source. The reviews related to composiyion of starch materials is presented below:

A study entitled 'Glucose production from treated sago starch granules by raw starch digesting amylase from Penicillium brunneum' was carried out by Haska (1991). Penicillium brunneum from sago palm tree at a sago processing site was used as a source of starch digesting amylase. Result revealed that all the raw starch digesting enzymes were effective for cereal starches, but root starches and sago starch were resistant to the enzyme reaction. Treatment of sago starch by heating to temperature below gelatinization temperature at lower pHs resulted in an increase in the ability of enzyme to digest sago starch granules. Heating to 60℃ at pH 2.0 resulted in a conversion rate of sago starch granules to glucose near to the conversion rate of raw corn starch to glucose. At higher concentration, the degree of hydrolysis of treated sago starch granules was about 275 per cent as compared to that of untreated sago starch granules. Enzyme in large amount or small portion at various time intervals was found effective in the hydrolysis of treated sago starch granules.

Khalil et al. (1995) performed a study on 'Preparation and characterization of starch acetate'. Maize starch for acetylation of native hydrolyzation and oxidization was studied. The different factors affecting acetylation process include textile warp sizing, liquor ratio, acetic anhydride, perchloric acid concentration, reaction time and temperature were investigated. It showed that the acetyl content increases to reach a maximum and then decrease on increasing either liquor ratio or perchloric acid concentration. Also it increased with increasing acetic anhydride concentration within the range examined, whereas the actylation reaction efficiency percent decreases. The solubility of acetylated starches derived from hydrolyzed or oxidized starches increased more than that of acetylated native starch. The solubility depends on the extent of acetylation and of the modification prior acetylation. Acetylation of starch improved its sizeability of cotton yarns.

Mostafa and El-Sanabary (1996) performed a study on 'Carboxyl-containing starch and hydrolyzed starch derivatives as size base materials for cotton textiles'. The changes in the molecular structure of maize starch and hydrolyzed starches derived by introducing carboxyl-containing groups via carboxymethylation and vinyl graft polymerization, and the effect that these changes have on the technical properties of yarns sized with the starches were investigated. It was found that the apparent viscosity of the pastes prepared from these products depends on the degree of hydrolysis prior to chemical modification. On the other hand, cotton yarns sized with these starch derivatives were measured for tensile strength, elongation at break and abrasion resistance. It was also found that the highest values of the properties were obtained with cotton yarns sized using poly methacrylic acid -grafted starch derived from hydrolyzed starch.

El-Zairy et al. (2002) conducted a study on 'Evaluation of some starch derivatives as thickening agents for printing polyester/cotton blended fabrics via discharge and resist styles'. Egyptian maize starch was used as starching material for preparation of starch derivatives via hypochlorite oxidation or etherification. The latter comprises cyanoethylation carbamoylethylation and carboxymethylation. The native and modified starches were evaluated as thickening agents in discharge printing of polyester/cotton-blended fabrics. The printed fabrics were previously dyed with dischargeable reactive and disperse dye mixture, using white or coloured discharge printing styles. After printing and steaming at different temperatures, for different intervals of time, the printed samples were washed, dried and assessed for degree of whiteness and colour strength (K/S). It has been found that the degree of whiteness and colour strength (K/S) depend on the time and temperature of steaming as well as the nature of thickening agent used. The highest degree of whiteness and the highest K/S values were obtained for the samples printed with pastes thickened with carbamoylethyl starch and steamed for 8 minutes at 200.DEG.C. The overall fastness properties, viz., rubbing or washing for the coloured printed goods ranged between 4 and 5 with the exception of the samples printed with native or hypochlorite oxidized starch pastes, which acquired a harsh handle.

Zhu (2003) carried out a study on 'Starch mono-phosphorylation for enhancing the stability of starch/PVA blend pastes for warp sizing'. The effect of starch mono-phosphorylation on the stability of starch–polyvinyl alcohol blend pastes was selected for warp sizing. The use of phosphorylated starch either as base material in the blended pastes or for enhancing the paste stability of native starch-polyvinyl alcohol blends is investigated. The stability of phosphorylated starch-polyvinyl alcohol blend pastes depends on the degree of modification of the starch. The starch monoester can also be used as stabilizer to increase paste stability. Increasing the degree of phosphorylation and/or amount of the starch monoester effectively retards the separation rates and enhances paste stability.

Zhu and Cao (2004) conducted a study on 'Modifications to improve the adhesion of crosslinked starch sizes to fiber substrates'. The results showed that crosslinking of starch stabilizes the viscosity of sizing paste, but excess crosslinking damages the adhesion to cotton and polyester/cotton blend fibers. Decreased adhesion can be eliminated by cationic modification of the crosslinked starch. The effect of cationic modification was present even when the degree of substitution as small as 0.021. Increasing the extent of cationic modification enhances adhesion. Moreover, cationic modification does not deteriorate viscosity stability.

Mostafa and Samarkandy (2005) conducted a study on 'Synthesis of new polymeric composite materials and its application in sizing of cotton textiles'. Pregelled starch composite was prepared by polymerizing pregelled starch with methacrylmide using potassium persulphate as initiator. Different factors affecting the composite preparation were studied with respect to concentration of initiator and monomer, polymerization time and temperature as well as rate of stirring. The composites expressed as total conversion of monomer to polymer were applied for sizing of cotton textiles. Results show that, the total conversion of poly methacrylmide - Pregelled starch composite was increased by increasing the persulphate concentrations from 0.1-0.3 based on weight of substrate then leveled off; increasing the methacrylamide concentration within the range studied; increasing polymerization time up to certain value then leveled off; and increasing polymerization temperature from 55° to 60℃, then decreases by raising the temperature to 65℃ and it serves as a good sizing agent for cotton textiles in comparison with that sized with pregelled starch alone.

Anis et al. (2007) studied on 'Sizing agents recovery by ultrafiltration: Effects of operating conditions'. The recycling of polyvinyl alcohol, polyacrylate and carboxymethyl starch based sizing agents by ultrafiltration and the parameters influencing the process were studied. The performance of the ultrafiltration process has been comparatively investigated at four different temperatures, 20℃, 30℃, 60℃ and 90℃, and six different time periods, 0 to 240 minutes with 40 minutes intervals. The effect of a lubricant has also been investigated. Results revealed that considerable increase in concentrate concentration with prolonged operating times and elevated temperatures. The use of lubricant did not have a considerable effect on ultrafiltration recovery efficiency, however, it passed to permeate at elevated temperatures resulting in decrease in the Chemical Oxygen Demand charge reduction.

Behera et al. (2007) conducted a study on 'Comparative analysis of size materials and their weaving potentials'. The different varieties of natural starches modified starches and synthetics size material on cotton and P/C blend yarns has been studied followed by their evaluation with respect to retrogradation, cohesive, adhesive and solubility. It is observed that the size paste characteristics and film properties of modified starch are better than those of the natural starch. Yarn sized with modified starch perform better than those of sized with natural starch and even some synthetic size starch give better results and the yarn sized with it give better weaving performance, close to that of PVA. Adhesive of size material with fibre substrate is found to have good correlation with weavability of sized yarns and it is an important parameter for selecting the size material for any application.

Tanapongpipat et al. (2008) worked out 'Process modification in the scouring process of textile industry'. The effects of scouring parameters on the scouring efficiency, including the weight ratio of de-sizing agent and fabric (5-80 g/g fabric), temperature of desizing agent tank (60-90^{o}C) and dipping time (2-8s), were studied. The results demonstrated that weight loss of sizing agent was significantly observed only in the de-sizing agent tank particularly in the first de-sizing tank and was found to a small extent in water tank.

The optimum condition in the scouring machine was found at a desizing agent to fabric ratio of 20 g/g fabric, with a temperature of the first desizing agent tank of 80°C, a temperature of the second desizing agent tank of 90°C, and dipping time of fabric of 7s. According to these conditions, more than 89 percent of the sizing agent was eliminated and only 3.52 mg/g fabric of sizing agent remained in the scoured fabric which was in an acceptable range for feeding to the downstream process known as dyeing process. Application of results to actual textile plant showed that there is a cost reduction due to improved utilization of rinse water, chemicals and energy in the process and consequent decreases in the generation of wastewater. Furthermore, the production capacity was increased from 30 m/min to 34.4 m/min.

Maatoug et al. (2009) carried out a study on 'Mechanical behavior of starch films'. Size formulations contained plasticizer i.e., glycerol and lubricants viz., Avirol, glycerin and tween20 with different concentration by using maize starch. Result revealed that tensile strength and extension of films were affected by hydrophilicity of the plasticizer and its concentration. Lower mechanical resistance when using lipid additives was also reported. The performance of a warp-sizing formulation is determined in part by the properties of lubricant type applied with it.

Ahmed (2010) conducted a study on 'An extensive study of the effect of the enzyme α-amylase used in textile conservation on silk fibers dyed with safflower and madder dye'. Result reveal that α-amylase causes first an improvement in the mechanical parameters (Tensile Strength, Elongation and Crystallinity index) of silk fabrics and a slight change in the optical parameters of silk dyed with Madder, safflower dye or mixture of mordanted with alum. Therefore, the fact that no drastic changes were recorded in the colour shades or the hues as well as in the brightness values and the mechanical parameters of the samples proved the suitability of α-amylase to remove the starch adhesive from archeological silk fabrics having either madder or safflower dye.

Reddy and Yang (2010) conducted a study on 'Citric acid and cross-linking of starch films'. The study concluded that citric acid can cross-link starch and improve the tensile strength, thermal stability and decrease the dissolution of starch films in water and formic acid. Citric acid cross-linked starch films showed about 150 per cent higher strength than non-cross-linked films and have strength better than most cross-linked starch and synthetic polymer blended films previously developed. Films cross-linked with 5 pre cent citric acid had only 35 per cent loss in weight after being in formic acid for 5 h at 50 °C whereas the non-crosslinked films dissolved immediately.

Jin et al. (2011) conducted a study on 'Blending water-soluble aliphatic-aromatic copolyester in starch for adhesion of sizing paste to polyester fibers'. Polyester fiber was used for adhesion of starch for warp sizing. The result of the study concluded that the molar ratio of aliphatic units to aromatic ones should be 30:70 in consideration of biodegradability and adhesion and also included the adhesion increased as the amount of water-soluble aliphatic-aromatic copolyester blended in starch increased initially. However, excessively increasing the water-soluble aliphatic-aromatic copolyester content reduced the adhesion. The strongest adhesion was observed at 10 per cent water-soluble aliphatic-aromatic copolyester content.

2.3 Impact of sizing materials of physical parameters of cotton fabric

The physical parameters have greater influence and play an important role in determining the quality of the fabric. The physical properties are assessed to determine the appearance, structural, performance, durable and comfort in fabric, on sizing.

The test samples were assessed for cloth count, cloth thickness, cloth weight, cloth bending length, cloth crease recovery, cloth drapability, cloth abrasion resistance, cloth tensile strength and elongation and cloth air permeability. Cited below are few of the relevant studies conducted to determine the physical properties of the fabric.

A study on 'Bending properties of wet abraded woven fabrics' was conducted by Joshua (1994). It was inferred that moisture content in the abraded fabric enhanced the stiffness. Large amount of moisture in the fabric sample and the type used for abrasion altered the mode of fabric abrasion significantly.

The difference between the wet abraded and damp abraded fabrics indicated that the presence of moisture favourably supported the abrasion resistance. The damp abraded test sample showed higher percentage of variation in bending properties than the wet when compared with unabraded.

Joshua and Yerimah (1994) conducted a study on 'Thermal degradation of woven cotton fabrics'. Three woven cotton fabrics were exposed to elevated temperatures in an electrical heating oven to determine the effect of heat on the physical/mechanical properties. Results revealed that the thermal degradation affected adversely the mass, strength, stiffness, shrinkage and colour of test samples. However, rigidity was the parameter affected to a greater extent. The breaking load was reduced considerably with the slight changes in dimensional stability and thickness. Thus, the authors concluded that, while drying textile materials the fabric must not be allowed to suffer thermal degradation owing to overheating, since the thermal change is an irreversible one.

A study on 'Fabric feel, hand and appearance of some Indian suiting fabrics using Kawabata instruments' was performed by Datta and Patel (1995). A total of 44 men's suiting fabrics were selected and were classified into summer and winter suiting wherein the summer suitings included P/V blended fabrics, 100 per cent wool and P/W blended fabrics and winter suiting fabrics consisted of 100 per cent wool and P/W blended fabrics. The low stress mechanical and surface properties of above fabrics were measured by Kawabata Evaluation System-Fabric (KES-FB) in standard atmosphere of 65 per cent RH and 27^0C temperature. The results revealed that all the Indian P/W summer suitings were found to be good whereas some of the P/V summer suitings found to be poor in total hand value. High bending rigidity and hysteresis, large shear stiffness and hysteresis and low surface roughness were the typical features of Indian summer suitings. All P/W and woolen winter suitings were found to be average to very good in total hand value. However, the total hand value of winter suitings increased with the increase in wool content and a good winter suitings possessed low surface friction, low variability in surface roughness, low bending and shear stiffness and high compressional resilience.

A perusal of the study on 'Effect of laundering on crease recovery and stiffness of P/C blended uniform fabric' carried out by Bhavani and Shailaja (1996) revealed that, the fabric specimen tested for crease recovery resulted into decrease with abrasion. While the abrasion resistance increased significantly with the increase in polyester content. The ability of the blended fabric to accept and retain a durable crease, and to retain garment shape after pressing increased with the increase in the polyester content of the blend, while the cotton content provided the handle and comfort characteristics.

A perusal of the study 'Stiffness and crease recovery' conducted by Tarafder and Kauser (1996) revealed that, form the selected five different shirting materials viz., 100 per cent polyester, 64:36 P/C, 58:45 P/C, 45:55 P/V and 100 per cent cotton, a trend of decrease in drape quality of fabrics was observed with increase in the polyester content and the crease recovery of the fabrics depended on the material characteristics in terms of least or most prone to creasing.

A study entitled 'Effect of laundering on crease recovery and stiffness of P/C blended uniform fabric' was carried out by Bhavani and Shailaja (1996). The sample was tested in Eureka crease recovery tester (Sl no.1939 type EC&S) and Shirley's fabric stiffness tester respectively. Results revealed that, crease recovery was found to be greater in weftway than warpway. As the number of washes increased there was reduction in the crease recovery property as well as stiffness. Reduction in bending length values indicated the fabric gradually becoming soft, pliable and flexible on laundering.

Chanchal and Sharada (1996) conducted a study on 'Improving aesthetic appeal of khadi fabrics: Drapability of khadi'. The drapability of wool, silk and their blends with polyester and cotton were assesed before and after laundering and stiffening. The drape was assessed by subjective and objective evaluation and calculated correlation between the two variables. It was found that there existed good correlation between subjective and objective assessment of drape. After laundering, all the fabrics showed decrease in drape co efficient, which revealed that, after regular use, khadi fabrics usually become limp and loose. In order to improve the drapability of khadi materials, stiffness is added to the fabrics which give a better aesthetic appeal to the weaver.

Five different shirting materials viz., 100 percent polyester, 64:36 polyester/cotton 45:55 polyester/cotton were tested to know the effect of sampling on drape and crease behavior of the fabrics in a study on ' Stiffness and crease recovery'. A trend of decrease in drape quality was observed with increase in the polyester content where the crease recovery of the fabrics depended on the material characteristics in terms of least or most prone to creasing (Tarafder and Kauser, 1996).

Bhavani and Shailaja (1997) performed a study on 'Tensile and tear strength of fabrics'. For the tear strength test, fabric samples were tested in Ballistic tester (pendulum type) and the force applied to tear the fabric specimen was recorded. The tests were conducted for both original and laundered fabrics. Results revealed that, there was a gradual reduction in the tear strength of fabric with increase in the number of launderings may be because of the fact that tear strength of fabric is largely affected by the mobility of yarns within the fabrics during laundering and constructional features.

In a study on 'Shear stiffness and drapability' it was found that bending length is influenced by both fabric thickness and fabric cover whereas, drape co-efficient in cotton fabrics is related only to the fabric cover. High cloth cover significantly lead to high shear stiffness, high bending rigidity and poor draping quality. The use of coarser cotton lead to lower fabric bending stiffness and better drapability. Increase in the polyester content in the cotton polyester fabrics lead to reduction in shear stiffness, shear resilience and bending stiffness as well as improved drapability. As a result drapability depended on both shear stiffness bending rigidity (Sheela et al., 1997).

An experiment on 'Effect of washing on tensile strength and drapability of blended shirting materials' was conducted by Prabhu and Naik (1998). Twelve polyester/cotton blended shirting materials were selected to assess the effect of washing on strength decreased after subsequent washings. Decrease in weight and drape coefficient was also observed due to removal of applied finish during washing. From the results it is inferred that lower the weight and drape coefficient better is the drapability of the fabric. It was also noticed that the washing affected tensile strength only after 25 washes. This indicated that polyester content play a major role in blends i.e., higher polyester content improves the drape and enhances the durability.

Joshua (1998) studied on 'The assessment of fabric wear and handle caused by increments of accelerator abrasion in dry conditions'. Results showed that the changes in mechanical properties for both drill and sateen woven cotton fabrics were broadly similar. In general wear resistance as expressed by the lose in mass of both fabrics was accompanied by the changes in other properties like thickness and stiffness. Both thickness and stiffness values decreased with increase in wear rate. However, mass per square meter and thickness showed a consistent decrease with increasing duration of abrasion at a fairly uniform rate.

Sakshi et al. (1999) carried out a study on 'Impact of fungal growth on cotton material: Fabric tensile strength'. White poplin material was taken and three different finishes were given separately viz. desizing, sizing and blueing. Revive starch and robin liquid blue were the sizing and blueing agents respectively. The four fungal cultures, viz Aspergillus niger, Rhizophus stoloniger, Chaetonium globosum and Helminthosporium sps. were inoculated separately on control, desized, sized and blue samples. Finally the samples were assessed for effect on tensile properties of treated samples. The result of the study revealed that, fungal culture negatively affected the tensile strength on the cotton fabrics finished with blues and starches. However, desized fabrics were least affected by fungal growth. Hence, every consumer should remember to desize and completely sundry their cotton fabrics before storing.

A determination of fabrics stiffness by cantilever method does not incorporate the physical parameters of the fabric explicitly. Thus, to express the stiffness in terms of physical parameters like strip dimensions and mass per unit length, a study was conducted by Rayachaudhuri and Das (2001) titled 'Physical testing and mathematical modeling for stiffness characteristics of fabrics using polyester cotton blends'. In order to fulfill the requirement a simple mathematical model was developed and applied to the experimental results. The bending length of cent percent cotton fabric was found to be higher in both warp and weft directions at used condition compared to brand new condition. It was attributed to the decrease in load on the strip after washing.

The fabric heavily sized showed a significant decrease in load on the strip after washing. The fabric heavily sized showed a significant decrease in thickness and mass per area after desizing. The stiffness could be correlated with physical parameter viz., tensile strength, drape and thickness of the fabric using effective Young's modulus.

Sengupta et al. (2002) carried out a study on 'Influence of yarn structure, sizing ingredient and type of sizing properties and performance of sized yarns: Part I-Evaluation of sizing process using Zweigle G551 weavability tester'. The 6s ring spun and rotor-spun cotton yarn were selected for the study. The yarns were sized with different concentration, thin boiling starch i.e., 8, 11 and 14 per cent; PVA cold brand i.e., 5, 7 and 9 per cent and PVA hot brand 5, 7 and 9 per cent. It is observed that the number of abrasion strokes till break is higher in case of grey ring yarn than that in case of the yarns sized with thin boiling starch because the fluff generated on the surface of the grey yarn acts as a protective shield. The gain in strength after sizing is greater for rotor yarns. However, the loss in strength after a fixed number of strokes is less for rotor yarn than that for ring yarns. Though the strength of the yarns sized with thin boiling starch and polyvinyl alcohol for both hot and cold brand are not significantly different, the loss in strength after a fixed number of abrasion strokes is least for cold brand polyvinyl alcohol followed by the hot brand polyvinyl alcohol and thin boiling starch.

Sengupta et al. (2002) carried out a study on 'Influence of yarn structure, sizing ingredient and type of sizing properties and performance of sized yarns: Part II-A comparative study of sized yarn performance for ring and rotor-spun cotton yarns'. The 6s and 16s ring and rotor cotton yarn with cold and hot brand polyvinyl alcohol at different concentration were selected for the study. The result of the study revealed that the abrasion resistance of rotor yarns is better than that of ring yarns. The rotor yarns give better abrasion resistance at 140^0C because the higher temperature reduces size migration from inside to surface of the yarn, thereby ensuring more uniform deposition of size along the cross-section of the yarn. A better size distribution reinforces the open structure of rotor yarns and improves cohesion.

Sengupta et al. (2002) carried out a study on 'Influence of yarn structure, sizing ingredient and type of sizing properties and performance of sized yarns: Part III- A study of attrition during weaving for air-jet, ring and rotor yarns on a modern high speed weaving machine'. 30s polyester/viscose ring, rotor and air-jet yarn were sized with polyvinyl alcohol cold brand i.e., 5 and 9 per cent and drying temperature (70^0C-140^0C). It is observed that among the ring, rotor and air-jet yarns, the excellent abrasion resistance is obtained with air-jet yarn at higher size concentration and slow rate of drying. This is because at higher concentration there is good size film formation on the yarn surface and at slow rate of drying more outward size migration takes place, resulting in better size encapsulation. An air-jet yarn whose strength properties are derived from tightness and compression of the surface wrappings is, therefore, protected from the abrasion forces, caused during weaving, by this size film for a longer duration.

Mostafa (2003) conducted a study on 'Evaluation of nitrogen containing starch and hydrolyzed starch derivatives as size base materials for cotton yarns'. Cotton yarn was used for maize starch and hydrolyzed starches by introducing nitrogen containing group such as carbomeylethylation, as well as carbamation were studied. The effect of these changes on the technical properties of cotton yarns sized with the latter derived modified starch products increase by increasing the extent of hydrolysis and apparent viscosity of the paste prepared from those product depends on the degree of hydrolysis prior to chemical modification. On the other hand, cotton yarns sized with these starch derivatives were evaluated as sizing agents viz., measuring tensile strength, elongation at break and abrasion resistance. It was found that the highest values of the latter a fore mentioned properties obtained with cotton yarns sized with carbamoylethylated starch derived from native and hydrolyzed starches.

Mostafa and Morsy (2003) performed a study on 'Utilization of newly tailored modified starch products in easy care finishing'. Hydrolyzed starches, carboxy methylated starches and poly acrylic-acid graft co-polymer based on hydrolyzed and oxidized starches were synthesized on the cotton fabrics. Tailored starches on fabric performance when used in the cross linking formulation at a concentration range 5-50 gram per liter. The result of the study revealed that the nitrogen content, crease recovery angles and tensile strength of cotton fabric finished is the presence of their modified starches increase by increasing the extent of either hydrolysis or oxidation starches.

Naik and kulloli (2003) conducted a study on 'A comparative study of sizing agents on the physical parameter of unbleached cotton material'. Unbleached cotton material with 95 ends per inch and 84 picks per inch was selected. Sample size of 30.5x30.5cm size were starched using three material sizing agents viz., arrowroot, maida and sago and are commercial agent, revive. The result of the study revealed that, the sago sized samples showed gain in cloth weight in percent and shrinkage percentage. Higher cloth density in percent was observed with arrowroot and maida may provide better texture than applying singly.

Mortazavi and Boukary (2004) studied on 'Application of mixtures of resin finishing to achieve some physical properties on interlining cotton fabrics: I-Effect of stiffening and cross-linking agents'. Cotton fabric with 25 picks x 21 ends/cm was desized, scoured and bleached. A mixture of dimethylol dihydroxy ethylene urea, polyvinyl acetate and some other resins were examined in special finishing of cotton for producing interlining cotton fabrics properties. Some physical properties of fabric such as bending length, crease recovery angle, wettability time and thickness were studied with varying their concentrations. Results revealed that both bending length, thickness and wettability time of cotton fabrics increased on increasing polyvinyl acetate and dimethylol dihydroxy ethylene urea concentrations. But, crease recovery angle decreased on increasing polyvinyl acetate concentration and on the contrary increasing dimethylol dihydroxy ethylene urea concentration improved the crease recovery angle.

A study on 'New sizing agents and flocculants derived from chitosan' was carried out by Hebeish et al. (2005) to assess the aforementioned hydrolyzed chitosans and carboxymethyl chitosans as flocculants. Development of new textile sizing agents and flocculants were undertaken. Characterization of the hydrolyzed chitosans was performed through monitoring nitrogen content and apparent viscosity, while carboxymethyl chitosan was analyzed for degree of substitution along with apparent viscosity. Aqueous solutions of hydrolyzed chitosans or carboxymethyl chitosans were applied to light cotton with a view to envision the technical feasibility of such water soluble chitosans for textile sizing. Hundred percent size removals could be achieved with the hydrolyzed chitosans irrespective of the size solution concentration provided that the latter is not less than 8 percent. Different situation is encountered with carboxymethyl chitosan where the percent size removal increases by increasing its concentration in the sizing solution. Drying and heat treatment of the sized fabric at different temperature has practically no effect on percent size removal. This is observed with hydrolyzed chitosans and carboxymethyl chitosans. The sized fabrics exhibit an average increment in tensile strength of about 55 percent and an average decrement in elongation at break of about 3 percent. It was also found that efficiency of flocculation at pH6 is greater than at pH8.

Mishra et al. (2008) conducted a study on 'Stiffening of white silk fabric with arrowroot powder'. Silk fabric and arrowroot powder was selected for study. Samples of three different material-to-liquor ratio and three different concentration of stiffener i.e. 1:20, 1:30 and 1:40 and 12.50g, 18.75g and 25.00g were selected. Results of the study revealed that the material-to-liquor ratio and concentration of stiffener made a significant difference in air permeability, bending length, crease recovery and drapability of white silk fabric stiffening with arrowroot powder.

A study on 'Use of Amaranthus (Rajgeera) starch vis-à-vis wheat starch in printing of vat dyes' was conducted by Teli et al. (2009). Printing of vat dye on 100 percent cotton fabric was done using Amaranthus (Rajgeera) and wheat starch pastes. The prints were then analysed by measuring K/S and L*, a*, b* values by reflectance method, bending length, washing & rubbing fastness etc. Extraction of starch from Amaranthus (Rajgeera) and wheat was done by alkali steeping. The physical and chemical analysis of Amaranthus and wheat starch has been reported. Analysis of both the starches was done by measuring swelling power, paste clarity, crystallinity of starch using X-Ray diffraction and iodine binding. Results suggest that Amaranthus (Rajgeera) can be used to substitute wheat starch in textile printing.

Mohamed et al. (2010) conducted a study on 'Synthesis and application of new sizing and finishing additive based on carboxy methyl cellulose'. Pure cotton fabric and blended cotton with polyester were selected. Ammonium per sulfate was to initiate the polymerization of vinyl acetate monomer in presence of carboxy methyl cellulose to produce adduct under different conditions including, initiation concentration, temperature and time of polymerization as well as vinyl acetate to carboxy methyl cellulose ratio.

The result of the study revealed that the sample finished using carboxy methyl cellulose adduct acquired better mechanical properties such as wrinkle recovery angle, tensile strength, dye ability and oily stain release than carboxy methyl cellulose alone or physical mixture polyvinyl acetate. Therefore, it appear that adduct was a promising easily renovate sizing agents.

El-Sheikh (2010) conducted a study on 'Carboxymethylation of maize starch at mild conditions'. Cotton fabric was used for carboxymethylation of maize starch. Although mild reaction conditions were employed, hundred percent reaction efficiency and a completely cold water soluble product with a clear and transparent solution were obtained. A multifunctional catalyst was used to accelerate the carboxymethylation reaction at 30^{o}C. An increase in the catalyst concentration was found to increase the reaction rate, thus the reaction time was reduced from 16 to 24 h. Hundred percent reaction efficiency was obtained using equivalent molar ratios of etherifying agents viz., 0.2 mol/mole St., 0.3 mol/mole St. of catalyst; isopropanol: water ratio of 90:10 and a material liquor ratio of 1:1.5 at 30^{o}C for 24 h. The carboxymethylation reaction was tested for its reproducibility and suitability for other types of starch viz., rice and potato while the carboxymethyl starch prepared was further characterized for its viscosity, transparency and suitability as a sizing agent for cotton yarns. The carboxymethyl starch prepared was found suitable as a sizing agent. The tensile strength of the sized samples increased by 38.6 percent compared with the blank samples and the desizing efficiency of the sized samples was 98 percent at 30^{o}C.

El-Sheikh et al. (2010) conducted a study on 'Photo-oxidation of rice starch. Part I: Using hydrogen peroxide'. Cotton yarns were used for oxidation of rice starch using ultra-violet irradiation and hydrogen peroxide as a photo-initiator was adopted. The extent of oxidation was determined by determining the carboxyl content, the carbonyl content and the viscosity of the oxidized rice starch obtained. It showed that optimum conditions for the oxidation system were: using 0.4 percent of hydrogen peroxide and a material liquor ratio of 1:6 at 60^{o}C for 4 hrs of ultra-violet irradiation. The sizing agent prepared viz., the oxidized rice starch was evaluated by measuring the tensile strength and elongation at break of the sized cotton yarns and determining of the percent of size removed from the sized cotton yarns by washing. The results obtained were: 490 kg, 456 kg; 5.4, 4.7 per cent and 86, 55 per cent for tensile strength, elongation at break and size removal for cotton yarns sized by oxidized starch and cotton yarns sized by oxidized starch used by the company respectively.

Midha (2011) carried out a study on 'Study of stiffness and abrasion resistance of needle-punch nonwoven blankets'. The effect of machine parameters such as depth of needle penetration and punch density on fabric stiffness and abrasion resistance of needled blankets has been studied. The effect of calendaring and sandwiching hollow polyester fibers between two layers of fine polyester fibers on the abrasion resistance and fabric stiffness has also been studied. It was observed that fabric stiffness first increases and then decreases as the depth of needle penetration increases. Increase in punch density leads to a decrease in fabric stiffness only at higher levels of depth of penetration due to fiber rupture. Calendaring improves the fabric abrasion resistance properties but fabric stiffness also increases. Sandwiching of hollow polyester fibers between the two layers of fine denier polyester fibers improves the abrasion resistance without increasing the fabric stiffness.

3. MATERIAL AND METHODS

The present investigation on 'Efficiency of sizing materials on cotton' is carried out in Hubli-Dharwad corporation area to find out the varieties of starching materials available in the market for the use of commercial dhobis and common consumers; and impact of selected sizing agents on the structural, performance, durable, and comfort properties as well the visual appearance and tactile properties of the test samples.

The methodology adopted to carryout the present study is divided into two sections viz., survey method (A) and experimental procedures (B). The survey method included three parts viz., the first part focused on gathering information regarding the availability of starching materials in the local market of Hubli-Dharwad corporation area and the respondents were the shop owners who did promote sizing materials; the commercial dhobis in the corporation area were interviewed to elicit the information about sizing materials commonly chosen for starching cotton articles, in the second part of the survey; however it was imperative to find out the type of starches selected for household laundering by the working and non working women, who formed the third category of respondents. The results of the survey were considered in further study while selecting the sizing agents, sourcing the test sample, method of sizing and hand washing of sized samples.

On the other hand the experimental procedure focused on the study of impact of sizing materials on the physical parameters viz., structural, performance, durable and comfort features of the test sample and the visual as well as tactile properties too. Further the sized samples were subjected to hand washing to assess its impact on the above mentioned physical characteristics and visual – tactile properties.

The detailed classification of methodology involved in this investigation is presented under this following heading:

3.1 Survey method

- 3.1.1 Selection of the sample
- 3.1.2 Criteria set for selection of the sample
- 3.1.3 Tools used for data collection
- 3.1.4 Pilot study
- 3.1.5 Variables included for the study
- 3.1.6 Classification of the independent variables

3.2 Experimental procedure

- 3.2.1 Sizing
  - 3.2.1.1 Selection of test sample
  - 3.2.1.2 Criteria set for test sample
  - 3.2.1.3 Selection of starches
  - 3.2.1.4 Criteria set for selection starches
  - 3.2.1.5 Pilot study on starch preparation
  - 3.2.1.6 Sizing the test samples
- 3.2.2 Physical testing
  - 3.2.2.1 Structural properties
    - 3.2.2.1.1 Cloth count (threads per inch)
    - 3.2.2.1.2 Cloth thickness (mm)
    - 3.2.2.1.3 Cloth weight (GSM)

3.2.2.2 Performance properties

3.2.2.2.1 Cloth bending length (cm)

3.2.2.2.2 Cloth crease recovery (degree)

3.2.2.2.3 Cloth drapability (%)

3.2.2.3 Durable properties

3.2.2.3.1 Cloth abrasion resistance (cycles)

3.2.2.3.2 Cloth tensile strength (g) and elongation (%)

3.2.2.4 Comfort properties

3.2.2.4.1 Cloth air permeability ($m^3/cm^2/min$)

3.3 Subjective Evaluation

3.3.1 Aesthetic appeal

3.3.2 Visual appearance

3.4 Laundering

3.5 Statistical methods used for data analysis

3.6 Hypothesis set for the study

3.1 Survey method

3.1.1 Selection of sample

The study was conducted during the year of 2010-2011 in Hubli-Dharwad corporation area of Karnataka state. The respondents in the study comprised of 50 grocery shop owners, 30 dhobis and 50 each working and non-working women, selected randomly. The sample size, and criteria for selection of sample varied with each category. The respondents were personally interviewed by visiting the shop owners, dhobis, working and non working women from different localities of Hubli-Dharwad cities.

3.1.2 Criteria set for selection of sample:

Criteria set for selection of different group of respondents were:

The shop owners: i) The shops have good collection of starching materials

ii) There will be good promotion of both natural and instant starching materials

The dhobis: i) The dhobis who under take washing, starching and ironing of cotton clothes singly or in combination

ii) The dhobis who use both natural and instant starches

The women: i) The women who starch clothes at home

ii) The women who send cotton clothes to commercial dhobis for starching and ironing

iii) Women who use both natural and instant starches

3.1.3 Tools used for data collection

Survey was the tool adopted to collect the relevant information from the shop owners, dhobis and working & non working women. In all three self structured interview schedules were prepared separately. The first one was administered to shop owners to elicit the specific information on various sizing materials available in the shops and their promotion; the second was administered to local commercial dhobis to gather explicit information on type of sizing agents used for varieties of cotton, various laundry related processing's under taken in the units.

The third schedule consisted of two parts viz., part A included series of questions pertaining to demographic information like age, education, family size, family type, and annual income of the working and non working women and part B dealt with specific information on preference for cotton clothes, purchasing practices of starching materials, and method of home laundering followed for cottons.

3.1.4 Pilot study

The pilot study was conducted in rural and urban locality of Hubli-Dharwad Corporation area. Ten grocery shop owners, five dhobis and fifteen each working and non-working women were interviewed with self structured interview schedules. Sample selected for pre test were not included for actual data collection.

On the basis of pilot study the questions in the schedule were modified by substituting and eliminating the suitable and irrelevant items, respectively.

3.1.5 Variables included for the study

The following independent and dependent variables were included for the survey of working and non working women.

Independent variables

- Age
- Education
- Family size
- Family type
- Annual income

Dependent variables

- Preference for sizing materials
- Laundry practices

3.1.6 Classification of the independent variables

3.1.6.1 Age of the respondents (years)

The age of the respondent was categorized on the basis of mean $\pm$ 0.425 Standard Deviation for both working and non-working women and grouped as younger, middle and elderly groups.

Categories	Age groups (years)		
	Younger	Middle age	Elderly
Working women	< 36	36-44	> 44
Non-working women	< 37	37-44	> 44

3.1.6.2 Education of the respondents

Based on the education level, the respondents were classified as primary, secondary, intermediate, graduate and post graduate for both working and non-working women.

3.1.6.3 Family size

The number of members in the working and non working families ranged from 3 to 10. For the convenience the size of the families were decided into these categories such as small, medium and large. The classification was done on the basis of mean $\pm$ 0.425 Standard Deviation.

Categories	Size of family		
	Small	Medium	Large
Working women	< 3	3-5	> 5
Non-working women	< 5	5-6	> 6

3.1.6.4 Family type

The families were grouped into two categories *viz.,* nuclear and joint according to the family constitution.

3.1.6.5 Annual income of the family

The families of working and non working women were grouped into three income levels based on their annual income based on mean $\pm$ 0.425 Standard Deviation.

Categories	Annual income (Rs.)		
	Low	Middle	High
Working women	< 2,54,045	2,54,045 – 7,09,140	> 7,09140
Non-working women	< 1,58,813	1,58,813 – 2,82,853	> 2,82,853

3.2 Experimental procedures

The experimental procedures involved sizing of the test samples, assessment of various physical parameters viz., structural, performance, durable, comfort properties along with the aesthetic appearance. Hand washing of sized samples was also an important part of the experiment. The details on experimental procedure are presented below:

3.2.1 Sizing

Sizing is one of the temporary finishes given to cotton clothes. Sizing of cotton is essential to impart crispiness to the fabric and to help the clothes remain clean for a longer time by holding down the surface fibres which catch dust and dirt,.

3.2.1.1 Selection of test sample

The test sample selected for the present study is cotton kora muslin (gray), specially hand woven having cloth count of 70 ends X 60 picks per inch, 34.80GSM without any finish applied on to it. This cotton muslin is most suitable for sari, kurta/tops and veil. Considering the remarks and keeping in view of the textile experts, the test sample was exclusively hand woven on order and taken for further experiment.

3.2.1.2 Criteria for selection of test sample

Criteria set for selection of the test sample were

- The cotton fabric should be suitable for sari, kurta/tops and veil
- The cotton muslin should be free from all types of basic finishes
- The cotton muslin should be hand woven
- The working and non working women have collection of either sari, kurta/tops or veil of this material

3.2.1.3 Selection of starches

Based on the results of the survey, two sizing materials one each from natural and instant sources, commonly used by dhobis and women consumers were selected for the present study.

3.2.1.4 Criteria set for selection of starch materials

- The starches are popularly sold in the local market
- The starches are used by the commercial dhobis and women consumers
- The starch is prepared by both cold and hot process

3.2.1.5 Pilot study on starch preparation

Considering the results of 3.2.1.3 two sizing agents was chosen, one each from natural and instant sources for the present study. However, it was necessary to finalize the optimum percentage (concentration) of starch to be selected for the actual sizing of the test sample. In this context the test sample was sized with 5%, 7% and 10% concentrations, dried, ironed and displayed for the acceptance. These samples were assessed for the visual appearance and tactile properties by the textile experts in the department. On the basis of the evaluation results made by the textile experts it was finalised to starch the test sample with 10% starch at two dilution levels.

3.2.1.4 Sizing of test samples

The test sample was sized with two sizing materials one each drawn from natural and instant source. However, the method of starch preparation was adopted according to the source of the size. The two starches selected in the present were arrowroot (natural, hot process) and revive (instant, cold process).

Arrowroot starch

Recipe

MLR : 1:30

Starch concentration : 10%

Weight of test sample : 78 g

Method : Hot process

Dilution : 1:1 and 1:2

Sizing time : 30 min

Drying method : Room temperature

State of drying : Complete

Method

Take required amount of starch powder according to OWS (On Weight of Sample). Mix starch powder in cold water to make fine paste. Take required amount of water and keep for boiling. Add paste to boiling water and observe the rupture of starch particle and record the time of rupture. Strain the starch solution through fine muslin cloth. Dilute the starch in required amount of water to obtain 1:1 and 1:2 levels of dilution. The test sample was dipped in the arrowroot solution for 30 minutes, completely dried at room temperature and ironed flat.

Revive starch

Recipe

MLR	: 1:30
Starch concentration	: 10%
Weight of test sample	: 76 g
Method	: Cold process
Dilution	: 1:1 and 1:2
Sizing time	: 30 min
Drying method	: Room temperature
State of drying	: Damp

Method

Calculate amount of revive powder and mix with little cold water to make fine paste. Add more water to the paste and stir continuously to ascertain complete dissolution of the sizing material. Dilute the concentrated size to 1:1 and 1:2 levels. The test sample was dipped in the revive solution for 30 minutes, partially dried (damp) at room temperature and ironed flat.

3.2.2 Physical testing

After sizing the test samples were subjected to physical testing to determine the quality parameters of the fabric. The various tests to assess the structural, performance, durable, and comfort properties were carried out in the testing laboratory of the Department, College of Rural Home Science, Dharwad.

3.2.2.1 Structural properties

When deciding on a fabric it is imperative to consider certain fabric properties to infer on its end use. The geometry of the fabric is nothing but its structure and in a woven fabric ends and picks per unit area, cloth thickness and GSM are the three features invariably decide on the cloth configuration. These parameters do form a base for the performance, durability and comfort properties of a woven fabric. Hence, an effort was made to find out the impact of sizing on the structural properties of the test sample.

3.2.2.1.1 Cloth Count (threads per inch)

Cloth count is the number of warp yarns (ends) and filling yarns (picks) per unit area, when the fabric is held under zero tension and is free from folds and wrinkles. The number of warp and weft yarns per unit area is determined by using a suitable magnifying counting glass.

The number of warp and weft yarns in one square inch of the fabric is counted at ten randomly selected places across the width and along the length of the test samples, so that a different set of yarns is counted each time. Further, the mean values of ends and picks per inch are calculated.

Number of specimen tested	: 15 each warpway and weftway
Method	: Direct counting the threads per unit area, 1 inch
Instrument used	: Magnifying counting device, the pick glass

3.2.2.1.2 Cloth thickness (mm)

Thickness is the distance between one surface to its opposite. In textiles, the distance between the upper and lower surface of the material measured under a specified pressure. The specimen was tested as directed in ASTM test method D-1777-1975.

The average thickness of the material is determined by observing the linear distance that a movable plane is displaced from a parallel surface by the textile material while under a specified pressure.

The specimen tested was free from folds, wrinkles, crushing and distortions. The woven fabric is placed on the anvil of the test apparatus and the pressure foot is brought into contact with the opposite side of the material and the thickness is recorded in mm.

Shape of the Anvil : Round

Area of the Anvil : 1 cm diameter

Shape of the pressure foot : Round

Number of tests : 15

Instrument used : Shirley's thickness tester

3.2.2.1.3 Cloth weight (GSM)

The weight of the cloth is expressed as mass per unit area i.e. g/sq mt. A sample size of 5 x 5 cm is cut and weighed on an electronic weighing balance to determine the weight per square meter (g). Also the warp and weft threads were separated and weighed to calculate the percentage composition of warp and weft using the following formula;

Weight of 5 x 5 cm sample : g

Number of specimen tested : 5

Instrument used : Electronic weighing balance

3.2.2.2 Performance properties

The performance of the sized sample was assessed for cloth bending length (cm) crease recovery angel (degree) and drape coefficient (%) for both the yarn directions to measure the result of two sizing agents with two dilution levels.

3.2.2.2.1 Cloth bending length (cm)

Cloth bending length is the length of the fabric that bends under its own weight to a definite extent. It equals to half the length of rectangular strip of fabric that bends under its own weight to an angle of 41.5°. It is also equal to the length of a rectangular strip of material that bends under its own weight to an angle of 7.1°. Bending length is expressed in centimetres. It is one of the fabric qualities that determines the manner in which the fabric drapes *i.e.* higher the bending length stiffer the fabric.

The specimen was tested as directed in BS test methods: 3356-1961.

Place the test specimen on the platform with the scale on the top of it lengthwise and the zero of the scale coinciding with the leading edge of the specimen. Start pushing the specimen along with the scale slowly and steadily when the leading edges project beyond the edges of the platform. An increasing part of the specimen overhangs and starts bending on its own weight. When two inclined lines (of the inclined plane making an angle of 41.5° with the horizontal) of the tester coincide, record the length of the overhanging portion from the scale.

Four readings from each specimen with each side up are taken.

Size of the specimen : 25 x 2.5cm

No. of specimen tested : One with four reading (Both warpway and weftway)

Name of the instrument : Shirley's stiffness tester

Further, the bending length was calculated by using the formula

$$\text{Bending length} = \frac{L}{2} \text{ cm}$$

Where, L is the mean length of the overhanging portion in cm.

3.2.2.2.2 Cloth crease recovery angle (degree)

Crease resistant is that property of the fabric which causes it to recover from forming deformation that normally occur during its use. The recovery will depend on time, varying for different fabrics from an instantaneously recovery to a slow disappearance of the crease.

Crease and its resistance can be explained on molecular theory, i.e. the cross link may break, within the molecules and reform a new position, on removal of the load, there will be no recovery. Alternatively the cross link may be strained without breaking and show a recovery on delaoding. Cellulosic materials are notoriously susceptible for creasing. The feature more accepted in a fabric is, it can be deformed but rapidly recovers form the deformation. There must be a resilience which includes some resistance to creasing but also a powerful and rapid recovery therefrom.

This method determines the wrinkle recovery of hand woven fabrics.

The specimen was tested as directed in AATCC test method 66-1975.

The test specimen is creased for a definite period of time at a known load and then allowed to recover or to regain its crease. The recovery is measured in terms of the extent of an angle to which the sample has been recovered.

Size of the specimen : 5 x 2.5 cm

Weight/load applied : 2 kg

Creasing period : 5 min

Recovery period : 5 min

No. of specimen tested : 5 each warp way and weft way

Name of the instrument : Crease recovery tester

3.2.2.2.3 Cloth drapability (%)

Drape is one of the subjective characteristics of fabric that contributes to aesthetic appearance. Fabric drape is the extent to which a fabric deforms when it is allowed to hang under its own weight. The drapability of the fabric is assessed by either calculating the drape coefficient or by number of nodes formed on draping the sample.

The specimen was tested as directed in IS test method 8357 -1977.

Drape co-efficient is the area covered by the shadow of the draped specimen expressed as percentage of the area of the annular ring of fabric.

A specimen is cut by means of a circular template, which is sandwiched between two horizontal discs of smaller diameter and the unsupported annual ring of fabric is allowed to hang down. On switching the lamp, it gives a circular parallel beam of light and falls on the cloth. Place the ammonia sheet (printing paper) of known dimension on the base plat form with sensitive side up, laying flat. The line of vision was kept along the baseboard and the height of the lower fringe of specimen was adjusted so that it was about 2 inches above the paper. The time setting knob was adjusted to 4 min, the green' pilot lamp lit up, when the buzzer alarm rings, the ammonia paper is removed, rolled and placed in the developing box where strong ammonia solution was kept. The lid was shut airtight. After 4 minutes the drape pattern was ready.

Further, drape co-efficient is calculated by

$$F = \frac{\frac{W}{w} - a}{(A-a)} \times 100$$

Where,

W : Weight of the pattern in gram

w : Weight of 1 sq cm of the paper in gram

A : Area of specimen disc (cm^2)

a : Area of supporting disc (cm^2)

Name of the instrument : BTRA drape meter

Size of the specimen : 25 cm diameter

Size of the printing paper : 29 x 29 cm

No. of specimen : 4

Test method : IS 8357 - 1977

3.2.2.3 Durable properties

3.2.2.3.1 Cloth abrasion resistance (cycles)

Cloth abrasion is the wearing away of any part of material by rubbing against another surface. The specimen is abraded by rubbing multi-directionally against an abradant having specified surface characteristics held in a fixed position without any creases. The pills of matted fibres interfering with proper contact between the specimen and abradant during the test were removed, as they would cause marked vibration of the abradant plate.

The specimen was abraded until a hole was formed and the number of cycles was noted. Further, the estimation of degree of wear is determined by loss in mass and thickness of the fabric.

Name of the instrument : Martindale abrasion tester

Pressure applied : 30g/cm^2

Type of abradant : Zero Emery Paper

Type of abrasion : Flat

Determination of end point : Formation of hole

Number of specimen tested : 4

Test method : IS 12673 - 1989

3.2.2.3.2 Cloth tensile strength (g) and elongation (%)

Tensile strength is the ability of the material to resist strain or rupture induced by external force. It is expressed as force/unit cross- sectional area of the specimen at the time of maximum load.

The specimen were tested as directed in IS test method: 12676-1989.

The method employed to determine the breaking load of the test samples is by 'ravelled strip test'. The specimen of 5 cm wide piece was prepared by initially cutting the material to a width of about 7 cm and ravelling the threads from both sides until the width attained 5 cm. Though the test length is 20 cm in between the jaws, an extra length was cut to grip in the jaws.

Name of the instrument : INSTRON

Size of the speciman : 200 mm X 50 mm

Approach speed : 300mm/min

No. of specimen : 5

Test method : IS 1969 - 1985

3.2.2.4 Comfort properties

3.2.2.4.1 Cloth air permeability (m^3/cm^2/min)

Air permeability is the rate of air flow through a material under a differential pressure between the two fabric surfaces. This method covers the direct determination of the air permeability of textile fabrics by calibrated orifice method.

The specimen were tested as directed in IS method: 11056 – 1984.

The rate of air flow through a know area of fabric is adjusted to secure a prescribed pressure differential between the two fabric surfaces in the test area and from this the rate of air flow and the permeability of the fabric is determined.

Name of the instrument : PROLIFIC Air permeability tester

Pressure applied : 32 layers pressure differential: 10 mm

Size of the specimen : 5 cm^2

No. of the specimen : 5

Test method : IS 11056-1984

3.3 Subjective evaluation

A panel of 15 textile experts comprising of faculty members and PG students of the Department of Textile and Apparel Designing, College of Rural Home Science, UAS, Dharwad carried out subjective evaluation on the aesthetic and visual appearance and of sized samples.

3.3.1 Assessment of aesthetic appearance

The over all appearance of any fabric is a combination of its chromatic attributes (colour) and its geometric attributes (like gloss, shape, texture, shininess, haze and translucency). Thus, both types of attributes need to be measured and accounted for when making visual or instrumental assessment of fabric appearance.

Chromatic attributes: Chromatic attributes are those attributes associated with colour. They are normally divided into three components- hue, lightness and saturation.

Hue: The perceived colour of a substrate, such as red, green blue, yellow, orange or white.

Lightness: Whether the colour is closure to black or white. Sometimes the term ‘value’ is used rather than lightness.

Saturation: The degree of departure from grey. This is the vividness or purity of a colour.

In general, it is the chromatic attributes of the appearance are measured in the laboratory by using an appropriate spectrophotometer or subjectively bu visual appearance. However, the chromatic attributes of any substrate can never be completely separated from its geometric attributes.

Geometric attributes: Geometric attributes are those attributes associated with distribution of light from an object or substrate. For instance, a flat cotton weave muslin fabric is very different geometrically than that of cotton drapery. A glossy finish on a fabric looks quite different than a matte or dull one. There are many geometric attributes and some important as well basic ones are, gloss, haze and directionality.

Gloss: The property of a substrate / surface responsible for shining and or lustrous appearance.

Haze: The scattering of light within the surface of nearly clear sample that is responsible for a cloudy appearance.

Directionality: The characteristics of a sample which causes it to look differently depending on which direction it is turned/ held or draped.

Scheme of assessment: The above mentioned chromatic and geometric attributes were assessed by the panel members on the basis of 0-2 scale and the values were assessed by frequency and percentages.

Where,

2- Increase in the attribute

0- No change in the attribute

1- Decrease in the attribute

3.3.2 Assessment of visual appearance

It is known that the starching material does not usually affect the appearance of the white and light colour cottons, but the deposition of the starch granules do show on the fabric surface and affects the aesthetic appearance. Hence an effort was made study the effect of sizing on black colour cotton muslin sample by subjective evaluation where a panel of textile experts evaluated black colour cotton muslin cloth sized with both the sizing agents at 2 dilution levels considering various attributes viz., colour, lustre, patchy effect and stiffness. However, this is a combined assessment of both visual and tactile features. The evaluation is made according to 3.3.1 using 2-0 scale the results are presented in frequency and percentages.

3.4 Laundering

Laundering is another aspect of the present investigation. The sized samples were subjected for one hand washing to find out the effect of home laundering on the performance of sized samples.

The main aim of this part of the study was to asses the percentage change in the basic characteristics of the sized fabric on washing; to find out whether complete desizing is possible in single hand washing; if not whether the partially desized cotton is fit to use after one hand wash where a great deal of money could be saved.

After hand washing, the test samples were subjected to structural, performance, durable and comfort tests and these performance values were compared with the control as well as the sized samples.

For all practical purpose, the sized samples were laundered by kneading and squeezing method. Each sized sample is washed separately using 5gpl soap, rinsed twice in clear water, shade dried and ironed.

Soap concentration : 5 gpl

Soaking time : 15 min

Type of cleansing agent : Detergent powder

3.5 Statistical analysis

Appropriate statistical methods were adopted to analyse the data and infer on the results of the findings. The data was analyzed by using the following statistical methods wherever applicable:

- Frequency and percentages were calculated for all the variables
- Completely randomised design in three factorial format was used to find out the effect of independent variables *viz.,* two sizing materials (arrowroot, revive), dilutions (1:1 and 1:2) and directions (warp and weftways) on dependent variable *viz.,* cloth count, cloth thickness, cloth weight, cloth bending length and cloth crease recovery of the test samples.

3.6 Hypothesis

Following are the hypothesis set for the present study:

3.5.1 Sizing does not alter the structural properties of the fabric

3.5.2 Sizing agents, dilutions and yarn directions of the test samples do not influence the structural and performance properties on sizing

3.5.3 Home washing does not alter the structural, performance, durable and comfort properties of the sized samples

4. RESULTS

The results of the present study on 'Efficiency of sizing materials on cottons' are presented under the following headings.

4.1 Survey results

The survey was conducted using three self-structured questionnaire of which the first was administrated to shop owners to gather information on availability of starching materials in the shop and preference and factors considered while purchasing sizing material by the consumers; the second questionnaire was administered to *dhobis* to find out the types of starching material used and laundry practices adopted for cottons; and the third questionnaire was administrated to working and non working women to find out clothing preferences, selection of starches, care and laundry practices adopted for cotton clothes.

4.1.1 Availability of sizing materials in the local market

There are several types of sizing materials available in the local market both natural and synthetic for the use of *dhobis* and people who starch the clothes at home. Many times the availability of these starching materials vary within the locality of a region and sometimes regionalize too. In fact, this availability depends on the consumers demand. Keeping consumers demand in view, an effort was made to find out the availability of sizing materials in the local market.

4.1.1.1 Types of sizing materials available in the local market

Table 1 clearly indicates the varieties of sizing materials available in the local market. For the convenience of data collection and analysis, the sizing materials were categorized as instant (readymade or ready to use) and naturals. It is found that all the shops did sell sizing materials of both the categories however, the percentage varied. Irrespective of the categories greater per cent of the shops sold arrowroot (76.00%) and maida (68.00%) compared to revive powder (58.00%), revive liquid (50.00%) and vanish (40.00%).

Table 1: Types of sizing materials available in the local market

n= 50

SL. No.	Types of sizing materials	Shop owners
I	**Instant**	
a)	Inna	01 (02.00)
b)	Revive	
	i) Liquid	25 (50.00)
	ii) Powder	29 (58.00)
c)	Vanish	20 (40.00)
II	**Natural**	
a)	Arrowroot	38 (76.00)
b)	Maida	34 (68.00)
c)	Sago	19 (38.00)

Figures in parenthesis indicate percentage
Multiple responses possible

Table 2: Selection of sizing materials by consumers as perceived by shop owners

n= 50

SL. No.	Types of sizing materials	Consumer preference		
		I	**II**	**III**
I	**Instant**			
a)	Inna	-	-	01 (02.00)
b)	Revive	31 (62.00)	15 (30.00)	08 (16.00)
c)	Vanish	05 (10.00)	12 (24.00)	03 (06.00)
II	**Natural**			
a)	Arrowroot	32 (64.00)	05 (10.00)	01 (02.00)
b)	Maida	03 (06.00)	14 (28.00)	17 (34.00)
c)	Sago	04 (08.00)	05 (10.00)	10 (20.00)

Figures in parenthesis indicate percentage
Multiple responses possible

On the other hand the sizing materials least sold were inna (02.00%) among instant and sago (38.00%) among the naturals.

4.1.1.2 Selection of sizing materials by the consumers as perceived by shop owners

Table 2 reveals about shop owners view on consumers preference for sizing materials, indeed gives an idea about the most selling sizing materials. It is evident from this Table that the consumers are in the habit of using almost all types starches however, the percentage of selection varied, as opined by shop owners. Among the 'ready to use' starches, maximum consumers selected revive (I, 62.00% and II, 30.00%) compared to vanish (II, 24.00%). On the other hand 64.00 per cent gave first preference to arrowroot, followed by second and third preference to maida (34.00 and 28.00%, respectively); sago was given third and second preference (20.00 and 10.00%, respectively) by the consumers. Meanwhile the least preferred were sago (08.00%) and maida (06.00%).

4.1.1.3 Consumers preference for sizing materials as perceived by the shop owners

Table 3 provides information on preference for sizing materials by the *dhobis* and consumers. It is clear from this Table that irrespective of the categories, the respondents opted for both instant and natural sizing materials. More than 75 per cent of the respondents preferred revive followed by arrowroot (68.00%). *Dhobis* mostly preferred maida (46.00%) and sago (40.00%). About 25 per cent of consumers did use rice starch, occasionally. During the survey, the researcher found out that some of the *dhobis* did mix two starches of the same category like maida and sago or rice and sago in order to reduce the cost and to obtain good results.

4.1.1.4 Factors considered by the consumers while purchasing sizing materials as perceived by shop owners

Table 4 and Fig. 1 reveals the factors considered by the consumers, while purchasing sizing materials. The most important factor considered was the cost (84.00%), followed by brand (82.00%), advertisement (50.00%), labels (40.00%) and user friendliness (32.00%). The factors considered to be of less importance were efficiency (24.00%) and packing system (28.00%).

4.1.2 Preference for sizing material by the *dhobis*

Dhobis are the commercial launderers who under take washing, bleaching, starching, ironing and dry cleaning of cottons, silks, woollens and synthetics along with mending and repairing of clothes. Most of the city dwellers especially the working population gets the clothes, bed linen, table linen and furnishings, commercially cleaned. Therefore, it becomes imperative to find out the types of clothes/made-ups being laundered, sized and ironed; type of sizing materials used, number of clothes sized every day and cost for washing, starching and ironing, charged by the local *dhobis*.

4.1.2.1 Types of cotton dresses/made-ups commonly starched by *dhobis*

Table 5 reveals about types of dresses commonly starched by the commercial *dhobis*. It is found that the cotton kurtas, salwar-kameez, saris, shirts and veils are regularly starched by all *dhobis*.

4.1.2.2 Starching materials preferred by *dhobis*

It is evident from Table 6 that 70.00 per cent of the *dhobis* prefer natural sizing materials whereas 30.00 per cent instant or readymade starches.

4.1.2.3 Rationales for selecting starching materials by *dhobis*

Table 7 represents the reasons for choosing sizing materials and the agents may be instant or natural. *Dhobis* opined that instant starches are expensive (56.67%) though easy to prepare and apply (30.00%), where as natural starching is elaborate and lengthy process (83.33%) thus, time consuming. On the contrary the merits of natural starches are quality starch (70.00%), easy availability (70.00%), neat finish (56.67%) and easy to care (56.67%), as mentioned by *dhobis*.

Table 3: Consumers preference for sizing materials as perceived by shop owners

n= 100

SL. No.	Types of sizing materials	Shop owners
I	**Instant**	
a)	Inna	10 (10.00)
b)	Revive	76 (76.00)
c)	Vanish	25 (25.00)
II	**Natural**	
a)	Arrowroot	68 (68.00)
b)	Maida	46 (46.00)
c)	Rice	25 (25.00)
d)	Sago	40 (40.00)

Figures in parenthesis indicate percentage
Multiple responses possible

Table 4: Factors considered by the consumers while purchasing sizing materials as perceived by shop owners

n= 50

SL. No.	Types of sizing materials	Number of respondents
1	Advertisement	25 (50.00)
2	Brand	41 (82.00)
3	Cost	42 (84.00)
4	Efficiency	12 (24.00)
5	Labels	20 (40.00)
6	Packing style	14 (28.00)
7	User friendly	16 (32.00)

Figures in parenthesis indicate percentage
Multiple responses possible

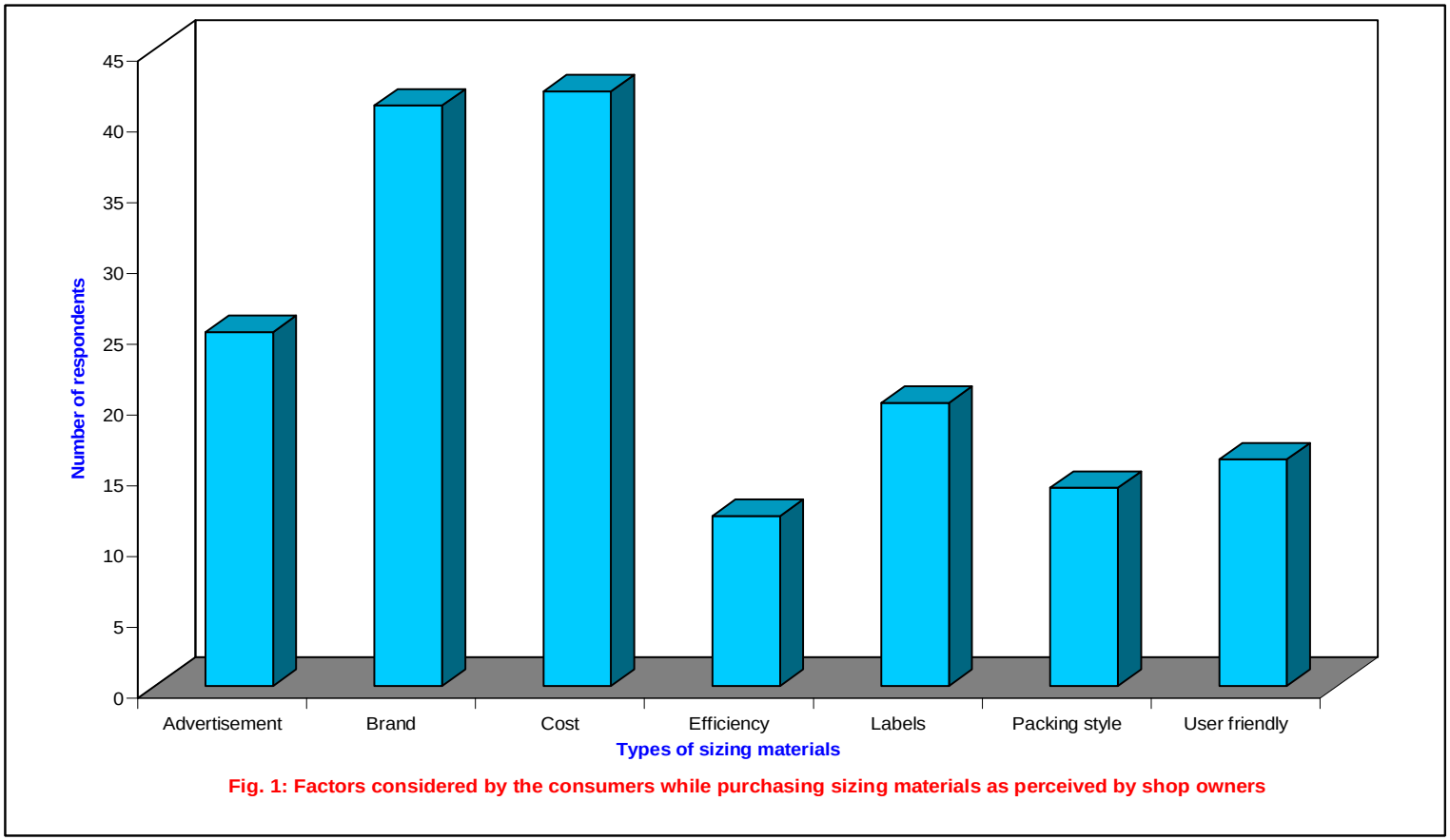


Fig. 1: Factors considered by the consumers while purchasing sizing materials as perceived by shop owners

4.1.2.4 Types of starching materials used for dyed cottons by *dhobis*

Table 8 indicates type of starching materials used for dyed cottons. It was essential to know whether both white and dyed cotton clothes are sized with the same sizing material or not. It was interesting to learn that 86.67 per cent of the *dhobis* indicated that a common sizing agent is used for both white and dyed cottons, may be instant or natural. However, very few of them (13.33%) mentioned that white and coloured cottons are sized with different starching materials.

4.1.2.5 Starching materials selected for white and dyed cotton by *dhobis*

Table 9 reveals the sizing materials used for white/light colour cotton as well as coloured cottons. It is clear from Table 8 that white and dyed (dark) cotton are starched with different sizing agents, which is evident from Table 9. Revive is used for white (23.33%) as well coloured (13.33%) cottons; whereas 46.67 per cent and 56.67 per cent of *dhobis* used arrowroot for white and dyed cottons respectively. Relatively a low per cent of them used sago for white (26.64%) and dyed (23.33%) cottons.

4.1.2.6 Number of cotton articles starched daily by *dhobis*

Table 10 and Fig. 2 gives an account on the number of dresses/made-ups starched each day by the local dhotis. It is evident from Table 5, that the dresses/made ups usually sized are kurta, salwar-kameez, sari, shirt and veils and the number of these articles starched each day varied. About 56.06 per cent of *dhobis* opined that on an average about 10 articles are starched each day followed by 20 articles (29.33%) and 30 articles (14.66%). Further, it is noted that 70.00 per cent of *dhobis* starch about 20 saris each day, along with about 26 kurtas (86.67%), 25 veils (83.57%) and 20 salwar-kameez (66.67%) also being starched. On the other hand 50.00 per cent of the *dhobis* indicated that about 15 shirts being starched each day.

4.1.2.7 Rates quoted by *dhobis* for ironing the starched clothes

It is a usual trend that the commercial *dhobis* do under take 'ironing' of clothes that are not starched in their unit, inspite of having processing units of washing, starching and ironing. It is evident that the charges for individual processing does vary. Thus, it was felt necessary to findout the amount charged exclusively for ironing the starched clothes. It is clear from Table 11, that all the *dhobis* under take ironing of starched clothes and the amount charged varied for different dresses. Cent per cent of the *dhobis* charged about Rs. 10, for each kurta or shirt or veil. The ironing charges for salwar-kameez was slightly higher than that of kurta and ranged from Rs. 10 to Rs. 30. However, maximum percentage of *dhobis* (66.67%) charged Rs. 11-20 for each pair of salwar-kameez followed by Rs. 21-30 (20.00%) and Rs. 10 (13.33%). A range of charges paid for ironing the starched saris is from Rs. 11-20 to Rs. 51-60. Among the *dhobis* greater per cent of them (30.00%) charged Rs. 21-30 followed by Rs. 31-40 (26.67%) and Rs. 11-20 (20.00%) for ironing the sari. However, very few charged Rs. 51-60 (06.67%) and Rs. 41-50 (16.67%).

4.1.2.8 Rates quoted by *dhobis* for starching and ironing cotton clothes

Table 12 indicates the price range charged for starching and ironing cotton clothes, the charges being remarkably higher than the price of ironing the starched clothes alone. The price for kurta, shirt and veil ranged between Rs. 20 to 80 and that of salwar-kameez was Rs. 20 to 60. However, the most expensive was sari ranged from Rs. 40 to 180.

It is further clear from this Table that majority of the *dhobis* charged Rs. 20 for shirts and veils (each 56.67%), Rs. 21 to 40 for kurta (56.67%) and salwar-kameez (43.33%) and Rs. 81-100 for sari (40.00%). However, very meager per cent of the *dhobis* charged Rs. 61-80 for kurta, shirt and veils (each Rs. 61-80) and Rs. 161-180 (10.00%).

4.1.2.9 Rates quoted by *dhobis* for washing, starching and ironing cotton clothes

Table 13 provides information on the amount charged for washing, starching and ironing of kurta, salwar-kameez, sari, shirt and veil and these charges are relatively higher than the corresponding starching and ironing charges.

Table 5: Types of cotton dresses/made-ups commonly starched by *dhobies*

n= 30

Sl. No.	Types of dresses	Number of respondents
1	Kurta	30 (100.00)
2	Salwar-Kameez	30 (100.00)
3	Sari	30 (100.00)
4	Shirt	30 (100.00)
5	Veils	30 (100.00)

Figures in parenthesis indicate percentage

Table 6: Starching materials preferred by *dhobies*

n=30

Sl. No.	Sizing materials	Number of respondents
1	Instant	09 (30.00)
2	Natural	21 (70.00)

Figures in parenthesis indicate percentage

Table 7: Rationale for selecting starching materials by *dhobies*

n= 30

Sl. No.	Sizing materials	Number of Respondents
I	**Instant**	
a)	Time saving	09 (30.00)
b)	Expensive	17 (56.67)
II	**Natural**	
a)	Easy care	17 (56.67)
b)	Time consuming	25 (83.33)
c)	Quality starch	21 (70.00)
d)	Neat finish	17 (56.67)
e)	Easily accessibility	21 (70.00)

Figures in parenthesis indicate percentage
Multiple responses possible

Table 8: Type of starching material used for dyed cottons by *dhobies*

n=30

Starching material	Number of respondents
Same as that of white cotton	26 (86.67)
Different from that of white cotton	04 (13.33)

Figures in parenthesis indicate percentage

Table 9: Starching materials selected for white and dyed cottons by *dhobies*

n=30

Sl. No.	Types of sizing materials	Colour of the cotton material	
		White/light	Dyed
I	**Instant**		
a)	Inna	-	-
b)	Revive	07 (23.33)	04 (13.33)
c)	Vanish	-	-
II	**Natural**		
a)	Arrowroot	17 (56.67)	14 (46.67)
b)	Maida	-	-
c)	Sago	08 (26.67)	07 (23.33)

Figures in parenthesis indicate percentage
Multiple responses possible

Table 10: Number of cotton articles starched daily by *dhobies*

n=30

Sl. No.	Types of dresses/made-ups	Number of articles starched daily		
		0-10	11-20	21-30
1	Kurta	26 (86.67)	04 (13.33)	-
2	Salwar-Kameez	20 (66.67)	05 (16.67)	05 (16.67)
3	Sari	07 (23.33)	21 (70.00)	02 (06.67)
4	Shirt	06 (20.00)	09 (30.00)	15 (50.00)
5	Veils	25 (83.67)	05 (16.67)	-

Figures in parenthesis indicate percentage

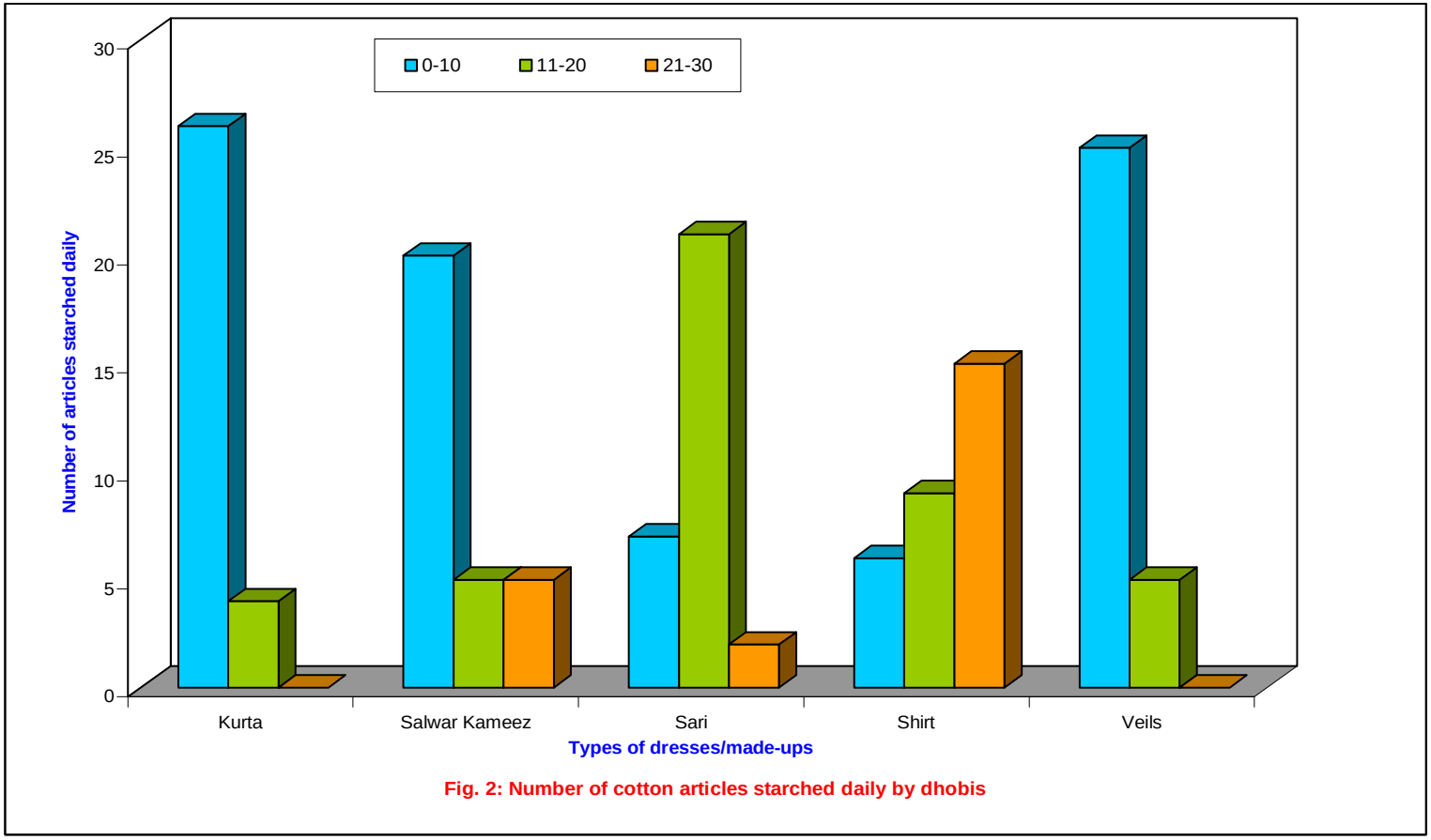


Fig. 2: Number of cotton articles starched daily by dhobis

Fig. 2: Number of cotton articles starched daily by dhobis

Table 11: Rates quoted by dhobis for ironing the starched clothes

n=30

Sl. No.	Dresses/ made-ups	Ironing charges (Rs.)					
		10	11-20	21-30	31-40	41-50	51-60
1	Kurta	30 (100.00)	-	-	-	-	-
2	Salwar-Kameez	04 (13.33)	20 (66.67)	06 (20.00)	-	-	-
3	Sari	-	06 (20.00)	09 (30.00)	08 (26.67)	05 (16.67)	02 (06.67)
4	Shirt	30 (100.00)	-	-	-	-	-
5	Veils	30 (100.00)	-	-	-	-	-

Figures in parenthesis indicate percentage

Table 12: Rates quoted by dhobis for starching and ironing cotton clothes

n=30

Sl. No.	Dresses/made-ups	Rate of starching and ironing (Rs.)								
		20	21-40	41-60	61-80	81-100	101-120	121-140	141-160	161-180
1	Kurta	07 (23.33)	17 (56.67)	04 (13.33)	02 (06.67)	-	-	-	-	-
2	Salwar-Kameez	11 (36.67)	13 (43.33)	16 (20.00)	-	-	-	-	-	-
3	Sari	-	-	07 (23.33)	03 (10.00)	12 (40.00)	-	-	05 (16.67)	03 (10.00)
4	Shirt	17 (56.67)	08 (26.67)	03 (10.00)	02 (06.67)	-	-	-	-	-
5	Veils	17 (56.67)	08 (26.67)	03 (10.00)	02 (06.67)	-	-	-	-	-

Figures in parenthesis indicate percentage

Table 13: Rates quoted by dhobis for washing, starching and ironing cotton clothes

n=30

Sl. No.	Dresses/made ups	Rate of washing, starching and ironing (Rs.)									
		20	**21-40**	**41-60**	**61-80**	**81-100**	**101-120**	**121-140**	**141-160**	**161-180**	**181-200**
1	Kurta	02 (06.67)	19 (63.33)	04 (13.33)	02 (06.67)	03 (10.00)	-	-	-	-	-
2	Salwar-Kameez	-	-	06 (20.00)	13 (43.33)	06 (20.00)	04 (13.33)	-	-	-	-
3	Sari	-	-	02 (06.67)	04 (13.33)	02 (06.67)	11 (36.67)	06 (02.00)	03 (10.00)	-	02 (06.67)
4	Shirt	07 (23.33)	10 (33.33)	07 (23.33)	02 (06.67)	03 (10.00)	-	-	-	-	-
5	Veils	04 (13.33)	15 (50.00)	07 (23.33)	02 (06.67)	02 (06.67)	-	-	-	-	-

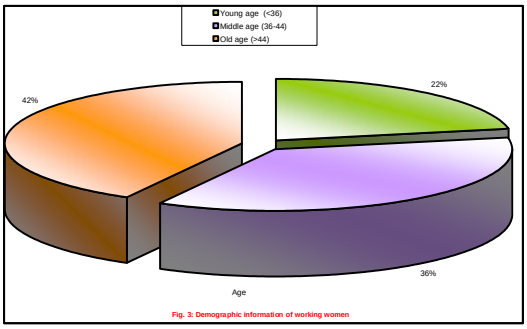
Figures in parenthesis indicate percentage

Table 14: Demographic information of working women

n=50

Sl.No	Demographic variables	Percentage of respondents
a)	**Age (years)**	
1.	Young age (<36)	11 (22.00)
2.	Middle age (36-44)	18 (36.00)
3.	Elderly (>44)	21 (42.00)
b)	**Education**	
1.	Primary (I-VII standard)	-
2.	Secondary (VIII-X standard)	03 (06.00)
3.	Intermediate (PUC I and II)	12 (24.00)
4.	Graduate	11 (22.00)
5.	Post graduate	24 (48.00)
c)	**Family size**	
1.	Small (<3)	15 (30.00)
2.	Middle (3-5)	15 (30.00)
3.	Large (>5)	20 (40.00)
d)	**Family type**	
1.	Nuclear	25 (50.00)
2.	Joint	25 (50.00)
e)	**Annual income (Rs.in lakh)**	
1.	Low income (<2,54,045)	05 (10.00)
2.	Middle income (2,54,045-7,09,140)	28 (56.00)
3.	Large income (>7,09,140)	17 (34.00)

Figures in parenthesis indicate percentage



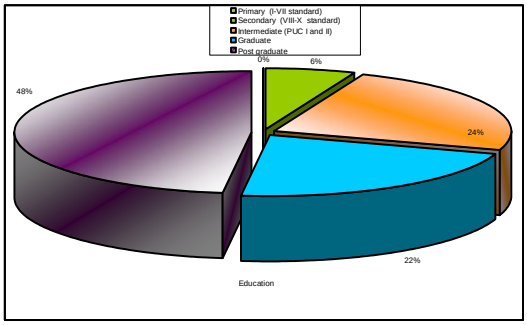
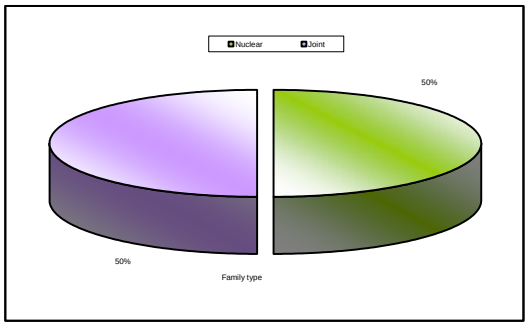
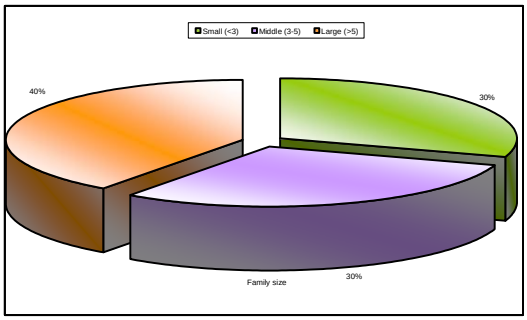


Fig. 3: Demographic information of working women





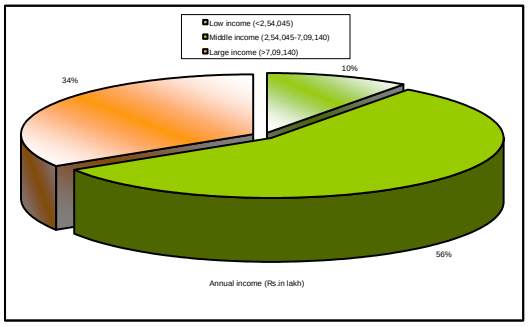


Fig. 3: Demographic information of working women

Table 15: Demographic information of non-working women

n=50

Sl. No	Demographic variables	Percentage of respondents
a)	**Age (years)**	
1.	Young age (<37)	13 (26.00)
2.	Middle age (37-44)	12 (24.00)
3.	Elderly (>44)	25 (50.00)
b)	**Education**	
1.	Primary (I-VII standard)	06 (12.00)
2.	Secondary (VIII-X standard)	16 (32.00)
3.	Intermediate (PUC I and II)	21 (42.00)
4.	Graduate	05 (10.00)
5.	Post graduate	02 (08.00)
c)	**Family size**	
1.	Small (<5)	19 (38.00)
2.	Middle (5-6)	10 (20.00)
3.	Large (>6)	21 (42.00)
d)	**Family type**	
1.	Nuclear	09 (18.00)
2.	Joint	41 (82.00)
e)	**Annual income (Rs.in lakh)**	
1.	Low income (<1,58,813)	18 (36.00)
2.	Middle income (1,58,813-2,82,853)	15 (30.00)
3.	Large income (>2,82,853)	17 (34.00)

Figures in parenthesis indicate percentage

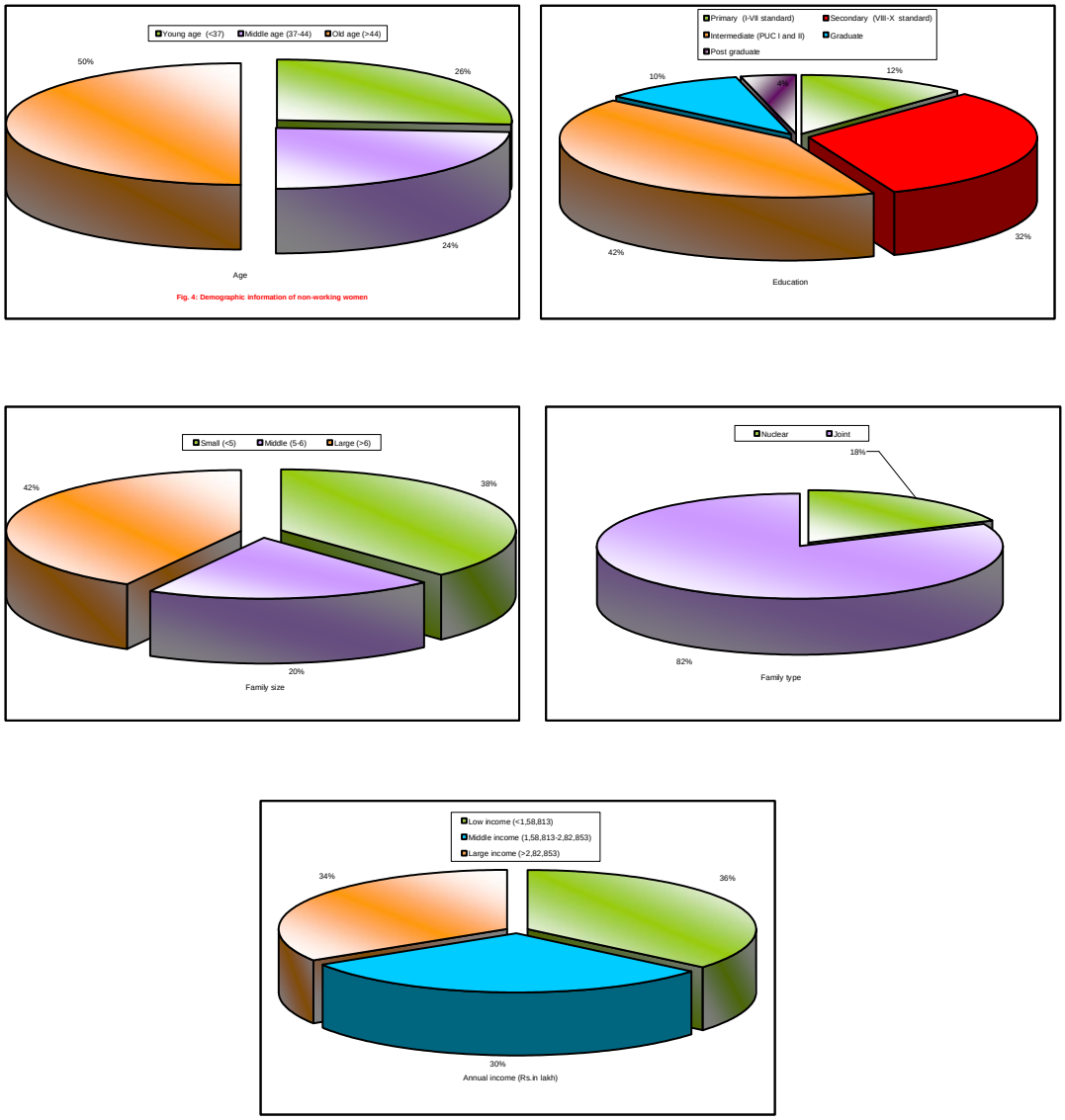


Fig. 4: Demographic information of non-working women

Fig. 4: Demographic information of non-working women

In fact the range starts from Rs. 20 to Rs. 100 for kurta and shirts, Rs. 41 to Rs. 120 for kurta, Rs. 41 to 160 and Rs. 20 to 100 for veil, which clearly reveals that among the five varieties of clothes, sari is the most expensive to be starched and ironed.

Further it is evident from this Table that majority of the *dhobis* charged Rs. 21 - 40 for kurta (63.33%), shirt (33.33%), veils (50.00%); Rs. 61 to 80 for salwar-kameez (43.33%) and Rs. 101-120 for saris (36.67%). Mean while very few per cent of *dhobis* charge Rs. 61 to 100 for kurta, sari, shirt and veil. It is interesting learn that about 07.00 to 10.00 per cent of the *dhobis* charged Rs. 181 to 200 and Rs. 141 to 160 for washing, starching and ironing the saris, respectively.

4.1.3 Demographic information of working and non working women

Table 14 and 15 reveal about the demographic information of the working and non-working women and highlights on the age group, education level, family size, family type and annual income.

4.1.3.1 Age

Table 14 and Fig. 3 records that majority of the working women belonged to old age (42.00%), followed by middle age (36.00%) and younger age (22.00%). On the other hand in Table 15 and Fig. 4, discloses that the age group to which non working women belonged to is old age (50.00%), young age (26.00%) and middle age (24.00%) groups

4.1.3.2 Education

Table 14 and Fig. 3, revealed that cent per cent of the working women were educated at different levels *viz.,* post graduate (48.00%), intermediate (24.00%), graduate (22.00%) and secondary (06.00%). None of working women had education only upto primary standard. But it is clear from Table 15, Fig. 4, that maximum non-working women had education upto intermediate level (42.00%) followed by secondary (32.00%), primary (12.00%), graduate (10.00%) and post graduate (04.00%).

4.1.3.3 Family size

Table 14 and Fig. 3, depicts that more than 40.00 per cent of the working women families have large size family with more than 5 members followed by medium and small size family (15.00 and 15.00%, respectively). On the contrary it is observed from Table 15 and Fig. 4, that majority of the non working women (42.00%) belonged to large family size with more than 7 members followed by small family size (38.00%) and medium family size (20.00%) having less than 5 and more than 6 members respectively.

4.1.3.4 Family type

An appraisal of Table 14 and Fig. 3 shows that half of working women (50.00%) belonged to nuclear family system whereas 50.00 per cent belong to joint family system. Mean while it is learnt from Table 15 and Fig. 4, that majority of non working women (82.00%) belonged to joint family system and rest to nuclear family systems.

4.1.3.5 Annual income of the family (Rs. in lakh)

The annual income of the working and non-working women is presented in Table 14 and Fig. 3 and Table 15 and Fig. 4, respectively. Table 14 and Fig. 3, gives an account of classification of the working women according to annual income. Majority of working women (56.00%) belonged to middle income group(Rs. 2,54,045 to 7,09,140) followed by 34.00 per cent of them to high income group having annual income more than Rs. 7,09,140, whereas, 10.00 per cent to low income group with less than Rs.2,54,045. On the hand it is evident from Table 15 and Fig. 5 that the annual income of the non-working families ranged from less than Rs.1,58,813 to more than 2,82,853 lakh of which 36.00 per cent fell in the category of low income(Rs.<1,58,813), 34.00 per cent to high (Rs.>2,58,813) and rest (30.00%) to middle income groups.

4.1.4 Preference for clothing by working and non-working women

The survey was conducted among working and non-working women is elicit the information regarding types of clothes, fibre content, preference for cotton clothes, mode of starching cotton clothes at domestic or commercial units.

4.1.4.1 Types of clothes used by working and non working women

Table 16 indicates the types of garments used as casual wear, daily wear, night wear and occasional wear by working and non-working women. It is found that tights-top (18.00%) and ghagra-choli (16.00%) were used occasionally by the working women, however none of the non-working group did use these garments.

Sari (60.00%), kurta (44.00%), salwar kameez (42.00) were the casual and daily wears; capris and nighties (each 38.00%), bermudas and salwar kameez (each 30.00%) were the night wears for working women. Though nighty was used as casual, daily and night wear by non-working women, majority of them did use sari as daily (46.00%) and occasional (64.00%) wears. In general the western clothes were used rarely by the non-working but some what commonly by the working women at home only.

4.1.4.2 Fibre content of the clothes

It is evident from Table 17 that cotton is the main fibre content of the garments worn by both working and non-working women except ghagra-choli which is either of silk or synthetic material. Majority of the working women used cottons sari (86.00%) and kurtas (60.00%); mean while they did have silk sari (72.00%) and silk salwar-kameez (54.00%), very few per cent of western dresses were made of synthetic or fancy yarns.

Majority of the non-working women possessed synthetic saris (64.00%) and salwar kameez (60.00%) compared to the corresponding cotton dresses. But they did wear cotton kurtas (44.00%) and nighty (42.00%). However, other western style garments were either of synthetic/fancy or blended.

4.1.4.3 Preference for cotton clothes by working and non working women

Table 18 clearly indicates that both working and non-working women preferred cotton clothes especially saris (each 100%), salwar-kameez (88.00% and 62.00%), nighty (78.00% and 80.00%) and kurta (48.00% and 32.00%), respectively. Infact, both the categories of the respondents did prefer cotton daily and casual wears for home, but the percentage slightly varied.

4.1.4.4 Mode of starching cotton clothes by working and non working women

According to the Table 19 the respondents did starch their cotton clothes at home as well as sent to commercial laundering of the total 54.00 per cent of working women, 24.00 per cent always starched at domestic level, whereas, 30.00 per cent, sometimes and 08.00 per cent never sent cotton clothes to commercial laundering. On the other hand 90.00 per cent of non-working women starched at home of which 60.00 per cent always, 30.00 per cent sometimes but 10.00 per cent never. However, the 10.00 percentage of non-working women always sent cottons to commercial laundry.

4.1.4.5 Rationale to starch cotton clothes at home by working and non working women

Table 20 reveals about consumers preference to starch cotton clothes either at home or at commercial centres. Mean while it was necessary to know the reasons why consumers prefer home starching or commercial one. The main reasons to starch at home as opined by working women were it is possible to take special care (36.00%), better handling of garments (32.00%), adopt easy care procedures (30.00%), further starching at home works out to be inexpensive (28.00%). Similarly, non working women mentioned that special and self caring of garments (50.00%), better handing of cottons (48.00%), better maintenance of durability (46.00%), time saving (46.00%) and easy care (40.00%) is possible when they starched at home.

Majority of the women irrespective of the category mentioned that there was no good dhobi who could starch the clothes up to their expectation. However, it was also mentioned that, poor quality starching (working 36.00%) and high charges (non-working 38.00%) were other reasons for not getting starched at commercial units.

Table 16: Type of clothes used by working and non-working women

n= 100

Sl. No.	Types of clothes	Working women (n_1=50)				Non-working women (n_2=50)			
		Casual wear	Daily wear	Night wear	Occasional wear	Casual wear	Daily wear	Night wear	Occasional wear
1	Bermuda	18 (36.00)	09 (18.00)	15 (30.00)	10 (20.00)	12 (24.00)	04 (08.00)	07 (14.00)	05 (10.00)
2	Capris	14 (28.00)	15 (30.00)	14 (38.00)	10 (20.00)	06 (12.00)	03 (06.00)	05 (10.00)	09 (18.00)
3	Ghagra-choli	-	-	-	08 (16.00)	-	-	-	-
4	Jeans	10 (20.00)	-	-	04 (08.00)	03 (06.00)	-	-	07 (14.00)
5	Leggings	14 (28.00)	10 (20.00)	09 (18.00)	14 (28.00)	11 (22.00)	-	-	14 (28.00)
6	Kurta	22 (44.00)	21 (42.00)	15 (30.00)	18 (36.00)	16 (32.00)	04 (08.00)	03 (06.00)	07 (14.00)
7	Nighty	13 (26.00)	11 (22.00)	19 (38.00)	-	28 (46.00)	21 (42.00)	19 (38.00)	-
8	Salwar-Kameez	21 (42.00)	20 (40.00)	15 (30.00)	25 (50.00)	11 (22.00)	04 (08.00)	05 (10.00)	12 (24.00)
9	Sari	30 (60.00)	25 (50.00)	13 (26.00)	30 (60.00)	07 (14.00)	23 (46.00)	17 (34.00)	32 (64.00)
10	Skirt	09 (18.00)	08 (16.00)	-	-	07 (14.00)	-	-	-
11	Tights-top	-	-	-	09 (18.00)	-	-	-	-
12	T-shirts	15 (30.00)	10 (20.00)	-	09 (18.00)	11 (22.00)	-	-	-

Figures in parenthesis indicate percentage
Multiple responses possible

Table 17: Fibre content of the clothes

n=100

SL. No.	Types of clothes	Fibre content (n_1 = 50)					Fibre content (n_2 = 50)				
		Cotton	Silk	Wool	Synthetic/ fancy	Blends	Cotton	Silk	Wool	Synthetic/ fancy	Blends
1	Bermuda	16	-	-	10	12	12	-	-	05	10
		(32.00)			(20.00)	(24.00)	(24.00)			(10.00)	(20.00)
2	Capris	12	-	-	09	13	07	-	-	-	09
		(24.00)			(18.00)	(26.00)	(14.00)				(18.00)
3	Ghagra-choli	-	05	-	03	-	-	-	-	-	-
			(10.00)		(06.00)						
4	Jeans	10	-	-	04	10	15	-	-	10	10
		(20.00)			(08.00)	(20.00)	(30.00)			(20.00)	(20.00)
5	Leggings	10	-	-	08	18	13	-	-	04	10
		(20.00)			(16.00)	(36.00)	(26.00)			(08.00)	(20.00)
6	Kurta	30	08	-	20	16	24	02	-	06	12
		(60.00)	(16.00)		(40.00)	(32.00)	(44.00)	(04.00)		(12.00)	(24.00)
7	Nighty	43	-	-	16	20	21	-	-	20	15
		(86.00)			(32.00)	(40.00)	(42.00)			(40.00)	(30.00)
8	Salwar-Kameez	36	27	-	28	28	17	15	-	30	15
		(72.00)	(54.00)		(56.00)	(56.00)	(34.00)	(30.00)		(60.00)	(30.00)
9	Sari	42	36	-	38	34	28	17	-	32	15
		(84.00)	(72.00)		(76.00)	(68.00)	(36.00)	(34.00)		(64.00)	(30.00)
10	Skirt	07	03	-	07	09	09	-	-	10	-
		(14.00)	(06.00)		(14.00)	(18.00)	(18.00)			(20.00)	
11	Tights-top	-	-	-	-	02	-	-	-	-	-
						(04.00)					
12	T-shirts	10	-	-	11	13	07	-	-	-	-
		(20.00)			(22.00)	(26.00)	(14.00)				

Figures in parenthesis indicate percentage n_1 = Working women

Multiple responses possible n_2 = Non-working women

Table 18: Preference for cotton clothes by working and non-working women

n=100

Sl. No.	Types of clothes	Working women (n_1 = 50)	Non-working women (n_2 = 50)
1	Bermuda	19 (38.00)	12 (24.00)
2	Capris	15 30.00)	12 (24.00)
3	Ghagra-choli	08 (16.00)	-
4	Jeans	08 (16.00)	10 (20.00)
5	Leggings	15 (30.00)	06 (12.00)
6	Kurta	24 (48.00)	26 (32.00)
7	Nighty	39 (78.00)	40 (80.00)
8	Salwar-Kameez	44 (88.00)	31 (62.00)
9	Sari	50 (100.00)	50 (100.00)
10	Skirt	06 (12.00)	03 (06.00)
11	Tights-top	07 (14.00)	05 (10.00)
12	T-shirts	11 (22.00)	05 (10.00)

Figures in parenthesis indicate percentage
Multiple responses possible

Table 19: Mode of starching cotton clothes by working and non-working women

n=100

Category of respondents	Mode of starching					
	Domestic			Commercial		
	Always	Some times	Never starched	Always	Some times	Never starched
Working women (n_1 = 50)	12 (24.00)	15 (30.00)	04 (08.00)	15 (30.00)	04 (08.00)	-
Non-working women (n_2 = 50)	30 (60.00)	15 (30.00)	05 (10.00)	05 (10.00)	07 (14.00)	-

Figures in parenthesis indicate percentage
Multiple responses possible

Table 20: Rationale to starch cotton clothes at home by working and non-working women

n=100

SL. No.	Reason	Working women (n_1=50)	Non-working women (n_2=50)
1	Easy care	15 (30.00)	20 (40.00)
2	Time saving	08 (16.00)	23 (46.00)
3	Inexpensive	14 (28.00)	23 (46.00)
4	Type of starch as desired	15 (30.00)	20 (40.00)
5	Amount of starch as desired	11 (22.00)	20 (40.00)
6	Better handling of the garment	16 (32.00)	24 (48.00)
7	Special care	18 (36.00)	25 (50.00)
8	Better durability	10 (20.00)	28 (46.00)
Problems faced with the dhobi			
1	Non availability of good dhobi	20 (40.00)	20 (40.00)
2	High charge	11 (22.00)	19 (38.00)
3	Late service	15 (30.00)	05 (10.00)
4	Poor quality	16 (36.00)	05 (10.00)

Figures in parenthesis indicate percentage
Multiple responses possible

4.1.4.6 Rationale to starch cotton clothes at commercial units by working and non working women

In contrast to Table 20, reason to starch cottons at commercial units by working and non-working women is presented in Table 21. Working women clearly indicated that quality starching (48.00%) leads to quality finishing (40.00%), time constraint (34.00%) and lengthy process (time consuming process, 30.00%) were the reasons for sending cottons to commercial *dhobis*. However, some of them mentioned that there is limited space (14.00%) to starch at home and some do not have any interest in starching (18.00%) the clothes. Mean while non working women mentioned that there is limited space at home (20.00%) to carry out the process. Whereas, others mentioned quality starching (10.00%) and quality finishing (10.00%) is possible in commercial units. Very few women (08.00%) informed about non-availability of time.

4.1.5 Selection of starching materials by working and non working women

The present study focuses on starching materials, hence it was essential to study the factors exclusively considered while selecting of starching material like brand, cost, efficiency and labels.

4.1.5.1 Types of garments starched at home by working and non working women

All types of garments/made-ups in general may be categorized according to colour, size, GSM and types. This information is very essential to know about type of starching material, its concentration, method of starching, as well as drying and finishing method, adopted by the working and non-working women for different category cottons. Table 22 represents type of garments starched at home by working and non-working women. Irrespective of the category all the women did starch cotton clothes of both light and dark colour, small, medium and large size cottons, light and medium weight garments, but the percentage varied. Majority of working and non-working women starched white/light colour (56.00 and 70.00%) and dark colour (50.00 and 63.00%), small size (40.00 and 64.00%), medium (54.00 and 62.00%) and large (52.00 and 70.00%), light weight (48.00 and 38.00%) and medium weight (48.00 and 62.00%) garments at home. Majority of the working women also starched saris (56.00%), salwar-kameez (48.00%) and tops/kurtas (40.00%); whereas relatively greater percent of non-working women starched saris (62.00%), salwar-kameez (60.00%) and veils (42.00%) at home. However, relatively a lesser per cent of respondents starched bermudas (20.00 and 30.00%) at home.

4.1.5.2 Selection of starch materials for cotton cloth by working and non working women

As already learnt that both natural and instant starching materials are available in the local market for the consumers to starch cotton. It is interesting to know from Table 23 and Fig. 5 that none of the women from both the categories did use inna. Revive is popularly used by both working and non-working groups for white (working 58.00% and non-working 30.00%) and dyed cottons (working 58.00% and non-working 24.00%). It is also evident from this Table that natural sizing materials are more popularly used compared to instant ones. Among the natural sources, arrowroot and sago are popularly used by working women, whereas greater per cent of non working women used rice (42.00%) and maida (36.00%) for dyed cottons. However, relatively low per cent of non-working women used arrowroot.

4.1.5.3 Factors considered while selecting starch materials by working and non working women

Consumers always have certain criteria while selecting and purchasing any product. Similarly, both working and non-working women considered several factors while purchasing starch materials which is presented in Table 24.

Working women gave importance for brand (64.00%), labels (40.00%) and efficiency (24.00%), whereas, non-working women stressed on cost (50.00%), brand (38.00%) and package (30.00%) which are considered to be of least important by the working group.

4.1.5.4 Selection of sizing materials according to labels by working and non working women

Label is the most effective media that generates information about the entire product, its composition, efficiency and mode of utility. In fact the labels indicate the brand and care information.

Table 21: Rationale to starch cotton clothes at commercial units by working and non-working women

n=100

SL. No.	Reason	Number of respondents	
		Working women (n_1=50)	Non-working women (n_2=50)
1	Time constraint	17 (34.00)	04 (08.00)
2	Unaware about starching technique	08 (16.00)	-
3	No interest in starching	09 (18.00)	-
4	Space constraint	07 (14.00)	10 (20.00)
5	Easily accessible	07 (14.00)	-
6	Quality starching	24 (48.00)	05 (10.00)
7	Quality finishing	20 (40.00)	05 (10.00)
8	Quick services	08 (16.00)	-

Figures in parenthesis indicate percentage
Multiple responses possible

Table 22: Type of garments starched at home by working and non-working women

n= 100

SL. No.	Garment details	Working women (n_1=50)	Non-working women (n_2=50)
Garment colour			
1	White colour	28 (56.00)	75 (70.00)
2	Dark colour	25 (50.00)	31 (62.00)
Garment size			
1	Small size	20 (40.00)	32 (64.00)
2	Medium size	27 (54.00)	31 (62.00)
3	Large size	26 (52.00)	35 (70.00)
Garment weight			
1	Light weight garment	24 (48.00)	29 (58.00)
2	Medium weight garment	24 (48.00)	31 (62.00)
Types of garments/made-ups			
1	Bermudas	10 (20.00)	15 (30.00)
2	Salwar -kameez	24 (48.00)	30 (60.00)
3	Sari	28 (56.00)	31 (62.00)
4	Tops/kurta	20 (40.00)	16 (32.00)
5	Veils	19 (38.00)	21 (42.00)

Figures in parenthesis indicate percentage
Multiple responses possible

Table 23: Selection of starch materials for cotton clothes by working and non-working women

n=100

SL. No.	Sizing materials	Working women (n_1=50)		Non-working women (n_2=50)	
		White cotton	Dyed cotton	White cotton	Dyed cotton
1	**Instant**				
	a) Inna	-	-	-	-
	b) Revive	29 (58.00)	29 (58.00)	15 (30.00)	12 (24.00)
	c) Vanish	09 (18.00)	12 (24.00)	08 (16.00)	-
2	**Natural**				
	a) Arrowroot	12 (24.00)	12 (24.00)	07 (14.00)	07 (14.00)
	b) Maida	06 (12.00)	07 (14.00)	11 (22.00)	18 (36.00)
	b) Rice	04 (08.00)	06 (12.00)	13 (26.00)	21 (42.00)
	b) Sago	10 (20.00)	12 (24.00)	12 (24.00)	10 (20.00)

Figures in parenthesis indicate percentage
Multiple responses possible

Table 24: Factors considered while selecting starch materials by working and non-working women

n=100

SL. No.	Factors	Working women (n_1=50)	Non-working women (n_2=50)
1	Brand	32 (64.00)	19 (38.00)
2	Cost	07 (14.00)	25 (50.00)
3	Efficiency	12 (24.00)	10 (20.00)
4	Labels	23 (46.00)	10 (20.00)
5	Package	09 (18.00)	15 (30.00)
6	User friendliness	11 (22.00)	07 (14.00)

Figures in parenthesis indicate percentage
Multiple responses possible

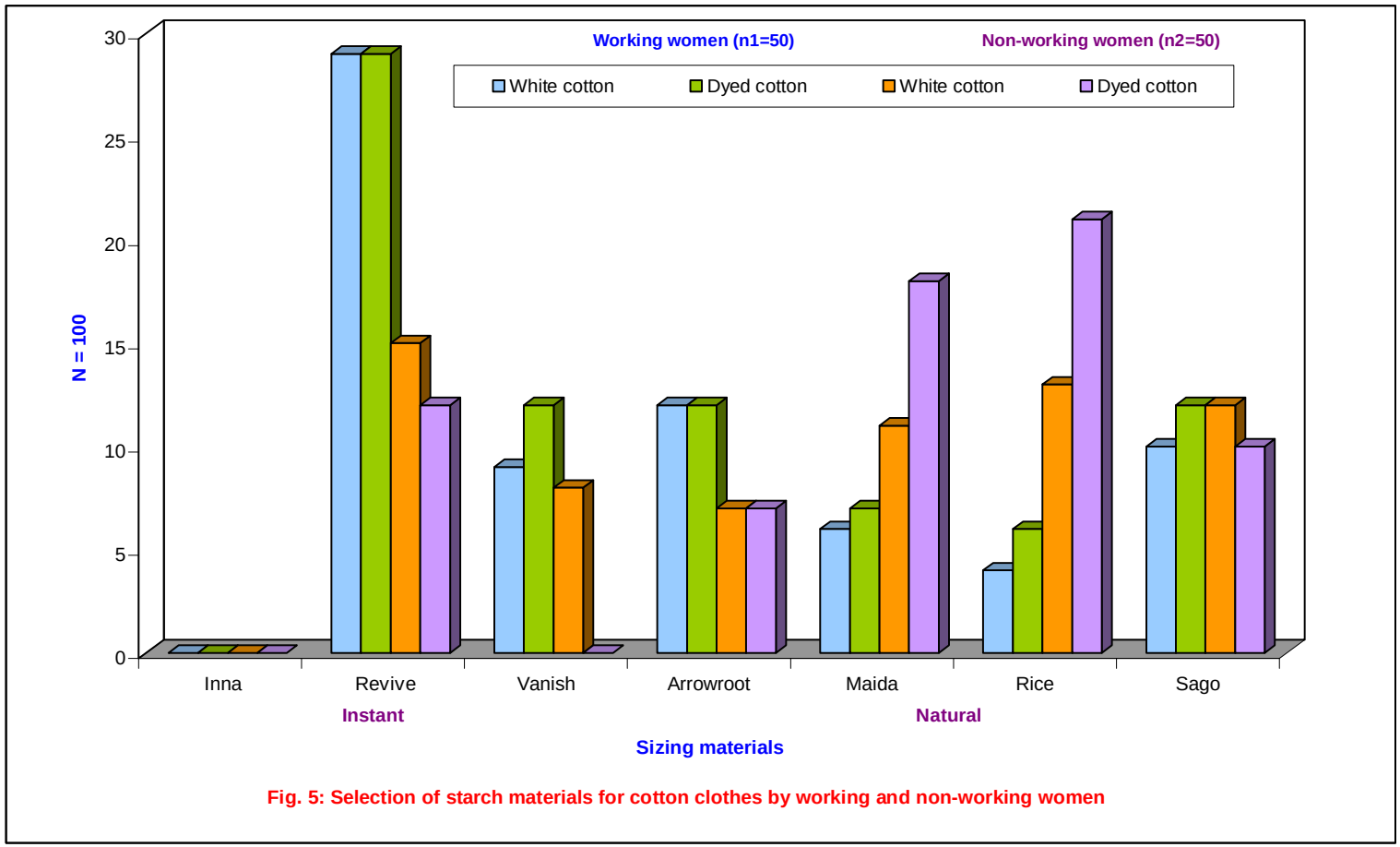


Fig. 5: Selection of starch materials for cotton clothes by working and non-working women

Fig. 5: Selection of starch materials for cotton clothes by working and non-working women

Working women who purchased instant starching materials always referred to brand labels (62.00%), information labels (38.00%) and care labels (32.00%), whereas among non-working group 20.00 per cent always looked for brand labels and care labels (18.00%). In other words it may be stated that greater per cent of non-working women gave least importance to labels (Table 25).

4.1.5.5 Sources of information for purchasing sizing materials

There are many sources other than labels that provide information about the products, indirectly leading to promotion.

Majority of the respondents got information about starching materials, from television advertisements (working 70.00% and non-working 50.00%), followed by personal experience (working 24.00% and non-working 42.00%). In fact non working women were influenced by the suggestions of friends/neighbour (24.00%) and shop keeper (20.00%). None of the respondents got information about starches through news papers (Table 26 and Fig. 6).

The common cotton clothes used by both working women and non-working women are saris, salwar-kameez, tops, veils and bermudas. Except bermudas other garments were starched regularly. At this juncture it is necessary to know about frequency of washing these garments which indirectly provides information about frequency of starching too.

4.1.6 Starching and finishing of cotton clothes by working and non working women

Durability of the garment directly reveals the quality of the product. And this quality is determined by fibre content, method fabric construction, mechanical and functional parameters of the fabric; stitch density, quality of sewing threads, seam perfection, permanency of colour and value applied on the garment; and finally the method of care and maintenance practices adopted by homemaker.

In other word, laundering practices adopted for washing should favour and support the durability of the garments where the practices encompass various activities like frequency of washing, method of home laundering, cleansing agents, sizing method, mode of finishing, types of iron box used, frequency of starching cotton clothes, storage of starched cotton clothes.

4.1.6.1 Frequency of home washing cotton garments by working and non working women

It is evident from Table 27 that greater per cent of working and non-working women (each 24.00%) washed bermudas after each wear where as least per cent washed, veils (working 10.00% and non-working 04.00%). About 15.00 per cent of working women did wash sari, salwar-kameez and tops after every wear.

Majority of the working women and non-working women laundered salwar-kameez (36.00 and 24.00%) and saris (20.00 and 18.00%) respectively, after two wears. On the contrary maximum working women (36.00%) and non-working women (30.00%) used saris at least three times before washing, as well as the veil (working 26.00% and non-working 36.00%). Cotton tops are washed either after first or second wear by the entire women group.

4.1.6.2 Method of home laundering of cottons adopted by working and non working women

The garments at home are laundered either manually or machine washed. However, the method adopted i.e., hand or machine wash depends on colour, size and types of clothes. From Table 28, it is clear that almost more than 60.00 per cent of non-working and 35 to 54 per cent of working women hand washed all categories of cotton clothes.

However, the working women used washing machine to cleanse medium size (44.00%), light weight (34.00%), tops (38.00%) and salwar-kameez (34.00%). Whereas, non-working women washed white/light colour (24.00%), small size (28.00%), light weight (20.00%) as well as veils (28.00%) in the washing machine.

Table 25: Selection of sizing materials according to labels by the working and non-working women

n=100

SL. No.	Types of labels	Always		Sometimes		Never	
		Working women (n_1=50)	Non-working women (n_2=50)	Working women (n_1=50)	Non-working women (n_2=50)	Working women (n_1=50)	Non-working women (n_2=50)
1	Information labels	19 (38.00)	06 (12.00)	30 (60.00)	15 (30.00)	-	10 (20.00)
2	Care labels	16 (32.00)	09 (18.00)	27 (54.00)	13 (26.00)	03 (06.00)	03 (06.00)
3	Brand labels	31 (62.00)	10 (20.00)	18 (36.00)	15 (30.00)		12 (24.00)

Figures in parenthesis indicate percentage
Multiple responses possible

Table 26: Sources of information for purchasing sizing materials

n=100

SL. No.	Sources	Working women (n_1=50)	Non-working women (n_2=50)
1	Personal experiences	15 (30.00)	21 (42.00)
2	Magazine	12 (24.00)	10 (20.00)
3	News paper	-	-
4	Television advertisement	35 (70.00)	25 (50.00)
5	Suggestion by friend / neighbour	02 (04.00)	12 (24.00)
6	Suggestion by shop owners	06 (12.00)	10 (20.00)

Figures in parenthesis indicate percentage
Multiple responses possible

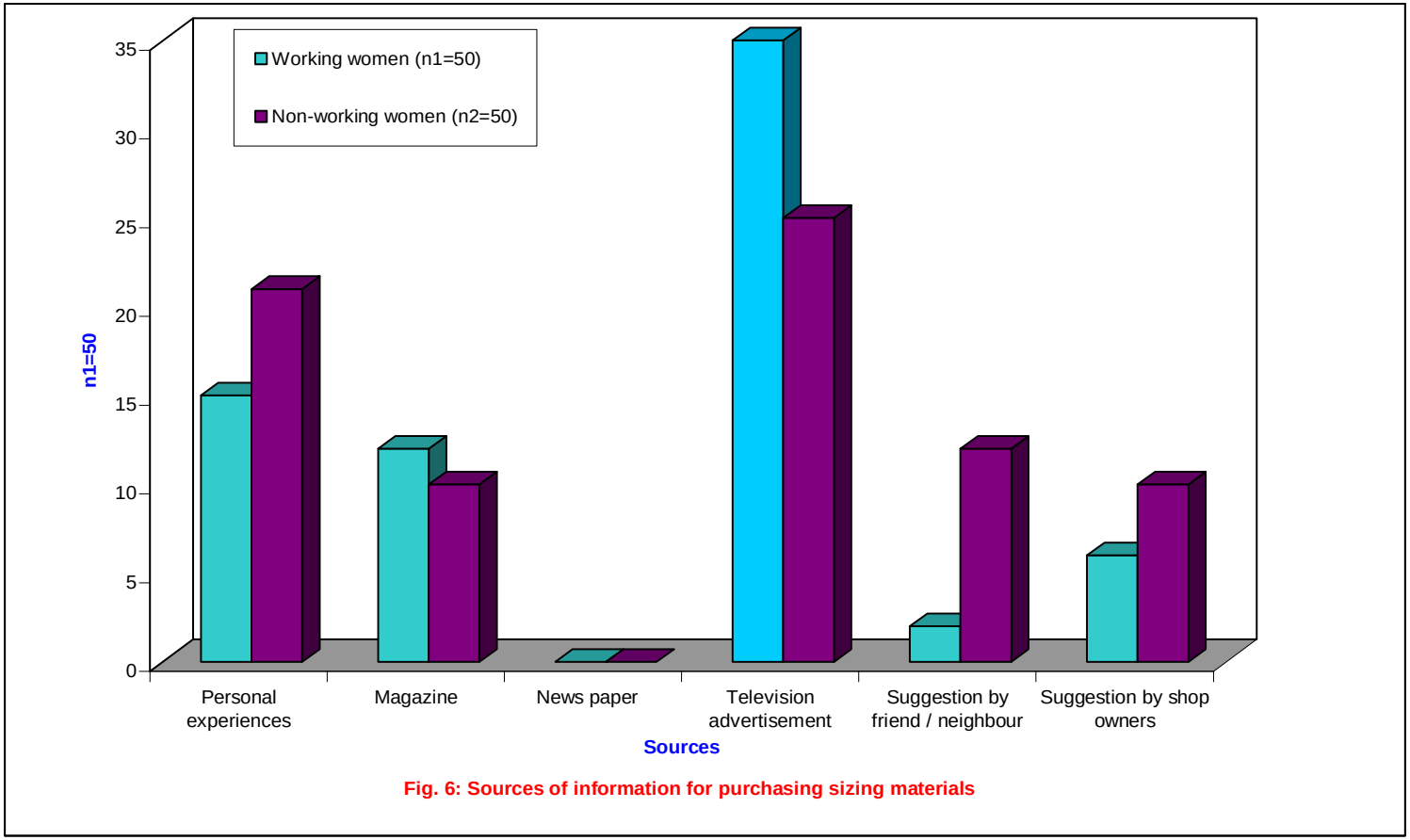


Fig. 6: Sources of information for purchasing sizing materials

Fig. 6: Sources of information for purchasing sizing materials

Table 27: Frequency of home washing cotton garments by working and non-working women

n=100

SL. No.	Types of labels	Frequency of washing cotton garments					
		After one wear		After two wears		After three wears	
		Working women (n_1=50)	Non-working women (n_2=50)	Working women (n_1=50)	Non-working women (n_2=50)	Working women (n_1=50)	Non-working women (n_2=50)
1	Bermuda	12 (24.00)	12 (24.00)	-	06 (12.00)	-	-
2	Salwar-kazmeez	08 (16.00)	02 (04.00)	18 (36.00)	12 (24.00)	10 (20.00)	05 (10.00)
3	Sari	08 (16.00)	09 (18.00)	10 (20.00)	09 (18.00)	18 (36.00)	15 (30.00)
4	Tops / kurta	07 (14.00)	05 (10.00)	04 (08.00)	10 (20.00)	04 (08.00)	09 (18.00)
5	Veils	05 (10.00)	02 (04.00)	08 (16.00)	02 (04.00)	13 (26.00)	18 (36.00)

Figures in parenthesis indicate percentage
Multiple responses possible

Table 28: Method of home laundering of cottons adopted by working and non-working women

n=100

SL. No.	Garment details	Method of home washing laundering			
		Working women (n_1=50)		Non-working women (n_2=50)	
		Manual	Machine	Manual	Machine
Garment colour					
1	White/light colour	21 (42.00)	20 (40.00)	25 (50.00)	12 (24.00)
2	Dark colour	27 (54.00)	16 (22.00)	30 (60.00)	10 (20.00)
Garment size					
1	Small size	17 (34.00)	17 (34.00)	38 (76.00)	14 (28.00)
2	Medium size	20 (40.00)	22 (44.00)	25 (50.00)	12 (24.00)
3	Large size	18 (36.00)	19 (38.00)	38 (76.00)	10 (20.00)
Garment weight					
1	Light weight	24 (48.00)	17 (34.00)	36 (72.00)	10 (20.00)
2	Medium weight	23 (46.00)	09 (18.00)	36 (72.00)	09 (18.00)
Types of garments/made-ups					
1	Bermudas	11 (22.00)	11 (22.00)	30 (60.00)	09 (18.00)
2	Salwar-kameez	23 (46.00)	17 (34.00)	32 (64.00)	07 (14.00)
3	Sari	25 (50.00)	12 (24.00)	27 (34.00)	04 (08.00)
4	Tops/kurta	18 (36.00)	19 (38.00)	12 (24.00)	12 (24.00)
5	Veils	27 (54.00)	14 (28.00)	27 (54.00)	14 (28.00)

Figures in parenthesis indicate percentage
Multiple responses possible

Table 29: Cleansing agents used for laundering white and dyed cottons by working and non-working women

n=100

Sl. No.	Colour of cotton garments	Respondents	Cleansing agents			
			Surf excel	Tide	Rin	Wheel
1	White/light colour	Working women (n_1=50)	14 (28.00)	10 (20.00)	12 (24.00)	04 (08.00)
		Non-working women (n_2=50)	15 (30.00)	12 (24.00)	04 (08.00)	19 (38.00)
2	Dark colour	Working women (n_1=50)	20 (40.00)	11 (22.00)	12 (24.00)	03 (06.00)
		Non-working women (n_2=50)	12 (24.00)	12 (24.00)	05 (10.00)	17 (34.00)

Figures in parenthesis indicate percentage
Multiple responses possible

4.1.6.3 Cleansing agents used for laundering white and dyed cottons by working and non working women

Selection of appropriate cleansing agent indicates intelligent care maintenance procedures. It is clear from Table 29 that all the respondents used detergent powder in place of soaps. From the Table it is clear that almost 1/4th of the working women used surf excel (8.00%) and rin (24.00%) for white cottons.

Whereas 40.00 and 24.00 per cent of working and non working women respectively, used the same cleansing agents for dyed/dark coloured cottons. On the contrary greater per cent of non-working women used wheel detergent for white/light (38.00%) and dark color cottons (34.00%). Similarly 30.00 per cent and 24.00 per cent of non-working women used surf excel for light and dark coloured cottons, respectively.

4.1.6.4 Sizing procedure preferred by working and non working women

The cleansed cottons are subjected for sizing to impart hand, texture, body, weight and improve drape quality. Basically there are two processes – hot and cold. It is displayed in Table 30 that 70.00 per cent of working and 74.00 per cent of non-working women preferred cold and hot processes, respectively, which indirectly indicates that they used instant and natural sizing materials.

4.1.6.5 Starching process adopted for varieties of cotton clothes by working and non working women

Further it is indicated in Table 31 that greater per cent of working women adopted cold processes for white/ light/ dark colour cotton (44.00%) of small size (54.00%), weighing either light or medium weight (40.00%). Further, more than 30.00 per cent of them adopted cold process for sari (32.00%) and tops/kurta (36.00%).

On the contrary more than 50.00 per cent of non-working women adopted hot process for sizing white/light colour cottons (54.00%), small (62.00%), medium (58.00%), large (78.00%) size articles, light and heavy weight (each 62.00%), sari and veil (each 62.00%), salwar kameez and tops (each 58.00%). Comparatively less than 20.00 per cent of non-working women sometimes adopted cold process.

4.1.6.6 Mode of finishing starched clothes by working and non working women

Drying starched clothes indicate the starching process adopted for different types of cottons. It is learnt that working women used instant starch and are finished when damp, the feature is evident from Table 32. Light and dark colour cotton, small (36.00%) and large (42.00%) articles of medium weight (34.00%) are ironed when damp. And these clothes were ironed in the commercial units (Table 33). Mean while around 35-50 per cent of working women dried the clothes completely and are comfortably ironed at home. On the contrary majority of the non-working women starched and ironed the clothes at home. Women of this category did not send clothes to commercial *dhobis* for ironing (Table 32 and 33).

4.1.6.7 Types of iron box used for finishing starched clothes by working and non working women

Table 34 indicated about the type of iron box used by the respondents. Majority of the working and non working women used thermostatic (automatic) iron box (64.00 and 78.00%, respectively) compared to steam (36.00 and 22.00%, respectively). It is learnt that none of the respondents used charcoal iron box, instead mentioned that, it works more effectively and efficiently in commercial units.

4.1.6.8 Frequency of starching cotton clothes by working and non working women

It is learnt that starching is a time consuming process hence, is not the task repeated frequently. From Table 35 it is clear that majority of the working and non working women starched the clothes as and when necessary (48.00 and 40.00%, respectively) followed by bimonthly (34.00 and 22.00%, respectively). Very meager per cent of them starched the clothes monthly.

Table 30: Sizing procedure preferred by working and non-working women

n=100

SL. No.	Sizing methods	Working women (n_1=50)	Non-working women (n_2=50)
1	Cold process	35 (70.00)	13 (26.00)
2	Hot process	15 (30.00)	37 (74.00)

Figures in parenthesis indicate percentage

Table 31: Starching process adopted for varieties of cotton clothes by working and non-working women

n=100

SL. No.	Garment details	Working women (n_1=50)		Non-working women (n_2=50)	
		Cold process	Hot process	Cold process	Hot process
Garment colour					
1	White/light colour	22 (44.00)	12 (24.00)	09 (18.00)	27 (54.00)
2	Dark colour	22 (44.00)	16 (32.00)	12 (24.00)	25 (50.00)
Garment size					
1	Small size	27 (54.00)	08 (16.00)	10 (20.00)	31 (62.00)
2	Medium size	20 (40.00)	14 (28.00)	09 (18.00)	29 (58.00)
3	Large size	15 (30.00)	10 (20.00)	05 (10.00)	34 (78.00)
Garment weight					
1	Light weight	20 (40.00)	15 (30.00)	12 (24.00)	31 (62.00)
2	Medium weight	20 (40.00)	16 (32.00)	29 (58.00)	31 (62.00)
Types of garments/made-ups					
1	Bermudas	07 (14.00)	03 (06.00)	10 (20.00)	16 (32.00)
2	Salwar-kameez	15 (30.00)	11 (22.00)	17 (34.00)	29 (58.00)
3	Sari	16 (32.00)	15 (30.00)	06 (12.00)	31 (62.00)
4	Tops/kurta	18 (36.00)	02 (04.00)	07 (14.00)	29 (58.00)
5	Veils	10 (20.00)	08 (16.00)	09 (18.00)	31 (62.00)

Figures in parenthesis indicate percentage
Multiple responses possible

Table 32: Mode of drying starched clothes by working and non-working women

n=100

SL. No.	Garment details	Method of drying			
		Working women (n_1=50)		Non-working women (n_2=50)	
		Dry	Damp	Dry	Damp
Garment colour					
1	White/light colour	21 (42.00)	20 (40.00)	39 (78.00)	-
2	Dark colour	17 (34.00)	16 (22.00)	27 (54.00)	12 (24.00)
Garment size					
1	Small size	22 (44.00)	18 (36.00)	34 (68.00)	-
2	Medium size	12 (24.00)	10 (20.00)	37 (74.00)	-
3	Large size	25 (50.00)	21 (42.00)	40 (80.00)	-
Garment weight					
1	Light weight	19 (38.00)	11 (22.00)	34 (68.00)	-
2	Medium weight	15 (30.00)	17 (34.00)	37 (74.00)	-
Types of garments/made-ups					
1	Bermudas	06 (12.00)	07 (14.00)	19 (38.00)	-
2	Salwar-kameez	15 (30.00)	08 (16.00)	25 (50.00)	-
3	Sari	12 (24.00)	17 (34.00)	21 (42.00)	12 (24.00)
4	Tops/kurta	07 (14.00)	02 (04.00)	12 (24.00)	06 (12.00)
5	Veils	10 (20.00)	12 (24.00)	25 (50.00)	-

Figures in parenthesis indicate percentage
Multiple responses possible

Table 33: Mode of finishing starched clothes by working and non-working women

n=100

SL. No.	Garment details	Method of finishing (ironing)			
		Working women (n_1=50)		Non-working women (n_2=50)	
		Home	Dhobi	Home	Dhobi
Garment colour					
1	White/light colour	10 (20.00)	35 (70.00)	24 (48.00)	-
2	Dark colour	12 (24.00)	29 (58.00)	24 (48.00)	-
Garment size					
1	Small size	27 (54.00)	19 (38.00)	30 (60.00)	-
2	Medium size	12 (24.00)	12 (24.00)	32 (64.00)	-
3	Large size	10 (20.00)	32 (64.00)	30 (60.00)	-
Garment weight					
1	Light weight	14 (28.00)	32 (64.00)	29 (58.00)	-
2	Medium weight	13 (26.00)	21 (42.00)	30 (60.00)	03 (06.00)
Types of garments/made-ups					
1	Bermudas	06 (12.00)	07 (14.00)	18 (36.00)	-
2	Salwar-kameez	15 (30.00)	08 (16.00)	25 (50.00)	-
3	Sari	12 (24.00)	17 (34.00)	32 (64.00)	05 (10.00)
4	Tops/kurta	07 (14.00)	02 (04.00)	20 (40.00)	-
5	Veils	10 (20.00)	12 (24.00)	27 (34.00)	-

Figures in parenthesis indicate percentage
Multiple responses possible

Table 34: Type of iron box used for finishing starched clothes by working and non-working women

N-100

SL. No.	Types of iron box	Working women (n_1=50)	Non-working women (n_2=50)
1	Steam iron box	18 (36.00)	11 (22.00)
2	Thermostatic iron box	32 (64.00)	39 (78.00)

Figures in parenthesis indicate percentage

Table 35: Frequency of starching cotton clothes by working and non-working women

n=100

SL. No.	Frequency of starching	Working women (n_1=50)	Non-working women (n_2=50)
1	Monthly	09 (18.00)	05 (10.00)
2	Bimonthly	17 (34.00)	11 (22.00)
3	Whenever necessary	24 (48.00)	20 (40.00)

Figures in parenthesis indicate percentage

Table 36: Storage of starched clothes by working and non-working women

n=100

SL. No.	Duration of storage	Working women (n_1=50)	Non-working women (n_2=50)
1	One month	03 (06.00)	-
2	Three months	07 (14.00)	12 (24.00)
3	Six months	19 (38.00)	19 (38.00)
4	A year	21 (42.00)	19 (38.00)

Figures in parenthesis indicate percentage

Table 37: Number of wears of starched clothes by working and non-working women before washing

n=100

SL. No.	Numerals of wear	Types of starched clothes									
		Fibre content (n_1 = 50)					Fibre content (n_2 = 50)				
		Kurta	Salwar-kameez	Sari	Tops	Veils	Kurta	Salwar-kameez	Sari	Tops	Veils
1	Once	15 (30.00)	10 (20.00)	-	17 (28.00)	-	10 (20.00)	06 (12.00)	-	10 (20.00)	-
2	Twice	10 (20.00)	18 (36.00)	07 (14.00)	-	-	09 (18.00)	12 (24.00)	08 (16.00)	08 (16.00)	04 (08.00)
3	Thrice	04 (08.00)	-	18 (36.00)	-	18 (36.00)	12 (24.00)	07 (14.00)	12 (24.00)	-	13 (26.00)
4	More than 3 times	-	-	25 (50.00)	-	25 (50.00)	15	-	30 (60.00)	-	13 (26.00)

Figures in parenthesis indicate percentage
Multiple responses possible

n_1 = Working women
n_2 = Non-working women

4.1.6.9 Storage of starched clothes by working and non working women

The cotton clothes are best suited for summer. However, starched clothes should not be stored for long period to avoid fungal growth, especially in monsoon. It was felt necessary to know about respondents view on storage of starched clothes. It is clear from Table 36 that majority of working and non-working women stored the starched clothes for a period of one year (42.00% and 38.00%, respectively), followed by six months (each 30.00%) and three months (14.00 and 24.00%, respectively).

4.1.6.10 Number of wears of starched clothes by working and non working women before washing

It is true that starching cotton clothes is an expensive of affair and people do express that cottons need maintenance. All the clothes after wash are worn at least twice or thrice depending on the length of wear and amount of soiling. Similarly, the starched clothes are also worn a couple of times before next laundering. A casually look at Table 37 indicates that majority of working women wore kurta and tops and washed after each wear (30.00 and 34.00%, respectively), whereas sari and veils were used three or more than 3 times (each 25.00%) before next wash. Similarly, the trend of numbers of wear of these garments by non-working women is in line with working women, however the percentage varied. Among the non working group 60.00 per cent of them did wear starched saris more than three times before washing.

4.2 Experimental results

The experimental was carried out in the laboratory to assess the impact of sizing material and hand washing on physical parameters of cotton muslin cloth.

Sizing is one of the temporary finishes given to cotton clothes especially for casual and occasional wears, since daily wears usually do not need the essence of starch. As learnt already sizing does bring change in the structural, performance, durable and comfort properties of the fabric.

The fabric sample is starched separately with 10 per cent each arrowroot and revive with 1:1 and 1:2 dilution levels. In all, the test sample was subjected for 2 types of starches one being natural and the other instant at two levels of dilution totaling to 4 treatments. After sizing, shade drying and ironing, the test samples were assessed for various parameters. “Nevertheless the sized samples were subjected to hand wash to observe its impact of these physical parameters”.

The physical parameters of the fabric can be sub grouped as structural, performance, durable and comfort properties which are inter dependable; because some form mechanical parameters and the others functional. The quality of the fabric at control, after size and hand wash finish is evaluated as a product of mechanical and functional features.

4.2.1 Effect of sizing on structural properties

The cloth count, thickness and GSM are the basic yet foundation parameters under the umbrella of structural properties.

4.2.1.1 Effect of sizing on cloth count (threads per inch)

Cloth count of the woven textile is the number of ends and picks per unit length and was calculated while the fabric is under zero tension and free from folds and wrinkles. Cloth count is influenced by the respective yarn density and fabric set.

The effect of sizing on this property is presented in Table 38 and Fig. 7 and Fig. 7 and it is clear that there is increase in threads per unit area of the test samples sized with arrowroot and revive at both the dilution levels, 1:1 and 1:2. The observations indicated that the percentage increase in pick per inch is greater than the corresponding ends per inch; maximum yarn consolidation in weft direction is observed with revive (16.67%) and arrowroot (13.33%) at 1:2 dilution compared to 1:1 dilution (10.00% and 06.66% arrowroot). Whereas, the percentage increase in ends per inch was same at 1:1 and 1:2 dilutions, when starched with selected agents.

Table 38: Effect of sizing on cloth count (thread per inch), cloth thickness (mm) and cloth weight (GSM) of test sample

Sl. No.	Characteristics	Direction	Control sample	Starched samples			
				Arrowroot (10%)		Revive (10%)	
				Dilution		Dilution	
				1:1	1:2	1:1	1:2
Structural properties							
1	Cloth count (threads per inch)	Warp	70	72 (02.86)	74 (05.71)	72 (02.86)	74 (05.71)
		Weft	60	64 (06.66)	68 (13.33)	66 (10.00)	70 (16.67)
2	Cloth thickness (mm)	-	0.212	0.302 (42.00)	0.284 (35.85)	0.296 (39.62)	0.288 (35.85)
3	Cloth weight (GSM)	-	34.8	44.8 (28.73)	41.2 (18.39)	44.4 (27.58)	41.00 (17.81)

Figures in parenthesis indicate percentage increase over control value

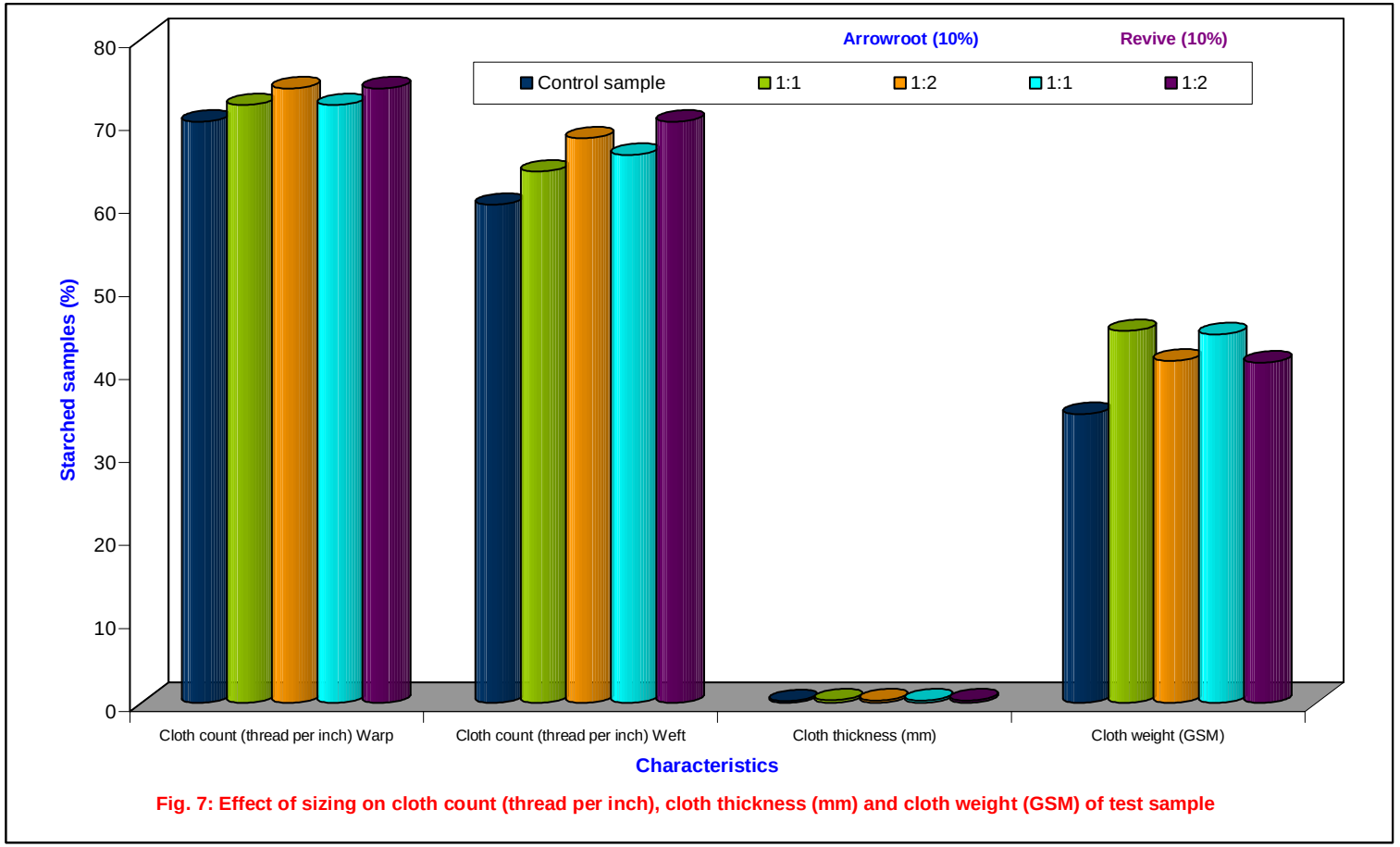
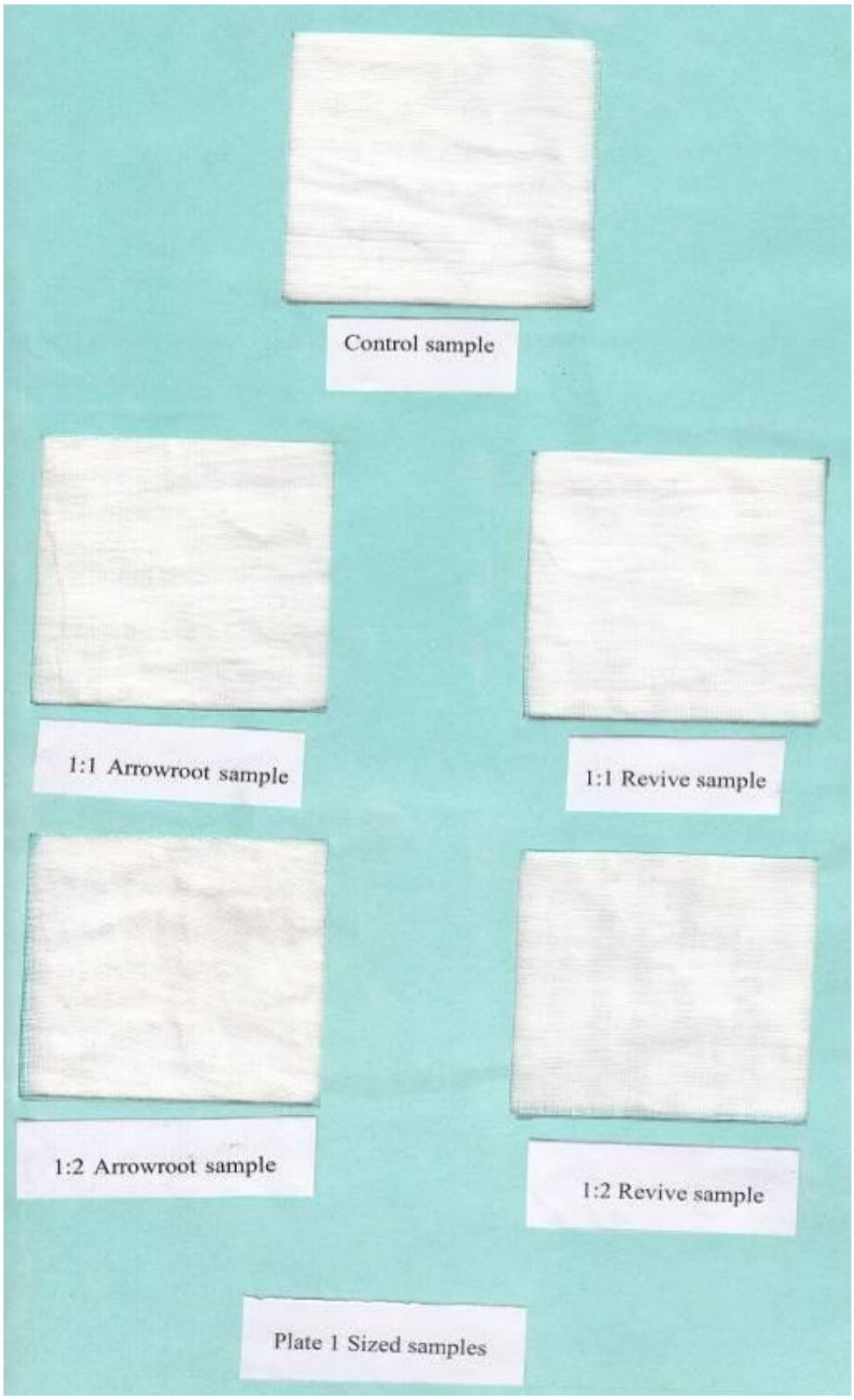


Fig. 7: Effect of sizing on cloth count (thread per inch), cloth thickness (mm) and cloth weight (GSM) of test sample

Fig. 7: Effect of sizing on cloth count (thread per inch), cloth thickness (mm) and cloth weight (GSM) of test sample



P)late 1. Sized samples

Analysis of variance for two sizing materials, two dilutions and two directions of yarn is presented in Table 39. ANOVA indicated that the sizing materials, dilutions, yarn direction and their interactions have influenced the cloth count and are found to be highly significant.

4.2.1.2 Effect of sizing on cloth thickness (mm)

Cloth thickness is the distance between one surface to its opposite. In textiles, it is the distance between upper and lower surface of the material, measured under the specified pressure.

Table 38 and Fig. 7 indicates that there is increase in the cloth thickness on sizing and maximum thickness is observed with samples sized with arrowroot at 1:1 dilution followed by revive 1:1 (39.62%) and at 1:2 dilution level the cloth thickness was maximum with arrowroot (35.85%) followed by revive (33.96%) i.e., the cloth thickness was relatively greater when starched with arrowroot compared to revive at both the levels of dilution.

Analysis of variance for two sizing materials and two dilutions is presented in Table 40. ANOVA indicated that the influence of sizing materials and dilutions on cloth thickness was found to be highly significant (1%) and significant (5%), respectively.

4.2.1.3 Effect of sizing on cloth weight (GSM)

Cloth weight of the fabric depends on the fibre composition, yarn type, yarn twist, threads density, method of fabric construction and finish applied.

It is evident from Table 38 and Fig. 7 that in general there is increase in the GSM on starching. Greater increase in GSM is observed among the samples sized with 1:1 dilution than that of 1:2. Among all the four treated samples maximum gain in GSM is observed at 1:1 dilution when starched with arrowroot (28.73%) followed by revive 1:1 (27.58%) and at1:2 dilution, with arrowroot (18.39) and revive (17.81%).

Analysis of variance for two sizing materials and two dilutions is presented in Table 41. ANOVA indicated that the sizing materials, dilutions and their interactions have influenced the cloth weight and were found to be highly significant.

4.2.2 Effect of sizing on performance properties

Every fabric manufactured has definite end use, thus has all intrinsic qualities or characteristics to perform better as per the specification. Therefore, several varieties and qualities of fabrics are produced and made available in the market for the consumers to select wisely for clothing, bed linen furnishing and industrial purposes.

Cotton being universal fabric has innumerable end uses of which clothing is the most focused one since it forms the basic necessity of human kind. Cotton cloth is produced in varied GSM that helps the people to select material for variegated end uses. There are several parameters of a cloth that determine its performance *viz.,* bending path, crease recovery and drape coefficient. Hence, an effort was made to assess the impact of sizing on these parameters and evaluate its performance.

4.2.2.1 Effect of sizing on cloth bending length (cm)

Cloth bending length is the property of the fabric that depends on the energy required to produce a given bending deformation under its own weight. The constructional feature affecting the stiffness of a cloth is mainly its nature of the fibre, yarn type, yarn count, fabric geometry, cloth weight, cloth thickness and finish applied.

The bending length (cm) of the cloth on sizing increased in both the directions i.e., warpway end weftway. However, warpway bending path was higher than the respective weftway. It is interesting to note from Table 42 and Fig. 8, that the warpway bending length of both arrowroot and revive at 1:1 dilution was same (4.8 cm) whereas that of revive was higher (4.4 cm) compared to arrowroot (4.28 cm) at 1:2 dilution. A similar trend was observed in weftway too i.e., bending length was 4.7 cm and 4.75 cm respectively when sized with arrowroot and revive at 1:1 level. However weftway bending length was relatively small when measured at 1:2 dilution i.e., 4.18 cm and 4.32 cm for arrowroot and revive respectively.

Table 39: ANOVA for assessment of cloth count (thread per unit) on sized samples

Source of variable	Degree of freedom	Starched samples		
		MSS	F	SEM
Sizing materials (S)	2	42.467	52.536**	0.200
Dilution (D_1)	1	17.067	21.113**	0.164
S x D_1	1	216.600	267.959**	0.284
Direction (D_2)	2	4.467	5.526**	0.164
S x D_2	2	8.600	10.639**	0.284
D_1x D_2	1	1.067	1.320	0.284
S x D_1 x D_2	2	1.067	1.320	0.401
Error	48	0.808	-	-

**** -** Significant at 1% level

Table 40: ANOVA for assessment of cloth thickness (mm) on sized samples

Source of variable	Degree of freedom	Starched samples		
		MSS	F	SEM
Sizing materials (S)	2	0.022	295.409**	0.856
Dilution (D_1)	1	0.001	7.682*	0.856
S x D_1	2	0.000	1.955	1.211
Error	24	7.333	-	-

* - Significant at 5% level
**** -** Significant at 1% level

Table 41: ANOVA for assessment of cloth weight (GSM) on sized samples

Source of variable	Degree of freedom	Starched samples		
		MSS	F	SEM
Sizing materials (S)	2	0.001	557.891**	0.487
Dilution (D_1)	1	0.000	123.175**	0.487
S x D_1	2	6.012	31.599**	0.689
Error	18	1.903	-	-

**** -** Significant at 1% level

Table 42: Effect of sizing on cloth bending length (cm), cloth crease recovery (angle) and cloth drape coefficient (%) of test samples

Sl. No.	Characteristics	Direction	Control sample	Starched samples			
				Arrowroot (10%)		Revive (10%)	
				Dilution		Dilution	
				1:1	1:2	1:1	1:2
Performance properties							
1	Cloth bending length (cm)	Warp	1.7	4.8 (182.33)	4.28 (151.76)	4.8 (182.35)	4.4 (158.82)
		Weft	1.4	4.7 (235.71)	4.18 (198.57)	4.75 (239.28)	4.32 (208.57)
2	Cloth crease recovery (angle)	Warp	80.8^0	84.4^0 (04.45)	81.2^0 (0.49)	84.4^0 (04.45)	83.8^0 (03.71)
		Weft	78.6^0	82.2^0 (04.58)	80.0^0 (01.82)	83.4^0 (06.10)	83^0 (05.59)
3	Cloth drape coefficient (%)	-	37.6	93.7 (149.20)	86.0 (131.11)	93.9 (149.73)	88 (135.63)

Figures in parenthesis indicate percentage increase over control values

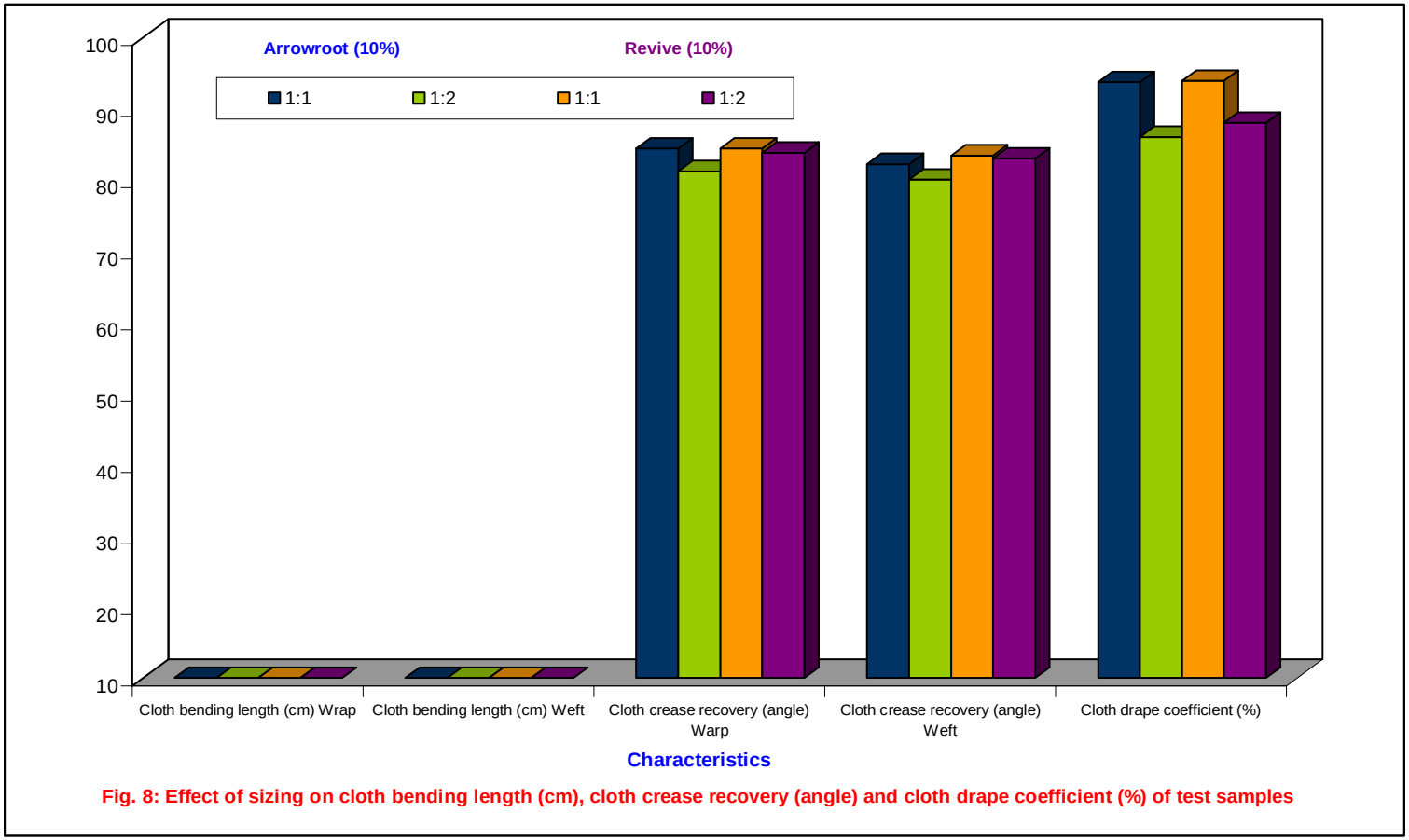


Fig. 8: Effect of sizing on cloth bending length (cm), cloth crease recovery (angle) and cloth drape coefficient (%) of test samples

Fig. 8: Effect of sizing on cloth bending length (cm), cloth crease recovery (angle) and cloth drape coefficient (%) of test samples

Analysis of variance for two sizing materials, two dilutions and two directions of yarn is presented in Table 43. ANOVA indicated that the sizing materials, dilutions, their interactions and yarn direction have influenced the cloth bending length and were found to be highly significant but the interaction of sizing materials and directions was found to be significant.

4.2.2.2 Effect of sizing on cloth crease recovery (angle)

Crease recovery angle is one of the performance properties directly supports the bending length of that fabric. Cloth crease recovery is the angle of recovery indicates the soft and pliability of a fabric. Greater the recovery angle, stiffer the fabric is. In general the warpway recovery is greater than its corresponding weftway recovery; and higher the dilution level lower the recovery angle. It is evident from Table 42 and Fig. 8 that irrespective of sizing materials the warpway recovery angle was 84.4° (increased by 04.45% over control) in contrast to its corresponding weftway recovery angles i.e., 82.2° (arrowroot) and 83.4° (revive) at 1:1 dilution level. However, the warpway crease recovery angle at 1:2 dilution level was lower (81.2° arrowroot and 83.8°, revive) than 1:1 dilution. On the other hand the weftway recovery angle at 1:1 dilution is higher in revive (83.4°) compared to arrowroot (82.2°) and that of 1:2 dilution are 83.0° and 80.0°, respectively.

Analysis of variance for two sizing materials, two dilutions and two directions of yarn is presented in Table 44. ANOVA indicated that the sizing materials and dilutions have influenced the cloth crease recovery and were found to be highly significant.

4.2.2.3 Effect of sizing on cloth drape co-efficient (%)

Drape in the ability to assume graceful appearance in use and is the result of interaction of warp and weft characteristics. Not all fabrics, of course, are expected to drape gracefully and indeed would be considered unsuitable and undesirable. Cotton being highly soft and pliable needs to be sized to improve its grace and drape. Drape not only measure stiffness of a fabric but yields a combination of other qualities. The fabric when draped on a drape meter may stand as a straight flat substrate like paper or canvas and may fall like a limp fabric in to several folds or the fall may be a variable between these two extremities.

The drapeability of fabric may be expressed in terms of drape coefficient (%) or number of nodes on draping. Higher the drape coefficient stiffer the fabric is. From Table 42 and Fig. 8, it is clear that there is increase in the drape coefficient values on sizing and invariablty it is higher at 1:1 dilution than 1:2 dilution. However, there was not much difference or variation in the drape coefficient values when starched with arrowroot (93.7 and 86.0) and revive (93.9 and 83.0) at 1:1 and 1:2 levels of dilutions.

4.2.3 Effect of sizing on durable properties

It is true that the strength of fibre, fibre structure, strength of yarn and yarn structure are commonly regarded as criterion of quality. However, the flexibility, resilience, moisture adsorption and similarly characteristics do assess the quality of a textite material i.e., the quality of a yarn depends upon the quality of the fibre and spinning operation; the quality of cloth is dependent upon the quality of fibre, spinning operation, weaving operation and finishing process. Similarly, strength is the result of several variables and is rather complex. Nevertheless, measurement of tensile properties is an important part of textile testing that determines the fabric strength including elongation and further focuses on durable aspects of the fabric.

'Wear' is net result of a number of agencies which reduce the serviceability of an article. Some of the important agencies are bending, stretching, tearing, abrasion, laundering and cleansing. The laboratory approach to assess the durability of the test samples in this study are abrasion resistance, tensile strength and its corresponding elongation.

4.2.3.1 Effect of sizing on abrasion resistance (cycles)

Cloth abrasion resistance is the wearing away of any part of material by rubbing against another surface. The abrasion resistance (cycle) of the test sample on sizing is presented in Table 45 and Fig. 9.

Table 43: ANOVA for assessment of cloth bending length (cm) on sized samples

Source of variable	Degree of freedom	Starched samples		
		MSS	F	SEM
Sizing materials (S)	2	47.329	2.611**	0.033
Dilution (D_1)	1	1.172	64.655**	0.027
S x D_1	1	0.285	15.736**	0.047
Direction (D_2)	2	0.306	16.862**	0.027
S x D_2	2	0.065	3.598*	0.047
D_1x D_2	1	0.000	0.011	0.047
S x D_1 x D_2	2	0.000	0.011	0.067
Error	36	0.018	-	-

**** -** Significant at 1% level
*** -** Significant at 5% level

Table 44: ANOVA for assessment of cloth crease recovery (angle) on sized samples

Source of variable	Degree of freedom	Starched samples		
		MSS	F	SEM
Sizing materials (S)	2	78.017	12.318**	0.562
Dilution (D_1)	1	12.150	1.918	0.459
S x D_1	1	46.817	7.392	0.795
Direction (D_2)	2	6.650	1.050**	0.459
S x D_2	2	2.817	0.445	0.795
D_1x D_2	1	2.017	0.318	0.795
S x D_1 x D_2	1	1.517	0.239	1.125
Error	48	6.333	-	-

**** -** Significant at 1% level

Table 45: Effect of sizing on cloth abrasion resistance (cycles), cloth tensile strength (g) & elongation (%) and cloth air permeability ($m^3/cm^2/min$) of test samples

Sl. No.	Characteristics	Direction	Control sample	Starched samples			
				Arrowroot (10%)		Revive (10%)	
				Dilution		Dilution	
				1:1	1:2	1:1	1:2
Durable properties							
1	Cloth abrasion resistance (cycle)	-	140	260 (85.71)	203 (40.00)	243 (73.57)	193 (37.85)
2	Tensile strength a) Breaking load (N)	Warp	87.2	153.6 (76.14)	138.00 (58.25)	154.0 (76.60)	135.9 (55.84)
		Weft	80	144.0 (79.55)	121.7 (52.12)	143.6 (78.75)	118.0 (47.50)
	b) Elongation (%)	Warp	5.2	6.40 (23.07)	6.90 (32.69)	6.60 (26.92)	6.10 (17.30)
		Weft	4.5	5.70 (48.87)	5.40 (66.67)	5.50 (17.78)	5.30 (31.11)
Comfort properties							
3	Cloth air permeability ($m^3/cm^2/min$)	-	554.1	399.6 (27.88)	434.0 (21.67)	416.40 (24.85)	458.80 (17.20)

Figures in parenthesis indicate percentage increase over control values

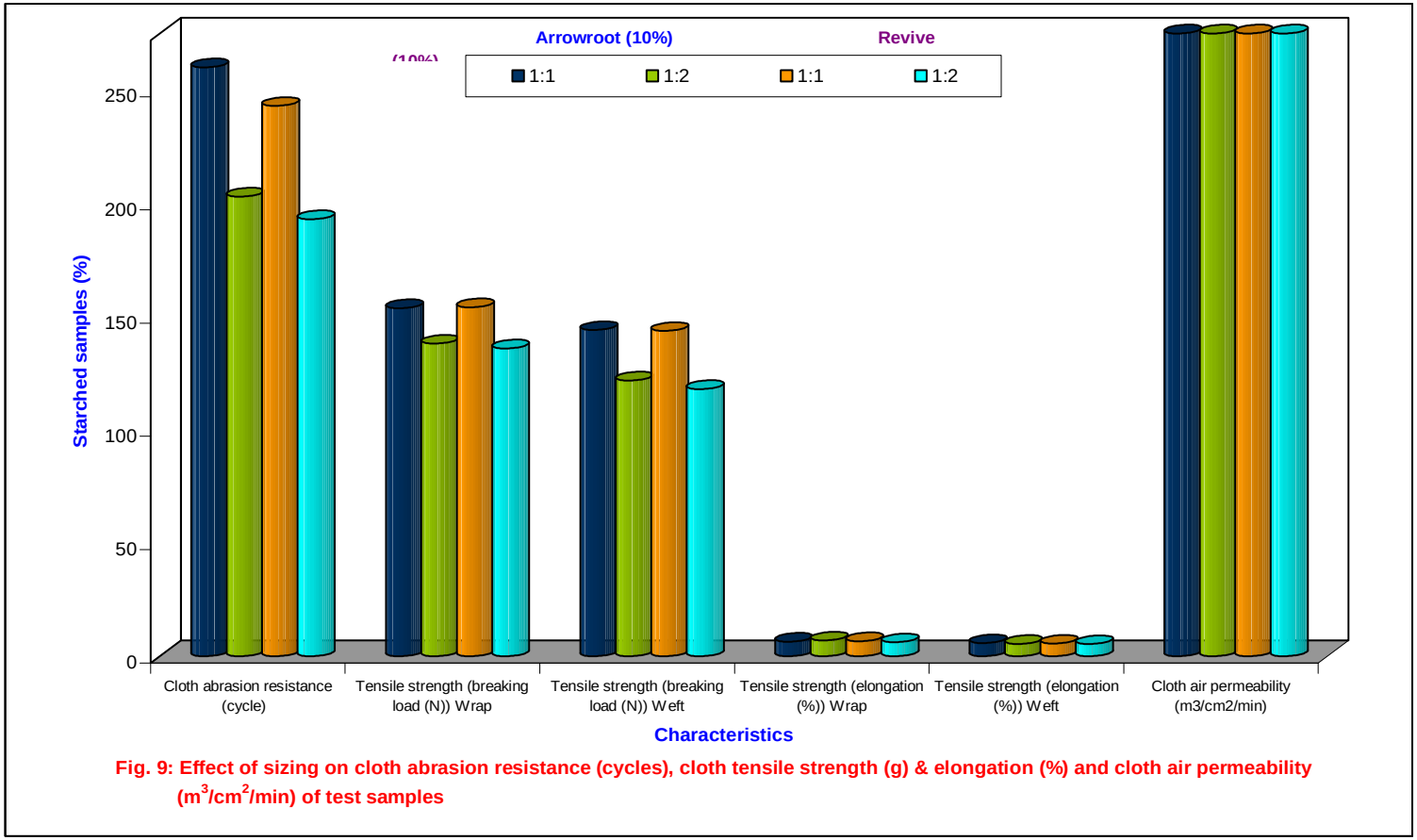


Fig. 9: Effect of sizing on cloth abrasion resistance (cycles), cloth tensile strength (g) & elongation (%) and cloth air permeability ($m^3/cm^2/min$) of test samples

Fig. 9: Effect of sizing on cloth abrasion resistance (cycles), cloth tensile strength (g) & elongation (%) and cloth air permeability (m3/cm2/min) of test samples

It is evident from this Table that, maximum resistance for abrasion (cycle) is found in test sample when sized with arrowroot (260) followed by revive (243) at 1:1 level of dilution compared to 203 and 193 cycles (arrowroot and revive) at 1:2 dilution. It clearly indicates that the abrasion resistance is better when the sizing concentration is higher.

4.2.3.2 Effect of sizing on tensile strength (g) and elongation (%)

Tensile strength is the ability of the material to resist strain or rupture induced by external force. It is expressed as force/unit on cross- sectional area of the specimen at the time of maximum load.

Table 45 and Fig. 9 does depict the results of tensile strength of control and sized test sample. In general there is remarkable increase in the tensile strength on sizing, however, the warpway strength is higher than its corresponding weftway strength at 1:1 and 1:2 levels of dilution. The descending order of warpway tensile strength on sizing with arrowroot is 153.60 g and 138.00 g at 1:1 and 1:2 levels of dilution respectively, similarly that of revive is 154.00 g and 135.90 g. The weft way breaking load is found to be higher in arrowroot i.e., 144.00 g (80.00%) followed by 143.60 g (78.75%) at 1:1 dilution and that of 1:2 dilution is 121.70 g (52.12%) and 118.0 g (47.50%) for arrowroot and revive, respectively.

Similarly, the percentage warpway elongations at 1:1 dilutions is found to be almost same when starched with arrowroot and revive so also at 1:2 dilution (6.90 and 6.10%); whereas the weftway elongation ranged from 5.30 per cent (revive, 1:2) to 5.40 per cent (arrowroot, 1:2). In other words the greater per cent elongation is observed when sized with higher concentration (1:1) than that of lower (1:2).

4.2.4 Effect of sizing on comfort properties

Cotton is the most comfortable fabric/garment for the entire population of the globe. However, the comfort properties are influenced by the structural properties, performance characteristics and durability features to some extent. Among several comfort properties air permeability is one of them.

Due to the manner in which yarns and fabrics are constructed, a large proportion of the total volume occupied by a fabric, infact is air space. The fabric must allow air to pass through but at the same time prevent the passage of dust and dirt. There is a relation on the effect of yarn density and fabric count. Sometimes the finish given to a fabric has considerable effect on permeability, even though the porosity may remain the same.

4.2.4.1 Effect of sizing on cloth air permeability ($m^3/cm^2/min$)

Air permeability is the rate of air flow through a material under a differential pressure between the two fabric surfaces.

From Table 45 and Fig. 9 it is clear that the air permeability decreased on sizing, in general compared to control. From the results it is evident that air permeability is higher when sized with revive and arrowroot at 1:2 dilution compared to 1:1. The ascending order of increase in air permeability over to control is 399.60 (27.88% arrowroot 1:1), 416.40 (24.85% revive 1:1), 434.0 (21.67%, arrowroot, 1:2) and 458.80 (17.20% revive, 1:2).

4.2.5 Effect of hand washing on structural properties of sized samples

Starching cotton clothes is a must and is universally accepted truth. The starched clothes may be worn/used at least 3-4 times before washing, however it depends on the decision of the wearer. It is also learnt in the routine practice that the starch in the clothes cannot be completely removed after first wash. Some per cent of the starch remains in the clothes. Hence, an effort was made to evaluate the structural, performance, durable and comfort properties and indicate whether the washed article is fit to use without starching.

4.2.5.1 Effect of hand washing on cloth count (threads per inch) of sized samples

The effect of washing on the structural properties of sized sample is presented in Table 46 and Fig. 10. It is clear from this Table that there is meager increase in ends/inch at 1:2 dilution of arrowroot and revive. Similarly in picks/inch of arrowroot sized sample at 1:1 and 1:2 dilutions.

Table 46: Effect of hand washing on cloth count (thread per inch), cloth thickness (mm) and cloth weight (GSM) of sized samples

Sl. No.	Characteristics	Direction	Control sample	Starched samples							
				Arrowroot (10%)				Revive (10%)			
				Dilution				Dilution			
				1:1		1:2		1:1		1:2	
Structural properties				**Sized**	**Washed**	**Sized**	**Washed**	**Sized**	**Washed**	**Sized**	**Washed**
1	Cloth count (thread per inch)	Warp	70	72 (02.86)	72 (02.86)	74 (05.71)	76 (08.51)	72 (02.86)	72 (02.86)	74 (05.71)	76 (08.51)
		Weft	60	64 (06.66)	66 (10.00)	68 (13.33)	70 (16.67)	66 (10.00)	66 (10.00)	70 (16.67)	70 (16.67)
2	Cloth thickness (mm)	-	0.212	0.302 (42.00)	0.288 (35.84)	0.284 (35.85)	0.250 (17.92)	0.296 (39.62)	0.264 (24.52)	0.288 (35.85)	0.252 (18.88)
3	Cloth weight (GSM)	-	34.8	44.8 (28.73)	42.5 (22.13)	41.2 (18.39)	38.8 (11.49)	44.4 (27.58)	42.3 (21.55)	41.00 (17.81)	38.2 (09.78)

Figures in parenthesis indicate percentage

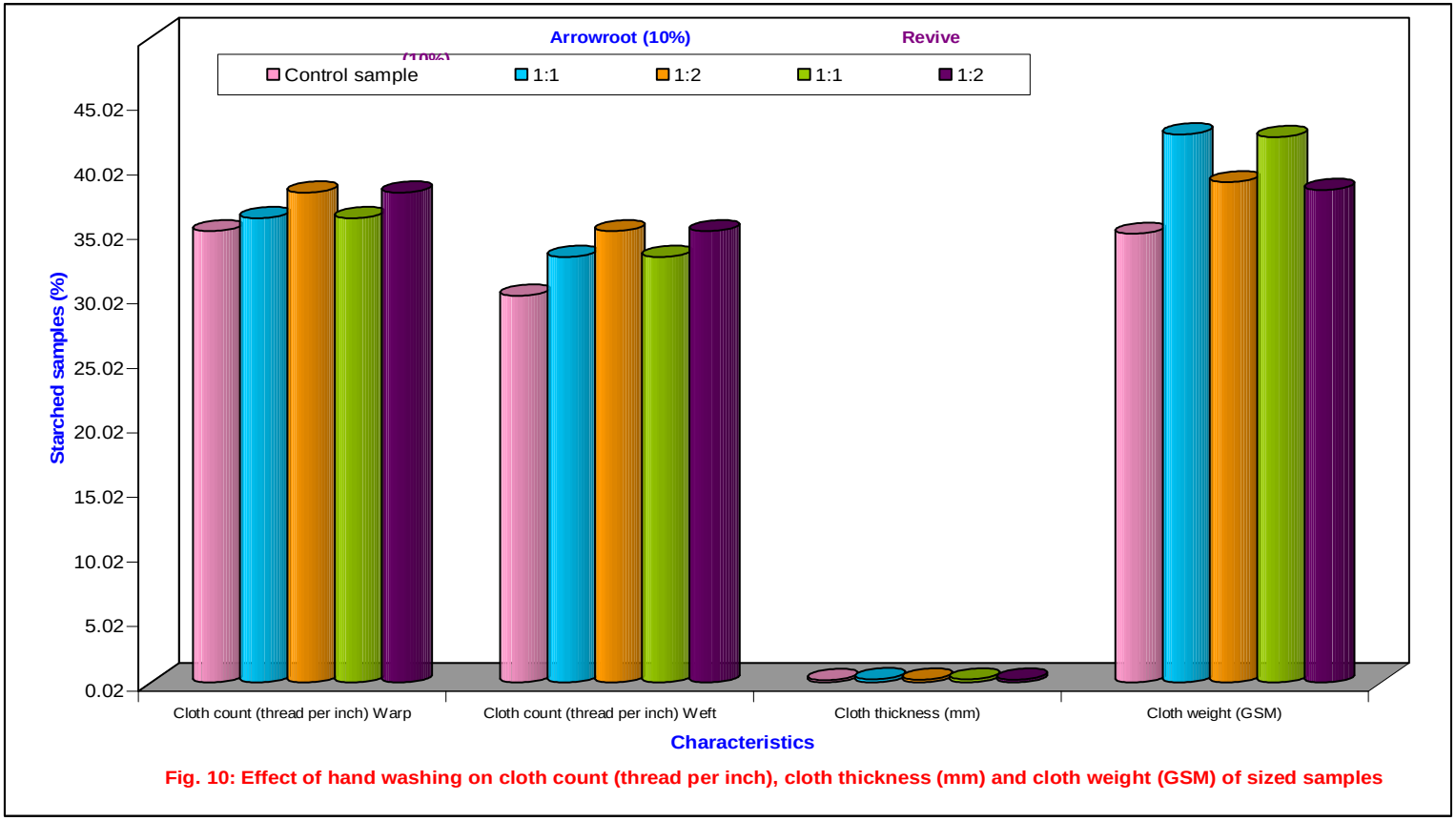


Fig. 10: Effect of hand washing on cloth count (thread per inch), cloth thickness (mm) and cloth weight (GSM) of sized samples

Fig. 10: Effect of hand washing on cloth count (thread per inch), cloth thickness (mm) and cloth weight (GSM) of sized samples

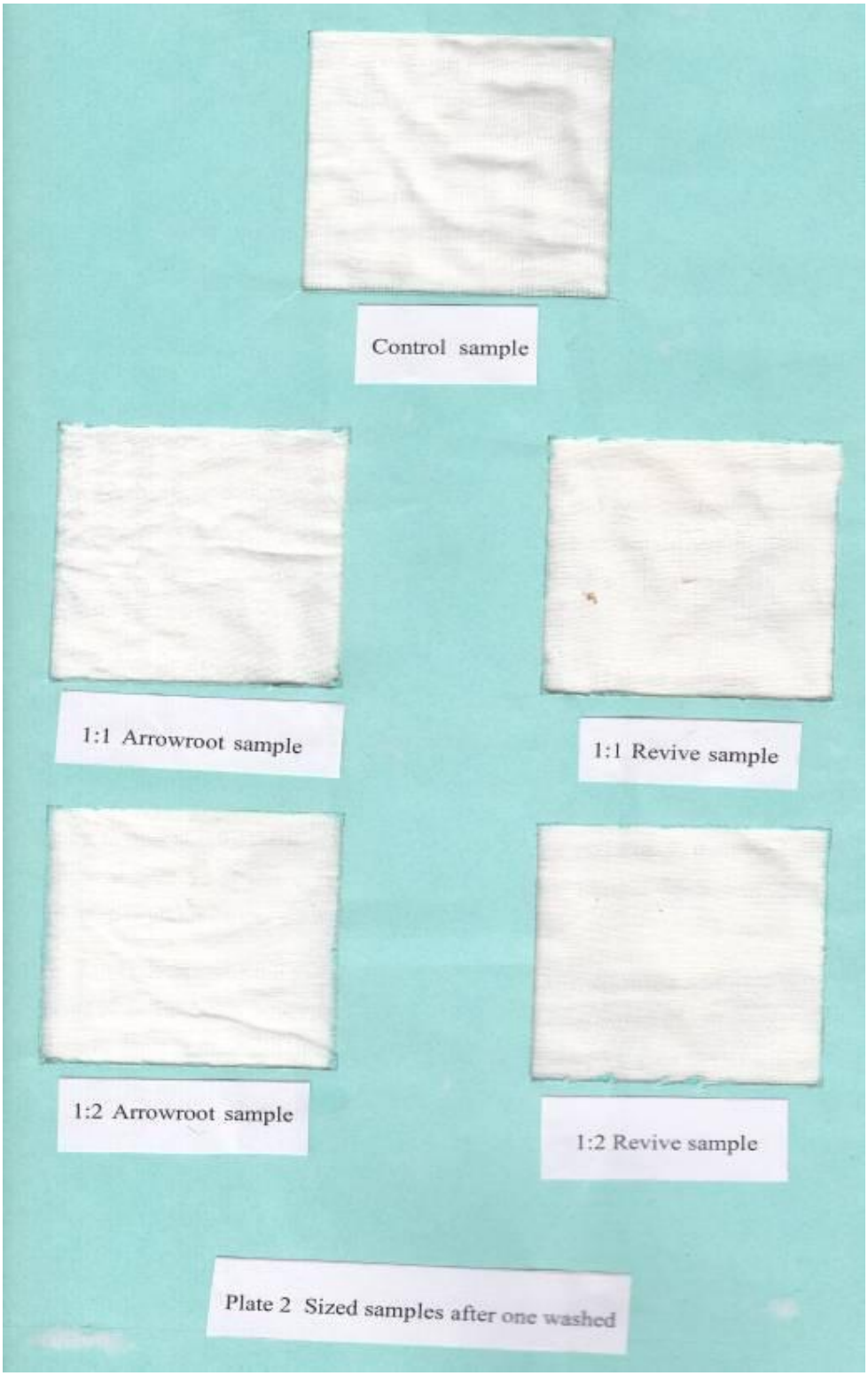


Plate 2. Sized samples after one washed

The increase in warp count from sized sample to that of washed sample is 05.71 to 08.51 per cent at 1:2 dilution and that of weft at 1:1 dilution is from 06.66 to 10.00 per cent for arrowroot and at 1:2 dilution is from 13.33 per cent to 16.67 per cent, irrespective of the sizing materials.

Analysis of variance for two sizing materials, two dilutions and two directions of yarn is presented in Table 47. ANOVA indicated that the sizing materials, dilutions, and their interactions have influenced the cloth count of sized samples after first wash and were found to be highly significant.

4.2.5.2 Effect of hand washing on cloth thickness (mm) of sized samples

After washing the sized sample, it is observed that there is decrease in the cloth thickness (mm) when compared to the thickness values of sized sample. However, the cloth thickness values after wash are higher than corresponding control sample. Maximum reduction in thickness is observed among arrowroot sample (17.92%) compared to revive (18.88%) at 1:2 dilution.

Analysis of variance for two sizing materials and two dilutions is presented in Table 48. ANOVA indicated that the influence of sizing materials and dilutions on cloth thickness of sized samples after first wash was found to be highly significant and significant respectively.

4.2.5.3 Effect of hand washing on cloth weight (GSM) of sized samples

GSM is one of the important structural properties that greatly influence the performance properties, especially the drape of the sari. There was reduction in the GSM of starched sample after the first wash, eventually because of partial desizing. Desizing is partial because it is obvious from Table 38 and Fig. 7, the GSM of control sample is at least 10-20 per cent lesser than the washed sample. Moreover, the GSM at 1:1 dilution is about 10 per cent greater than at 1:2 level.

Analysis of variance for two sizing materials, two dilutions and their interaction is presented in Table 49. ANOVA indicated that the sizing materials, dilutions, and their interactions have influenced the cloth weight of sized samples after first wash and were found to be highly significant.

4.2.6 Effect of hand washing on performance properties of sized samples

As already discussed the performance of starched articles is evaluated and expressed interms of stiffness and limpiness. Physically the stiffness of the fabric is assessed through bending length (cm), crease recovery (angle) and drape coefficient (%). The results of performance properties after wash is presented in Table 50 and Fig. 11 .

4.2.6.1 Effect of hand washing on cloth bending length (cm) of sized samples

On washing there is gradual decrease in bending length compared to sized sample but this bending path is greater than its corresponding control values. In general there is not much variation in warpway and weftway bending length of arrowroot and revive samples at 1:1 and 1:2 dilution levels. In fact the warpway bending path of all the treated sample was very closer to their corresponding weftway bending length. However, the bending length was longer at 1:1 dilution to that of 1:2 dilution.

Analysis of variance for two sizing materials, two dilutions, two directions of yarn and their interaction is presented in Table 51. ANOVA indicated that influenced of sizing materials, dilutions, their interactions and yarn directions were found to be highly significant but the interaction of sizing materials and yarn direction was found to be significant.

4.2.6.2 Effect of hand washing on cloth crease recovery (angle) of sized samples

After washing, the cloth crease recovery of the sized sample is decreased, in general, but this recovery angle is greater than its control values. The warpway recovery angle is relatively greater than the weft way recovery irrespective of dilution levels. However, at 1:1 dilution the warp way recovery is 83.2° and 82.3° (arrowroot and revive) and that of 1:2 dilution is 80.5° and 81.6° respectively. The weft way recovery at 1:1 dilution ranged from 80.4° to 81.9° and that of 1:2 dilution ranged from 79° to 81.4°.

Table 47: ANOVA for assessment of cloth count (thread per unit) of sized samples after wash

Source of variable	Degree of freedom	Starched samples		
		MSS	F	SEM
Sizing materials (S)	2	11.317	10.527**	0.231
Dilution (D_1)	1	8.817	8.202**	0.189
S x D_1	1	183.750	170.930**	0.327
Direction (D_2)	2	2.817	2.620	0.189
S x D_2	2	1.950	1.814	0.327
D_1x D_2	1	2.017	1.876	0.327
S x D_1 x D_2	2	8.317	7.736**	0.463
Error	48	1.075	-	-

**** -** Significant at 1% level

Table 48: ANOVA for assessment of cloth thickness (mm) of sized samples after wash

Source of variable	Degree of freedom	Starched samples		
		MSS	F	SEM
Sizing materials (S)	2	0.010	42.392**	0.000
Dilution (D_1)	1	0.001	6.168*	0.000
S x D_1	2	0.001	2.392	0.000
Error	24	0.000	-	-

**** -** Significant at 1% level
- Significant at 5% level

Table 49: ANOVA for assessment of cloth weight (GSM) of sized samples after wash

Source of variable	Degree of freedom	Starched samples		
		MSS	F	SEM
Sizing materials (S)	2	0.000	222.994**	0.527
Dilution (D_1)	1	0.000	97.200**	0.527
S x D_1	2	5.712	25.706**	0.745
Error	18	2.222	-	-

**** -** Significant at 1% level

Table 50: Effect of hand washing on cloth bending length (cm), cloth crease recovery (angle) and cloth drape coefficient (%) of sized samples

Sl. No.	Characteristics	Direction	Control sample	Starched samples							
				Arrowroot (10%)				Revive (10%)			
				Dilution				Dilution			
				1:1		1:2		1:1		1:2	
Performance properties				**Sized**	**Washed**	**Sized**	**Washed**	**Sized**	**Washed**	**Sized**	**Washed**
1	Cloth bending length (cm)	Warp	1.7	4.8 (182.33)	3.9 (129.41)	4.28 (151.76)	3.00 (76.47)	4.8 (182.35)	3.9 (129.41)	4.4 (158.82)	3.57 (110.00)
		Weft	1.4	4.7 (235.71)	3.9 (178.57)	4.18 (198.57)	2.9 (107.47)	4.75 (239.28)	3.8 (171.42)	4.32 (208.57)	3.4 (142.85)
2	Cloth crease recovery (angle)	Warp	80.8 ^{o}	84.4^{0} (04.45)	83.2^{o} (02.97)	81.2^{0} (0.49)	80.5^{o} (00.37)	84.4^{0} (04.45)	82.4 ^{o} (01.87)	83.8^{0} (03.71)	81.6 ^{o} (00.99)
		Weft	78.6 ^{o}	82.2^{0} (04.58)	80.4 ^{o} (02.29)	80.0^{0} (01.82)	79.0 ^{o} (00.50)	83.4^{0} (06.10)	81.9 ^{o} (04.19)	83^{0} (05.59)	81.4 ^{o} (03.81)
3	Cloth drape coefficient (%)	-	37.6	93.7 (149.20)	88 (134.04)	86.0 (131.11)	73.0 (94.14)	93.9 (149.73)	87.4 (132.44)	88 (135.63)	71.6 (90.42)

Figures in parenthesis indicate percentage

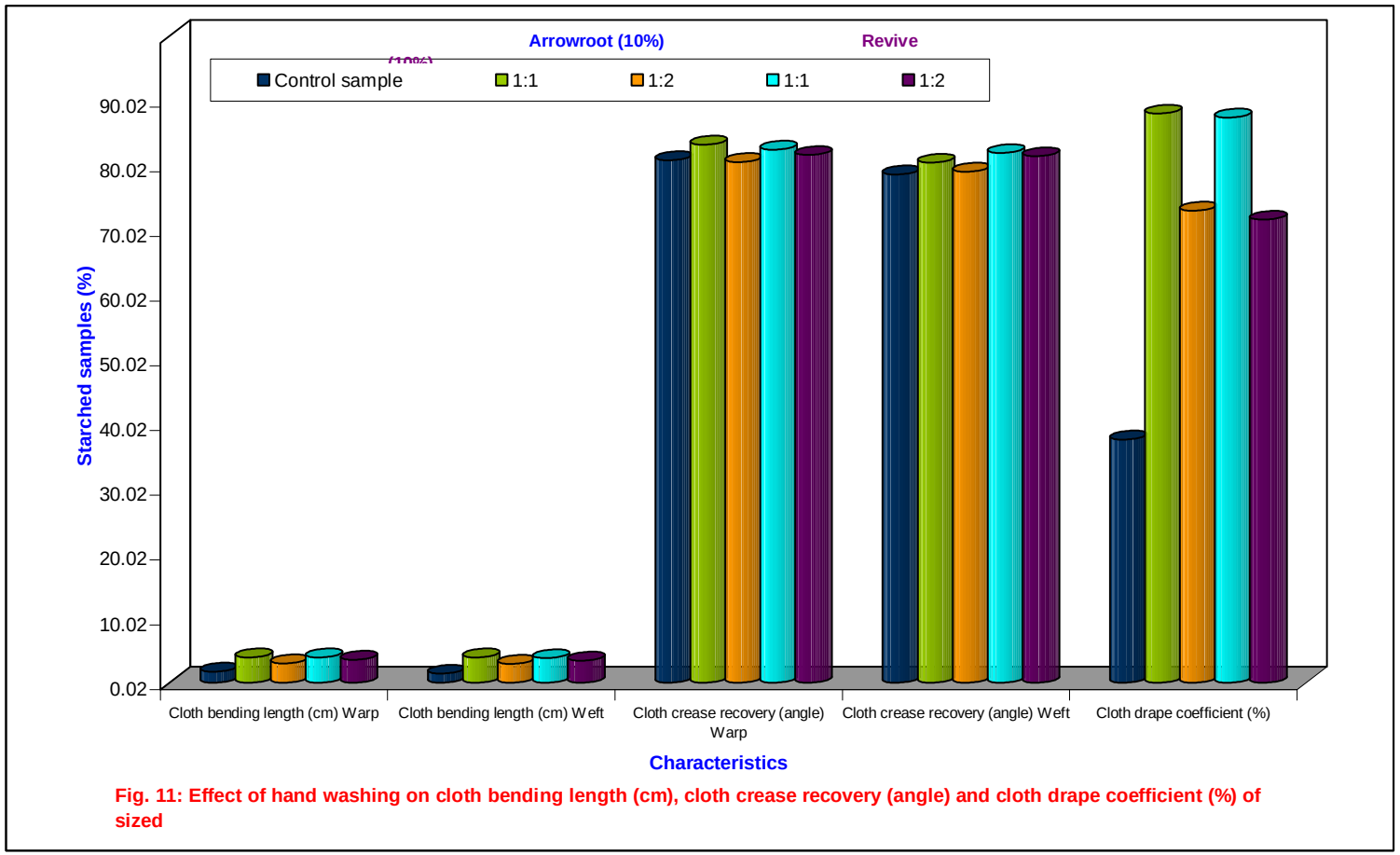


Fig. 11: Effect of hand washing on cloth bending length (cm), cloth crease recovery (angle) and cloth drape coefficient (%) of sized

Fig. 11: Effect of hand washing on cloth bending length (cm), cloth crease recovery (angle) and cloth drape coefficient (%) of sized materials

Table 51: ANOVA for assessment of cloth bending (cm) on after wash

Source of variable	Degree of freedom	Starched samples		
		MSS	F	SEM
Sizing materials (S)	2	21.638	1.212**	0.033
Dilution (D_1)	1	2.297	128.696**	0.027
S x D_1	1	0.285	15.981**	0.047
Direction (D_2)	2	0.891	49.903**	0.027
S x D_2	2	0.071	4.004*	0.047
D_1x D_2	1	0.010	0.572	0.047
S x D_1 x D_2	2	0.003	0.152	0.067
Error	36	0.018	-	-

**** -** Significant at 1% level
- Significant at 5% level

Table 52: ANOVA for assessment of cloth crease recovery (angle) on after wash

Source of variable	Degree of freedom	Starched samples		
		MSS	F	SEM
Sizing materials (S)	2	22.650	15.802**	0.267
Dilution (D_1)	1	10.417	7.267**	0.218
S x D_1	1	46.817	32.663	0.378
Direction (D_2)	2	2.917	2.035*	0.218
S x D_2	2	3.517	2.453	0.378
D_1x D_2	1	0.817	0.570	0.378
S x D_1 x D_2	1	0.317	0.221	0.535
Error	48	1.433	-	-

**** -** Significant at 1% level
*** -** Significant at 5% level

Analysis of variance for two sizing materials, two dilutions and two directions of yarn is presented in Table 52. ANOVA indicated that the sizing materials and dilutions have influenced the cloth crease recovery of sized samples after first wash and were found to be highly significant. But the influence of yarn direction is found to be significant.

4.2.6.3 Effect of hand washing on cloth drape coefficient (%) of sized samples

The total impact of cloth thickness, GSM, bending length and crease recovery of the fabric is depicted in its drape quality. It is learnt from Table 50 and Fig. 11 that the sized sample on washing lead to modification in these properties, that inturn has influenced the drapeability. There is reduction in the drape coefficient value of the test sample on washing. The drape coefficient at 1:1 level of dilution was greater (88.00 and 87.00%) for arrowroot and revive respectively, in contrast to 1:2 level (73.00 and 71.60%).

4.2.7 Effect of hand washing on durable properties of sized samples

As already discussed the durability of the fabric in the present study is evaluated on the assessment of abrasion resistance and tensile properties and impact of washing on these two characteristics is presented in Table 53 and Fig. 12.

4.2.7.1 Effect of hand washing on cloth abrasion resistance (cycles) of sized samples

The abrasion resistance of the fabric increased on sizing but was reduced on washing it. However, the abrasion resistance at 1:1 level is higher than 1:2 level and arrowroot showed better resistance at both levels of dilutions compared to revive sample. The decreasing order of abrasion resistance is 55.71 and 39.28 per cent (1:1 and 1:2 arrowroot), 30.71 and 25.71 per cent (1:1 and 1:2 revive). Though there is reduction in the abrasion resistance, the washed sample exhibited better resistance to that of control (Table 53 and Fig. 12).

4.2.7.2 Effect of hand washing on cloth tensile strength (g) and elongation (%) of sized samples

The tensile strength of the fabric reduced on washing when compared to unwashed (starched) sample. The reduction in tensile strength was relatively low in warpway compared to weftway for arrowroot and revive samples at 1:1 and 1:2 dilutions. In other words the tensile strength of wash sample was higher when compared to control. The decrease in warpway tensile strength at 1:1 dilution for arrowroot and revive is 51.49 per cent and 69.72 per cent and that of 1:2 dilution is 29.81 per cent 49.08 per cent respectively; and that of weftway tensile strength is 47.75 and 64.00 per cent for arrowroot and revive respectively at 1:1 level and that of 1:2 dilution is 36.54 per cent and 28.85 per cent. From these results it is clear that there did not exist a regular trend of decrease in the tensile strength of the test samples.

It is further noticed that percentage of elongation was inversely proportional to the corresponding tensile strength of the test sample on washing *i.e.* a trend of increase in elongation (%) was observed on washing, which was relatively higher than the elongation at break of sized sample. However, much variation in elongation was not observed between the corresponding warpway and weftway samples.

4.2.8 Effect of hand washing on comfort properties of sized samples

Aeration provides physical comfort to the wearer and porosity of the fabric is directly proportional to its air filtration. Greater the number of pores in a unit area, higher the volume of air passed through per second per square centimeter of fabric at a known water pressure. Starching either completely or partially blocks the fabric pores, which again depends on the dilution levels.

4.2.8.1 Effect of hand washing on cloth air permeability ($m^3/cm^2/min$) of sized samples

From Table 53 and Fig. 12 it is evident that the cloth air permeability is increased on washing due to washing off of the starch. The air permeability at 1:1 dilution for arrowroot and revive (15.64 and 14.73%, respectively) is relatively lower than at 1:2 dilution (14.58 and 12.32%, respectively), which clearly indicates that at 1:2 level of dilution the permeability is higher than at 1:1 dilution.

Table 53: Effect of hand washing on cloth abrasion resistance (cycles), cloth tensile strength (g) elongation (%) and cloth air permeability (m^3/cm^2/min of sized samples

Sl. No.	Characteristics	Direction	Control sample	Starched samples							
				Arrowroot (10%)				Revive (10%)			
				Dilution				Dilution			
				1:1		1:2		1:1		1:2	
Durable properties				**Sized**	**Washed**	**Sized**	**Washed**	**Sized**	**Washed**	**Sized**	**Washed**
1	Cloth abrasion resistance (cycles)		140	260 (85.71)	218 (55.71)	203 (40.00)	195 (39.28)	243 (73.57)	183 (30.71)	193 (37.85)	176 (25.71)
2	Tensile strength a) Breaking load (N)	Warp	87.2	153.6 (76.14)	132.1 (51.49)	138.00 (58.25)	113.2 (29.81)	154.0 (76.60)	148.0 (69.72)	135.9 (55.84)	130.1 (49.08)
		Weft	80	144.0 (79.55)	118.2 (47.75)	121.7 (52.12)	115.5 (44.38)	143.6 (78.75)	131.2 (64.00)	118.0 (47.50)	106.2 (32.75)
	b) Elongation (%)	Warp	5.2	6.40 (23.07)	8.5 (63.46)	6.90 (32.69)	7.1 (36.54)	6.60 (26.92)	6.7 (28.85)	6.10 (17.30)	5.3 (01.92)
		Weft	4.5	5.70 (48.87)	8.4 (86.67)	5.40 (66.67)	7.5 (66.67)	5.50 (17.78)	6.2 (37.78)	5.30 (31.11)	6.1 (35.56)
Comfort properties											
3	Cloth air permeability (m^3/cm^2/min)	-	554.1	399.6 (27.88)	467.40 (15.64)	434.0 (21.67)	473.3 (14.58)	416.40 (24.85)	472.5 (14.73)	458.80 (17.20)	485.8 (12.32)

Figures in parenthesis indicate percentage

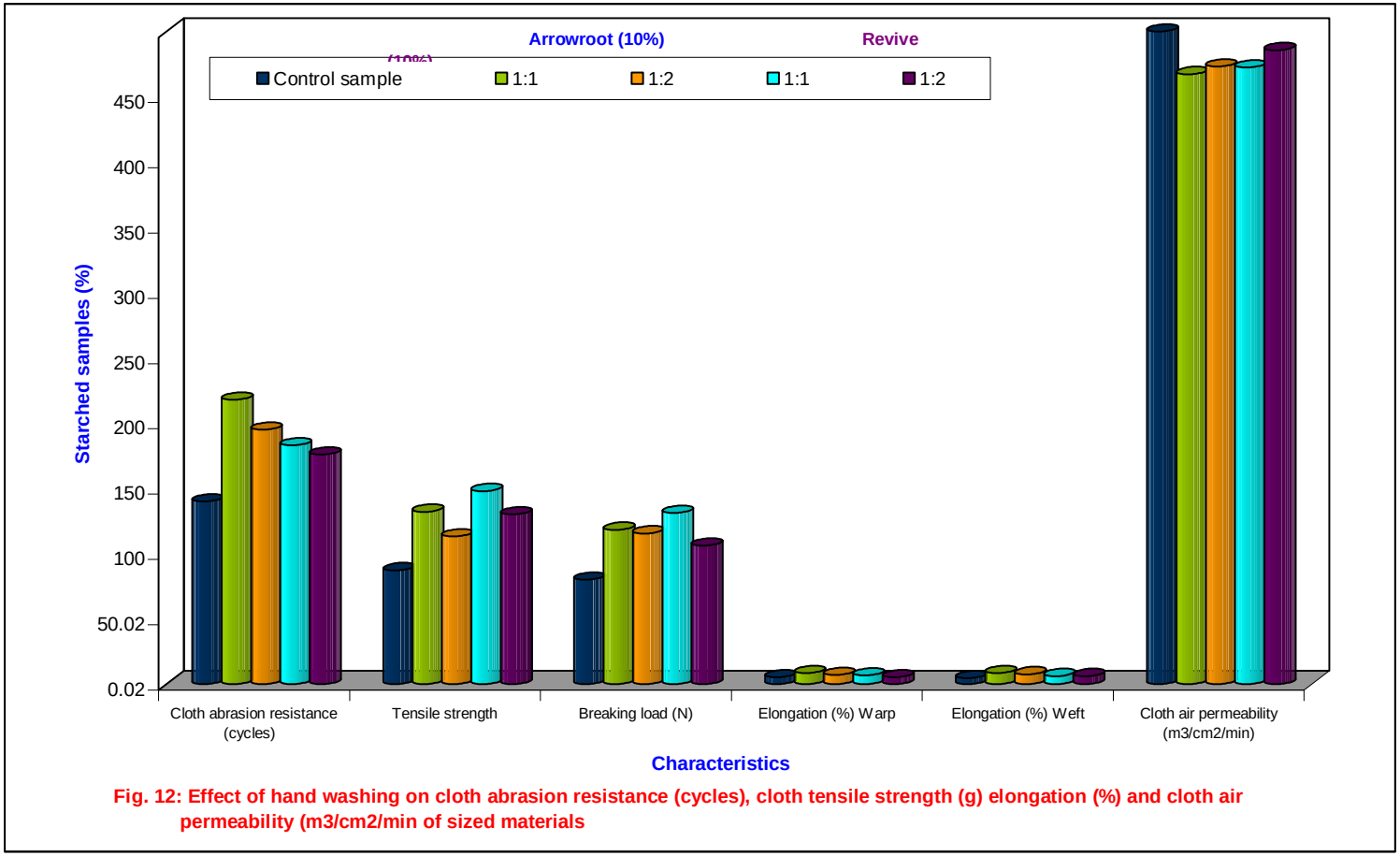


Fig. 12: Effect of hand washing on cloth abrasion resistance (cycles), cloth tensile strength (g) elongation (%) and cloth air permeability (m3/cm2/min of sized materials

Fig. 12: Effect of hand washing on cloth abrasion resistance (cycles), cloth tensile strength (g) elongation (%) and cloth air permeability (m3/cm2/min of sized materials

4.2.9 Effect of sizing on aesthetic appearance (2D effects) of sized samples

The sized samples were evaluated for chromatic and geometric appearance by the textile experts in the study department and the results are presented in the Table 54 and Fig. 13.

Chroma is basically a sociological factor influences not only social but psychological impression of an individual. White is colour, the perception which is evoked by light that stimulates all three types of colour sensitive cone cells in the human eye. The test sample in the present study is white in colour, however on starching there would be change in its sample due to coating of starch solution on fabric surface and this change is evaluated by the experts and rated as 2 (increase), 1 (no change) and 0 (decrease) in the attributes i.e., white colour.

From the Table 54 and Fig. 13 it is found that more than 50.00 per cent expressed that there was 'increase' in the colour (hue) when starched with arrowroot and 'no change' in colour when starched with revive. Less than 25.00 per cent indicated that there was decrease in the colour on starching compared to control sample.

Similarly there was increase in 'value' as expressed by the respondents when starched with arrowroot at both 1:1 and 1:2 as well 1:1 dilutions of revive. 'Value' is the relative lightness or darkness of a colour. "Value' suggests mass and contour of a contignous surface. Coating of sizing gel on fabric surface enhanced the lightness (value) at 1:1 dilution of both natural (arrowroot) and modified (revive) starch as indicated by the experts. However, 20-30 per cent of the respondents opined that the value reduced when starched with arrowroot but remained unchanged when revive is used.

Saturation is the brightness of a colour or the face of a colour or degree of departure from gray with respect to all colours. It is observed from Table 54 and Fig. 13, that more than 50 per cent of the experts stated that there was a degree of departure from gray at 1:1 and 1:2 level of dilutions when starched with arrowroot as well as revive. However, 20.00 per cent and 30.00 per cent of the experts felt that there was decrease in the saturation *i.e.,* brightness when starched with arrowroot and revive, respectively. On the other hand around 10.00 per cent of them expressed 'no change' in saturation on sizing.

Stiffening cotton fabric leads to modification of the fabric geometry and this geometry in the present study is assessed by visual observation. The textile experts evaluated the geometrical attributes of sized test samples and expressed deviation is lustre (glossy), haze (cloudy appearance) and directionality (warp and weftways). The results presented in Table 54 and Fig. 13 revealed that there was much change (rating 2) in lustre, haziness and directionality of the test samples at 1:1 dilution level compared to 1:2, irrespective of starching materials, as expressed by more than 60.00 per cent of the respondents. Mean while about 40-60 per cent of the textile experts indicated that there was 'no change' in these three attributes at 1:2 dilution, irrespective of the sizing materials. A meager per cent of the experts (10-20%) opined that there was decrease in the luster, haziness and directionality of the sized samples, ignoring the sizing agents.

4.2.10 Effect of sizing on the tactile properties (3D effects) of test samples

As already expressed consumers selected the cloth or clothes firstly by visual appearance, followed by tactile properties, which means by touching (hand) and feeling the fabric for various textural properties. Textural characteristics are as important as aesthetic appearance because the garment/fabric that is purchased need to provide proper physical comfort and level of this 'comfort' differs with age, gender, occupation, physic, BMR, psychology and physiology of an individual. The hand and feel of the gray fabric can be modified either temporarily or permanently by giving mechanical or chemical or combined finishes. Among several mechanical yet temporary finishes, stiffening is one of them, applied to cotton especially to improve the hand and feel and provide satisfactory physical comfort.

Table 54: Effect of sizing on aesthetic appearance (2D effects) of test samples

Sl. No.	Attributes	Dilution	Arrowroot 10%			Revive 10%		
			Rating			Rating		
			2	1	0	2	1	0
Chromatic attributes								
1	Colour (hue)	1:1	06 (60.00)	03 (30.00)	01 (10.00)	03 (30.00)	05 (50.00)	02 (20.00)
		1:2	05 (50.00)	03 (30.00)	0.2 (20.00)	03 (30.00)	05 (50.00)	02 (20.00)
2	Lightness (value)	1:1	05 (50.00)	03 (30.00)	02 (20.00)	06 (60.00)	01 (10.00)	03 (30.00)
		1:2	06 (60.00)	02 (20.00)	02 (20.00)	03 (30.00)	05 (50.00)	02 (20.00)
3	Saturation (degrees of departure from gray)	1:1	05 (50.00)	03 (30.00)	02 (20.00)	06 (60.00)	03 (30.00)	01 (10.00)
		1:2	07 (70.00)	02 (20.00)	01 (10.00)	05 (50.00)	03 (30.00)	01 (10.00)
Geometric attributes								
4	Lustre (glossy)	1:1	06 (60.00)	03 (30.00)	01 (10.00)	08 (80.00)	02 (20.00)	-
		1:2	03 (30.00)	05 (50.00)	02 (20.00)	03 (30.00)	06 (60.00)	01 (10.00)
5	Haze (cloudy appearance)	1:1	08 (80.00)	02 (20.00)	-	07 (70.00)	02 (20.00)	01 (10.00)
		1:2	04 (40.00)	06 (60.00)	-	06 (60.00)	04 (40.00)	-
6	Directionality (warp and weft ways)	1:1	02 (20.00)	04 (40.00)	04 (40.00)	07 (70.00)	03 (30.00)	-
		1:2	04 (40.00)	06 (60.00)		07 (70.00)	03 (30.00)	-

Figures in parenthesis indicate percentage 2 – Increase in the attribute 1 – No change in the attribute 0 – Decrease in the attribute

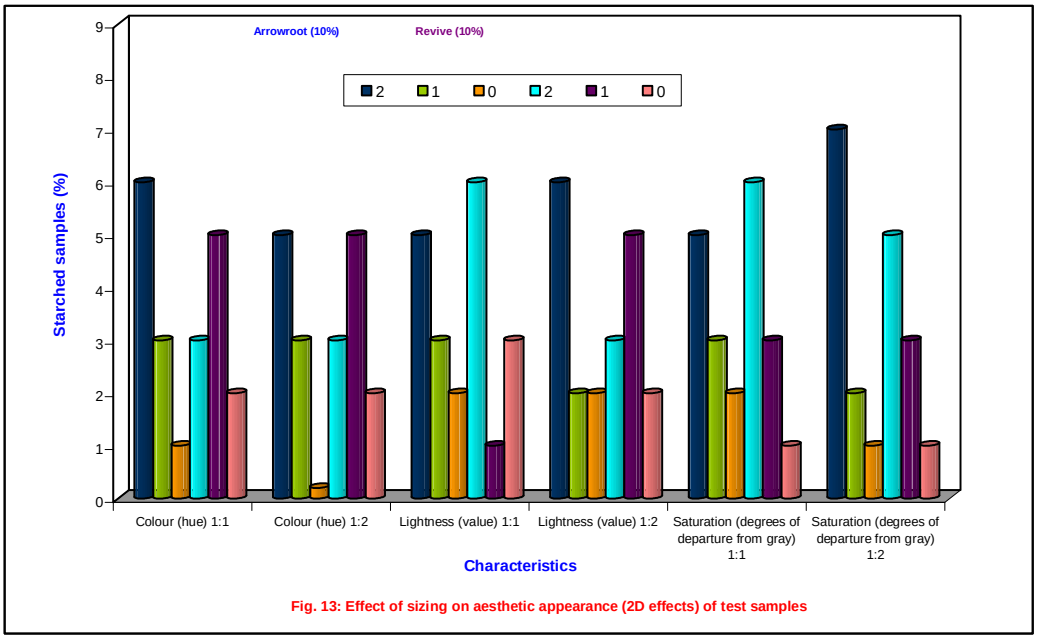


Fig. 13: Effect of sizing on aesthetic appearance (2D effects) of test samples

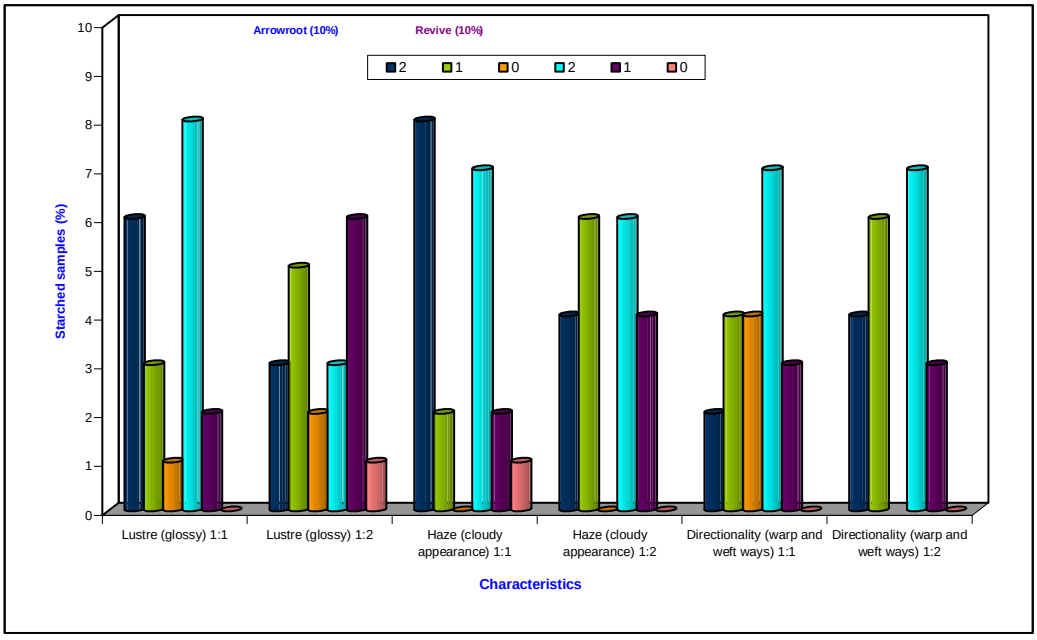


Fig. 13: Effect of sizing on aesthetic appearance (2D effects) of test samples

Table 55: Effect of sizing on the tactile properties (3D effects) of test sample

n=10

Sl. No.	Attributes		Dilution	Arrowroot 10%	Revive 10%
1	Evenness	Smooth	1:1	-	02 (20.00)
			1:2	05 (50.00)	02 (20.00)
		Rough	1:1	10 (100.00)	08 (80.00)
			1:2	05 (50.00)	08 (80.00)
2	Gentleness	Hard	1:1	08 (80.00)	10 (100.00)
			1:2	05 (50.00)	06 (60.00)
		Soft	1:1	02 (20.00)	-
			1:2	05 (50.00)	04 (40.00)
3	firmness	Crisp	1:1	10 (100.00)	100 (100.00)
			1:2	08 (80.00)	60 (60.00)
		Slippery	1:1	-	
			1:2	02 (20.00)	01 (10.00)

Figures in parenthesis indicate percentage
Multiple responses possible

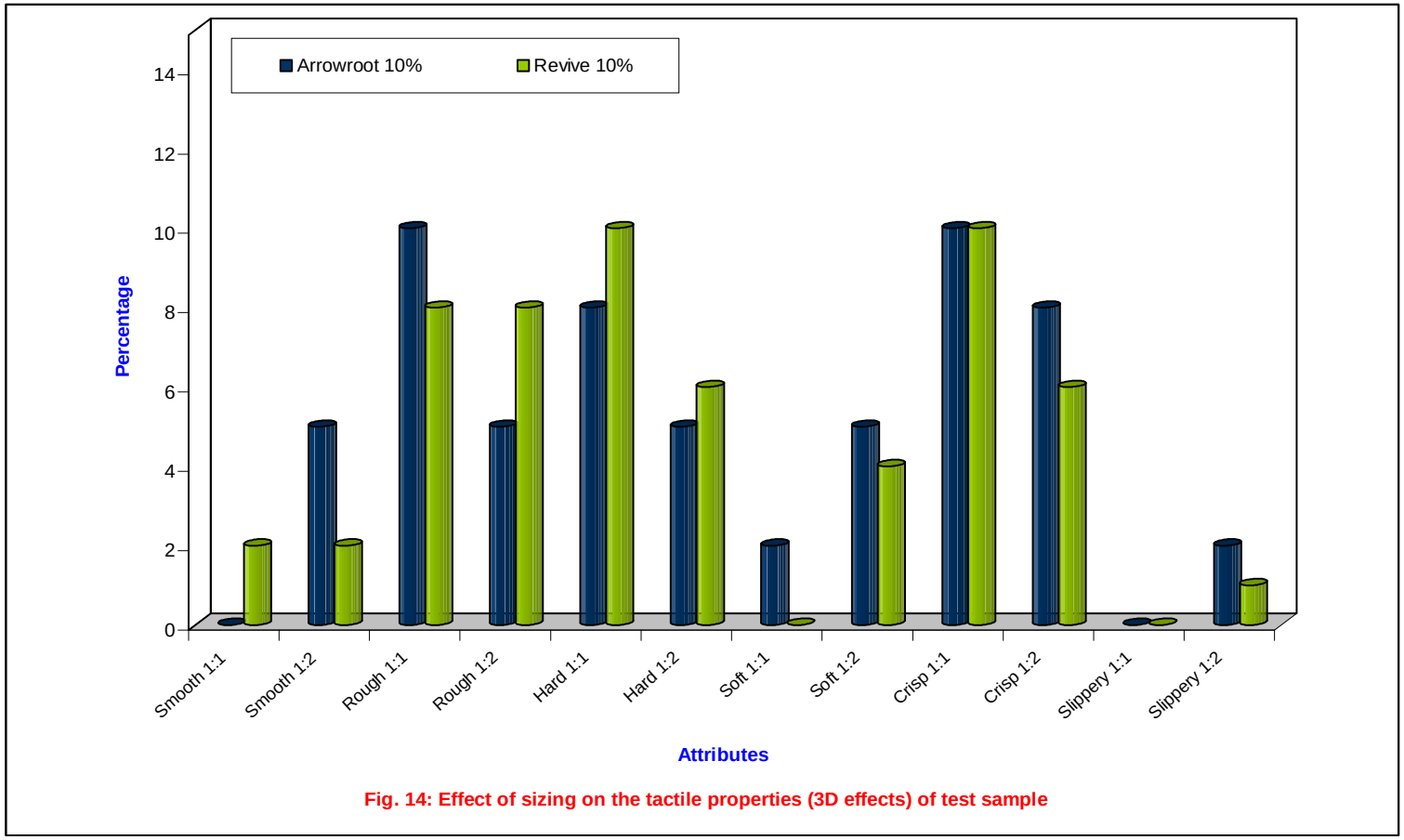


Fig. 14: Effect of sizing on the tactile properties (3D effects) of test sample

Fig. 14: Effect of sizing on the tactile properties (3D effects) of test sample

Table 55 and Fig. 14 reveals about the effect of sizing and tactile properties (3D effects) of test samples. The fabric was evaluated by textile experts for various attributes *viz.,* smoothness, roughness, hardness, softness, crispiness and slipperiness. The results revealed that at 1:1 dilution level the test samples were neither smooth (arrowroot) nor soft (revive) and non slippery (arrowroot and revive). In other words greater per cent of the experts opined that the sample stiff with arrowroot was rough and crisp (each 100.00%) and hard (80.00%) and that of revive was hard and crisp (each 100.00%) and rough (80.00%) at 1:1 level of dilution, whereas the smoothness, roughness, hardness, softness was reduced to 50 per cent with arrowroot starch at 1:2 dilution and that of revive was expressed smoothness (20.00%), hardness (60.00%), softness (40.00%) and crispness (60.00%). In other words the samples were found to be rough, hard and crisp when sized with concentrated rather starch of high viscosity.

4.2.11 Effect of sizing on the visual appearance of black cotton sample

All cotton articles irrespective of colour, dimension and GSM are starched either at domestic level or in commercial units. This is a long running practice prevailing everywhere since ages. However, some common problems arise while sizing dark coloured dyed cottons. The starch granules being white in colour, invariably appear on the fabric and the uneven spread results into patchy appearance. These blotches are more obvious on dark colour cotton than white or light colours. Hence, an effort was made to evaluate the effect of sizing on visual appearance of black cotton fabric. The textile expert evaluated the black cotton fabric sized separately with each 10 per cent of arrowroot and revive and revealed about change in the colour, lustre, patchy effect as well stiffness at 1:1 and 1:2 dilution levels.

Table 56 and Fig. 15 reveals about the effect of sizing on the visual appearance of black cotton fabric. The black cotton sample exactly same as white sample in all parameters except in hue was compared with the corresponding while test sample starched with arrowroot and revive at 1:1 and 1:2 dilution. It is found that there was no change in colour (each 50.00%) when starched with arrowroot and revive at 1:1 dilution as well as 1:2 level (each 60.00%). About 30-40 per cent opined that there was slight decrease in the black colour. Arrowroot did decrease the lustre at 1:1 dilution whereas the lustre increased with revive. Moreover, the black cotton exhibited better lustre at 1:2 dilution. Mean while the test sample exhibited higher degree of patches when starched with arrowroot but the fabric is safe without patches when revive is used. On the contrary the three attributes *viz.,* colour, lustre and patchy effects (blotches) did not interfere with the cloth stiffness. The level of stiffness of black cotton remained almost same when starched with arrowroot and revive.

Plate 4. Evalation of black colour cotton

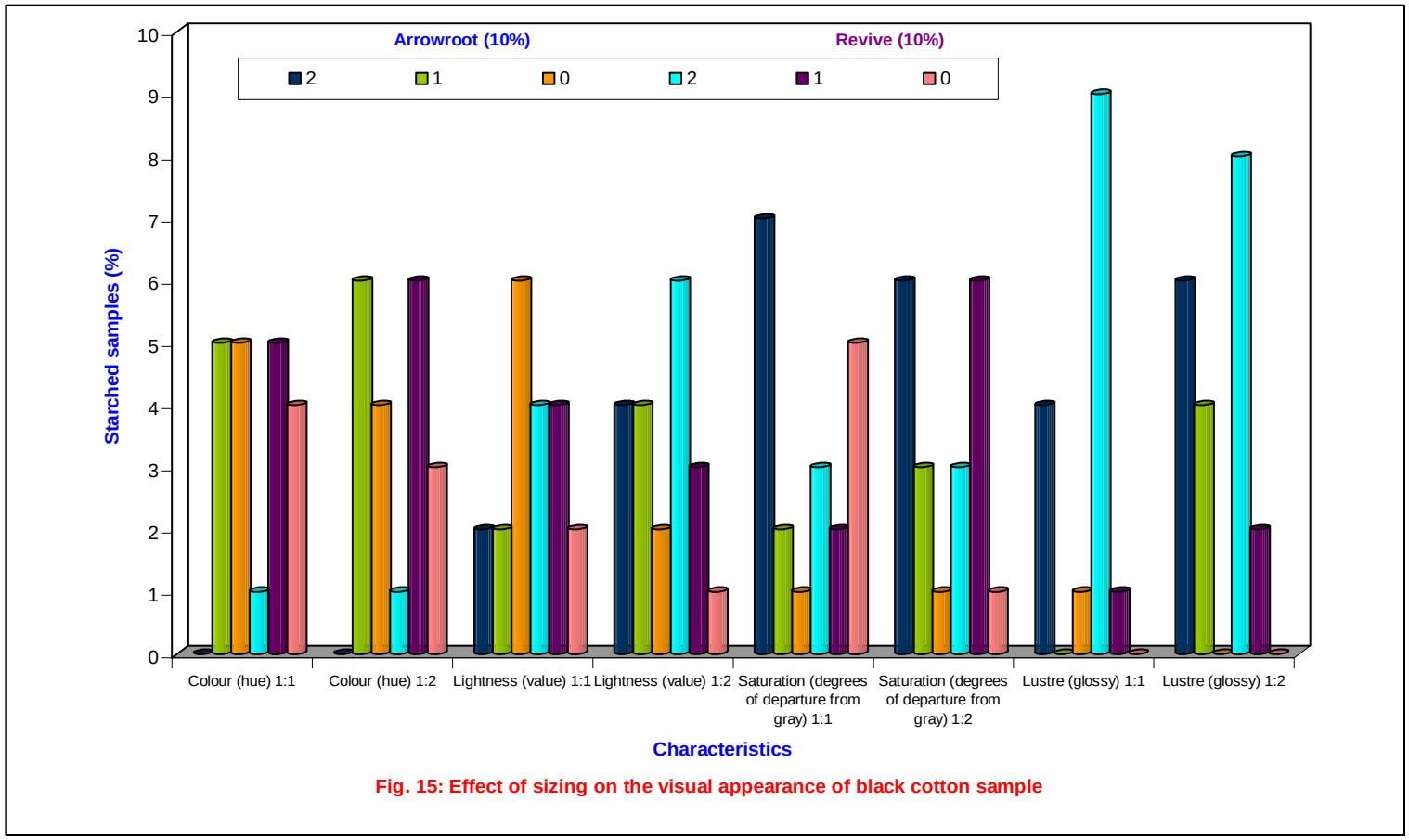


Fig. 15: Effect of sizing on the visual appearance of black cotton sample

Fig. 15: Effect of sizing on the visual appearance of black cotton sample

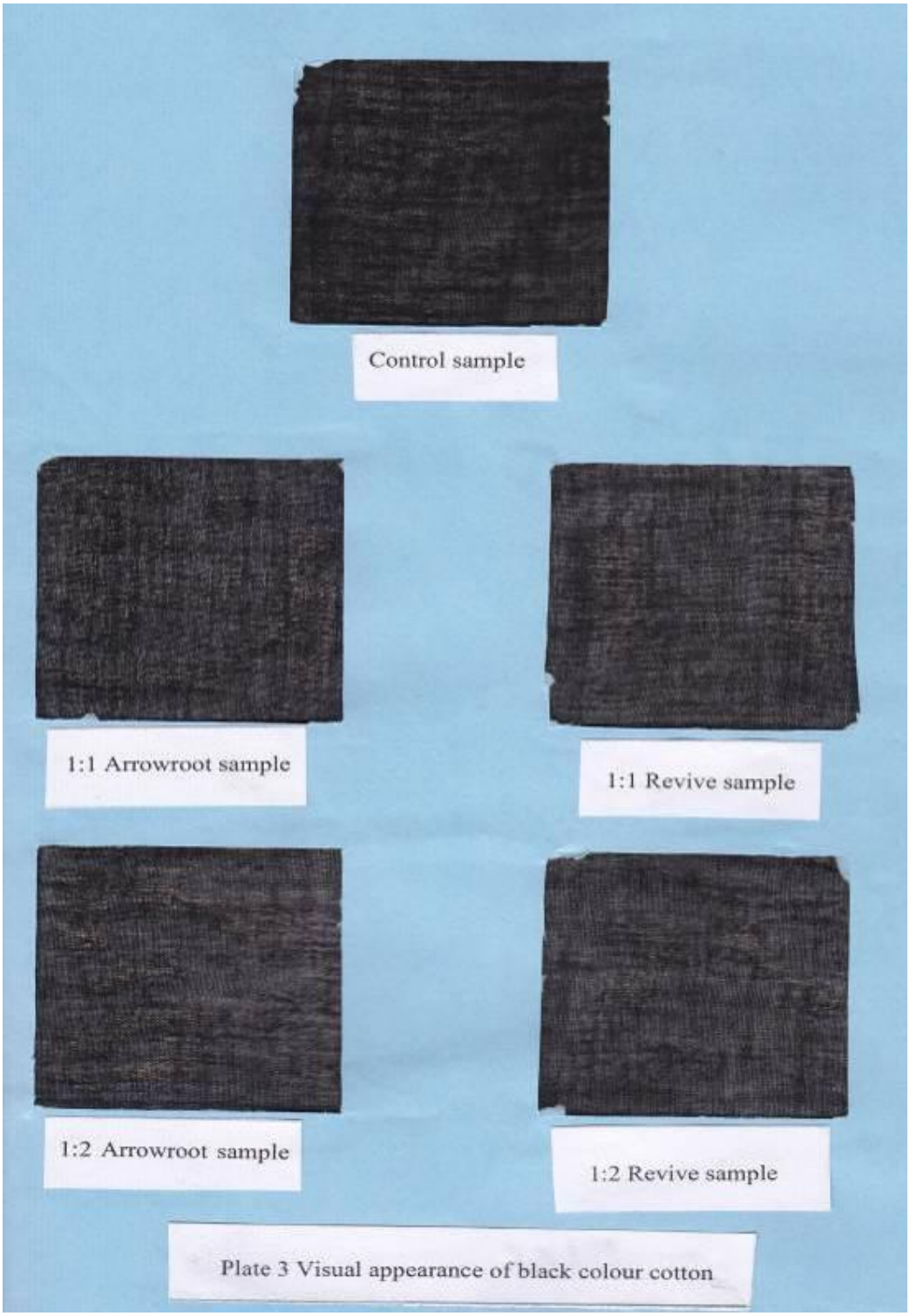


Plate 3. Visual appearance of black colour cotton

5. DISCUSSION

The results of the present study on 'Efficiency of sizing materials on cottons' are discussed in this chapter under the following headings:

5.1 Survey results

5.1.1 Availability of sizing materials in the local market

5.1.1.1 Types of sizing materials available in the local market

It is true that most of the consumers and *dhobis* in the selected locale purchase sizing materials from the local market. The commonly sold starching materials are – arrowroot, maida and sago from natural; revive, vanish and inna, from instant category. Among the natural and ready to use categories arrowroot and revive were most preferred by the respondents. Sago and inna were the least preferred (Table 1).

5.1.1.2 Selection of sizing materials: An opinion of shop owners

This may be because of sago being expensive as well its preparation is a lengthy process and there will be possibility of non gelatinized sago grain sticking on to the fabric, that in turn adversely affects ironing process.

Maida though produces good level of consistency, most of the time evolves patchy effect on all coloured fabrics as indicated by the shop owners. Sometimes it leads to uneven starching too. In fact instant starches are easy, simple, effective in preparation, time and labour saving because of cold process. Therefore, people opted for natural and synthetic sizing materials depending on the efficiency, convenience, comfort and liking. Odour is another factor that influenced choice of sizing material (Table 2 and 3).

5.1.1.3 Factors considered by the consumers while purchasing sizing materials as perceived by shop owners

The quality of sizing material sold in the shops depended entirely on the consumer demand and this demand is ultimately influenced by a couple of factors, prime factor being the 'cost' (Table 4). Sizing is one of the wet processes, completely a manual task that is time consuming and labour intensive. Some of the consumers did prefer natural sizing materials because of low cost. In fact these people are hardly influenced by packing style, advertisement and user friendliness. On the contrary the commercial *dhobis* do use instant starches, where cotton articles are commonly roller pressed. This category of people did consider cold process, brand, advertisement and packing styles along with cost. Nevertheless, both natural and instant sizing materials are user friendly.

Any product promotion is influenced by several personal and external factors. However, any buying depends directly on the purchasing power of the customer and for this the yard stick is 'money'. Therefore, the results eventually indicated that majority of the consumers gave first importance to cost. The other factors considered were brand, advertisement and labels which are equally important since, additional information on starching materials is obtained through media.

5.1.2 Preference for sizing material by the *dhobis*

5.1.2.1 Types of cotton dresses/made-ups commonly starched by *dhobis*

It is evident from Table 5, that all the *dhobis* under take starching of most common cotton dresses *viz.,* kurta, salwar-kameez, sari, shirt and veils. It directly indicates the consumer awareness towards aesthetics of cotton garment. Cotton, when starched do drape well with added essence of elegance.

5.1.2.2 Rationale for selecting starching materials by *dhobis*

There are several types of sizing materials available in the market both natural and instant. It is interesting to learn that almost 2/3rd of the *dhobis* used natural sizing materials may be because of easy availability, relatively in expensive, quality starching, simple to prepare, easy to apply, biodegradability and being traditionally used. However, it is evident from Table 7 that more than fifty per cent of *dhobis* opined instant starches are expensive (56.67%), though some mentioned as time saving (30.00%). Majority of the *dhobis* used natural sizing materials because easy to accessibility (70.00%), quality starch (70.00%), neat finish (56.67%) and easy care (56.67%). Meanwhile, 83.33 per cent of them expressed that natural starching is an elaborate and time consuming process, hence preferred readymade starches.

5.1.2.3 Starching materials selected for white and dyed cotton

Further the *dhobis* indicated that they did use different sizing agents exclusively for white and coloured cottons, which is evident from Table 8. It is noted that greater per cent of the *dhobis* used revive (23.33%) and arrowroot (56.67%) for white cottons, whereas relatively a low per cent used revive (13.33%) and arrowroot (46.67%) for colour rather dyed cottons. This clearly indicates that the *dhobis* might have used instant and natural sizes for dyed cotton and this choice is inverse to the sizes used for white cottons. It is true that, sometimes the sizing agent held physically on to the coloured clothes is predominant. This white smuggy and patchy appearance affects the aesthetics of dyed cottons especially the blacks. Hence, in order to avoid white patches on the dyed fabrics, *dhobis* might have used dilute sizing solution or might have strained the sizing solution before applying on to dark cottons. In fact mergre of the respondents used sago for white (26.67%) and dyed (23.33%) cottons may be because sago preparation is not only lengthy process but special care need to be taken to dissolve the entire granules for effective sizing, failing which the granules stuck on the fabric affect the final finishing *i.e.,* ironing (Table 9).

5.1.2.4 Number of cotton articles starched daily by *dhobis*

From Table 5 it is noted that variety of cotton clothes are starched in commercial units daily, used by both men and women. However, among these, greater number of cotton saris are starched rather than relatively small dresses like kurta, veils, kameez and shirts. It is true that sizing gives body, texture along with improves drape of the cotton articles.

Five and half meters of yardage, essentially needs sizing for graceful drape, failing which the beauty of the cotton sari eventually gets distracted because of its poor resiliency, one of its inherent characteristics of cotton. On the contrary kurta, kameez and veils sometimes are worn without starch by some users. *Dhobis* did mention that about 30 shirts are starched daily that include gents kurtas too (Table 10).

5.1.2.5 Rates quoted by *dhobis* for ironing the starched clothes

It is learnt from Table 11, 12 and 13 that the *dhobis* undertake washing, starching and ironing or starching and ironing or ironing alone as per the order of the consumers. Nevertheless, the price of each process is distinct and gets supplemented when the processes are combined. In fact minimum charges for ironing the starched clothes is Rs.10 specially small articles like kurta, salwar-kameez, shirt and veil, which is acceptable. However, minimum charge for ironing the starched sari is between Rs. 11-20 and usually is above Rs. 15 as indicated by the *dhobis*. The higher range of charges i.e., Rs. 21 to 60 ironing each for sari may be charged because of its delicacy, special handling, intricate surface embellishment, finer quality fabric that needs extra care to be taken while finishing (Table 11).

5.1.2.6 Rates quoted by *dhobis* for starching and ironing cotton clothes

The minimum charges for washing and starching of small size articles like tops, kurta, veil etc is Rs. 20. Generally majority of *dhobis* charged Rs. 21-40 to wash and starch small articles however very meager charged Rs. 41 to 80. When the clothes are fine, delicate, with surface embellishments may be thread work associated with varieties of sequences, mirrors and gold-silver threads need special handling while both starching and ironing, that involves time, skill and expertise. Thus, washing and starching of such clothes are charged with higher prices. Sari being long yardage of cloth need to be starched evenly, effectively and to be ironed absolutely crease free, hence charged Rs. 41-60 as minimum. But the range goes up to Rs. 161-180 with some of the professional and reputed commercial firms, known for the quality work (Table 12).

5.1.2.7 Rates quoted by *dhobis* for washing, starching and ironing cotton clothes

As the *dhobis* involve in complete, processing of washing, starching and sizing indeed a lengthy and labour intensive process, eventually fetch higher wages. In fact, majority of the *dhobis* charge Rs. 21 to 40 for smaller articles, but minimum range of Rs. 41-60 was charged for salwar-kameez and saris. As already discussed, the charges of washing to ironing of starched clothes, vary because of the special care and delicate handling required for finer clothes as well ornamented articles.

5.1.3 Demographic information of working and non working women

5.1.3.1 Demographic information of working and non working women

The variables encompassed under demographics of working and non working were distributed under different age groups, education levels, family sizes, family type and annual income of the families, presented in the Table 14 and 15 respectively. Majority of the women irrespective of the category belonged to old age group of more than 44 years. Irrespecting of the category, all working and non working women were educated which clearly indicates that literacy is cent per cent; but the level of education of working and non working women varied (Table14(b) & Fig 1(b) and 15(b) & Fig 2(b)). The impact of education is seen on family type, where majority belonged to large size joint family system (Table14(d) & Fig 1(d) and 15(d) & Fig 2(d)). The higher income group of non working women families is almost in line with the middle income level of non working women.

5.1.4 Preference for clothing working and non-working women

5.1.4.1 Types of clothes used by working and non working women

It is apparent to know the type of clothes commonly worn by working and non-working women as casual, daily, night and occasional wears.

These working women do wear western clothes at home but the common clothes at work were categorized as casuals, daily and occasional wears were sari, salwar-kameez and kurtas.

This may be because the working group being dwelling in a small city like Hubli and Dharwad, not really westernized but are conformists and live in a traditional and dignified society. On the contrary the non-working women being at home preferred to wear nighty at home to be considered by them as causal and daily wear; because of convenience and comfort. However, sari was used as occasional as well daily wear. It was interesting to learn that bermudas, capri, jeans, leggings, skirt, tights-top and t-shirts were used as domestic wear by relatively less per cent of non-working women (Table 16).

5.1.4.2 Fibre content of the clothes used by working and non working women

It is true that cotton wears are most comfortable compared to synthetics and therefore working women did purchase cotton clothes in greater per cent compared to synthetics. Moreover, silks being occasional wears are expensive as well not only need extra care and maintenance but involves additional expenditure. Thus, working women could afford silks, relatively in greater per cent than non-working. Synthetics produce fancy and glittering effects at low cost as well simple to care and maintain hence, such dresses are relatively popular among non-working group (Table 17).

5.1.4.3 Preference for cotton clothes by working and non working women

It is interesting to learn that both working and non-working women preferred cotton clothes especially as daily and causal wears at work as well at home because of its comfort properties like, breathability, water absorbency, coolness, good conductor of heat; aesthetic properties like, hand, feel, soft texture and elegance appearance (Table 18). Cotton is the universal textile material uses and eco friendly suitable for all age groups either at work or at home.

5.1.4.4 Mode of starching cotton clothes by working and non working

Among the total respondents each 30.00 per cent of working and non-working women starched the clothes at home as well in commercial laundry. Being working, the women might have time constraint and thus, sent clothes to commercial units, indirectly depended on *dhobis*. On the contrary the non-working women probably have ample of time to starch at home. Mean while, it was interesting to know that irrespective of the respondents very meagre per cent of the respondents (working 10.00% and non-working 08.00%) never starched at home but always preferred the commercial mode (Table 19).

5.1.4.5 Rationale to starch cotton clothes at home by working and non working women

From the total respondents majority of the working and non-working women preferred to starch at home than sending the clothes to commercial *dhobis*. Starching at home is advantageous because one can handle the cottons carefully according to its delicacy, select the starch material as per the desire, decide the concentration according to GSM, end use, utility and comfort, further it is economical when carried out at domestic level (Table 20).

5.1.4.6 Rationale to starch cotton clothes at commercial units by working and non working women

The working women are aware about the quality of commercial starching, its efficiency, evenness, quality finishing and timely service. Further women being in service have little time to work on starching. Moreover, washing, starching and drying of cotton clothes need additional space, which was not available, as expressed by non working (Table 21).

5.1.5 Selection of starching materials by working and non working women

5.1.5.1 Types of garments starched at home by working and non working women

It is found that both working and non working women did starch all coloured cottons, irrespective of size, GSM and type. It is evident from Table 22 that women from both categories possessed more of white/light coloured cottons, of size either medium or large, having medium GSM. In fact majority did starch saris and salwar-kameez of medium weight garments. Bermuda, tops/ kurtas and veils are not starched regularly by the entire sample; may be it is not necessary or these garments do not need starching but could be worn without starch.

5.1.5.2 Factors considered while selecting starch material by working and non working women

From Table 23, it is clear that more than 50.00 per cent of the working women preferred revive starching powder may be because of its efficiency, impact, quality performance as well simple to handle. Among the non-working group greater per cent used maida and rice, the natural materials may be because of its abundance easy availability, simple to handle, inexpensive in comparison to other naturals and instant ones. Moreover, the other factors usually considered while selecting any starching materials are previous experience, liking, easy to handle, suggestions from friends and neighbours, appearance, fragrance, colour and so on. It is evident that working women gave importance for brand and labels because they selected ready made starches. Each synthetic starch is being branded neatly packed with informative labels that provides aesthetic information on the composition, recipe, method of application and finishing (Table 24). Mean while majority of non-working women gave importance for cost whereas some to brand and package.

5.1.5.3 Examination of labels and sources of information on purchasing sizing materials

Label is the indicative guide which directs the consumers to use the starch material effectively as per the information printed on the package. These labels are part and parcel of the branded products and the label clearly indicates that working women apart from being brand conscious are also particular about efficiency and cost of the product. Friends, relatives, neighbours and even the shopkeepers did influence the purchasing practice of the respondents to some extent (Table 25 and 26).

5.1.6 Starching and finishing of cotton clothes by working and non working women

5.1.6.1 Frequency of home washing cotton garments at home by working and non working women

Cotton clothes can be titled as “summer friendly garments” because as these garments absorb the sweat readily released from the body, thus keeps the skin cool and fresh. However, these clothes need to be washed frequently to keep them clean and neat. Frequency of washing rather number of wears before the garment is washed depends on length of wear, type of wear, type of work performed, weather conditions, body constitution, BMR, gender and many more. However, some of the garments like legwears, intimate garments, small size, light weight garments are laundered after each wear. In fact, it is evident from Table 27 that about 16-18 per cent of the women washed saris and salwar-kameez after each wear. But majority of them did launder salwar- kameez and saris after two and three wears respectively. This clearly indicates that the respondents laundered as and when the garments were soiled and needed freshness.

5.1.6.2 Method of home laundering of cottons adopted by working and non working women

There are two options when clothes are washed at home – manually or mechanically. It is evident from Table 28 that, majority of non-working women washed cotton clothes irrespective of colour, size, GSM and types, at home that too manually. It is possible to take care of clothes by selecting proper soap, brush and cleanse precisely the soiled areas, when washed manually. Many times manual washing gives self satisfaction of cleansing the articles to a level of expectation. Machine wash, some times may fail to cleanse ‘very soiled’ parts of the garments. Under such circumstances, additional manual brushing may be needed. Further, in manual washing not only each garment is treated individually but each part of the garment is examined and treated separately, which is not possible in machine washing *i.e.,* manual wash is individual care whereas and machine wash is mass care.

5.1.6.3 Cleansing agents used for laundering white and dyed cottons by working and non working women

Selection of cleansing agents depends entirely on personal and performance features. The respondents irrespective of the category used detergents according to the choice, liking, cost, size/shape, retention capacity, fragrance, efficiency, texture, durability, cleansing action, comfort and ease to manage. Of the four commonly used detergents, surf excel and wheel are popular among working and non working groups, respectively (Table 29).

5.1.6.4 Starching process adopted for varieties of cotton clothes by working and non working women

It is already learnt that (Table 23) working women preferred instant sizing materials to that of naturals, which indirectly reveals about preference for cold process, to that of hot, for many reasons like easy processing, simple application, sizing strength as desired, time saving and non clumsy process. On the contrary the non working women in majority preferred natural sizing materials, prepared by hot process for all types of cotton clothes including salwar-kameez and made ups, may be because of higher strength, low cost, easily available and practice adopted since long time (Table 30 and 31).

5.1.6.5 Mode of finishing starched clothes by working and non working women

'Drying of starched clothes' is one of the important features that influences the quality of ironing. Because, the clothes need to be ironed in damp condition if starched by cold process but when starched by hot process need to be pressed when clothes are completely dry. In fact respondents of both the categories dried the starched clothes according to the type of the starch materials selected *i.e.* instant or natural. On the whole irrespective of the category majority of them completely dried the starched clothes, which indicated the finishing method of clothes *i.e.,* domestic ironing (Table 33). However, the working women sent the large and heavy articles to *dhobis* for ironing.

5.1.6.6 Type of iron box employed, frequency of starching and storage of starched clothes by working and non working women

Table 34, 35 and 36 highlighted on type of iron box used for ironing, the frequency and storage of starched clothes. None of the respondents uses charcoal iron box, in fact it has become almost extinct at domestic level, may be because of its antique style, weight, cost of charcoal and cumbersome process. The most simple light weight iron box, easy to work with, is the thermostatic iron box and slightly advanced in steam iron box that are commonly used. Irrespective of iron box, the beauty of the starched clothes depends on the quality of finish. Nevertheless people who used cotton always exclaim as 'cotton need maintenance'. Keeping the maintenance cost in view, cottons are starched once a month or bimonthly or whenever necessary, because rate of frequency of starching varied among the respondents and the factors influenced starching were number of wear length of each wears, amount of soil and strength of starch on the cottons (Table 35). Simultaneously, it is learnt that majority of the women, irrespective of the category did store the starched clothes for a year or so, followed by six months. In fact, the clothes were not intentionally starched and stored but at times it so happened that starched clothes were stored for long duration. Further, non working women were found to be ignorant and not aware about the adverse effect of starch on cottons, when stored for long period.

5.1.6.7 Number of wears of starched cloths before washing

Consumers being aware about money involved in care and maintenance of cottons thus special care is taken by them while using (wearing) the sized clothes. The respondents opined that some of the starched dresses were worn twice, thrice and even more than three times before washing and it entirely depended on the desire and decision of the wearer (Table 37).

5.2 Experimental results

Effect of different sizing materials at 1:1 and 1:2 dilutions on physical parameter of cotton *viz.,* structural, performance, durable and comfort properties of test samples.

5.2.1 Effect of sizing on structural properties

Various structural properties like cloth count (threads per inch), cloth thickness (mm) and cloth weight (GSM) were assessed after sizing the test samples and the values were compared with that of control (Table 38).

5.2.1.1 Effect of sizing on cloth count (threads per unit)

Among the structural properties the most focal features is threads per unit area synonymously referred to cloth count, comprises of ends and pick per inch.

These threads provide basic/foundation structure to the cloth, that ultimately decides the end use of this cloth on the basis of GSM and thickness. In fact cloth count greatly contributed to cloth GSM and thickness. It is noted that consolidation of picks is greater than corresponding ends because the density of pick/inch is lower than ends/inch at control, giving sufficient space for the picks to relax and consolidate on wet treatment. In other words since ends/inch is relatively higher, there is less space for the existing yarns to move closer. It is clear that the percentage increase in cloth count is greater in 1:2 dilution than 1:1, which may be due to higher deposition of sizing material in dilution level within the pores that restricted the yarn relaxation (Table 38).

5.2.1.2 Effect of sizing on cloth thickness (mm)

As far as cloth thickness was considered a remarkable increase in thickness is noticed over control after sizing. The increase in thickness is directly proportional to dilution level i.e., lower the dilution level higher the thickness percentage is, this is mainly therefore of deposition of sizing materials on the substrate surface.

5.2.1.3 Effect of sizing on cloth weight (GSM)

As there is increase in the yarn density as well as cloth thickness on sizing, the GSM of the test sample automatically got elevated. GSM at control increased remarkably after sizing and is mainly due to increase in yarn density and deposition of starching material on the cloth surface.

Hence, the null hypothesis that sizing does not alter the structural properties the fabric is rejected *i.e.* there is change in the threads per unit area, cloth thickness and cloth weight on sizing.

5.2.2 Effect of sizing on performance properties

Cotton fabric encompasses most favourable comfort properties like good absorbency, breathability, good conductor of heat, with soft, supple and pliable texture thus making it more user friendly. However, the only limitation of cotton is its poor resiliency *i.e.,* it tends to wrinkle easily on application of even a slight pressure. This property of cotton invites for an additional yet common finish ‘sizing’ that improves the body, hand feel, texture, GSM and many performance properties.

5.2.2 Effect of sizing on performance properties

In the present study bending length (cm), crease recovery (cycle) and drape coefficient (%) are the three important performance properties taken into consideration to evaluate stiffness of test sample against pliability (Table 42).

5.2.2.1 Effect of sizing on cloth bending length (cm)

On sizing the bending length of the test sample increased, which invariably indicated that the fabric has become stiff. The warpway bending length of the sized sample in general was higher than its corresponding weftway bending path may be because of deposition of sizing material on yarn, which is usually greater within the pores the fabric structure. It is evident from Table 42 that ends per inch is greater than picks per inch and thus the sizing agent is held mechanically in greater per cent in warp direction than weftway. Further, the bending path is longer at 1:1 saturation than 1:2 saturation due to its higher concentration/consistency level. The concentration of sizing material is directly proportional to the mechanical deposition of sizing material on fabric surface that automatically increased the GSM and cloth thickness. The interaction of increase in GSM, cloth thickness and deposition of sizing material lead to increase in cloth stiffness.

5.2.2.2 Effect of sizing on cloth recovery (angle)

Cloth crease recovery is complimentary to cloth bending length *i.e.,* longer the bending path greater the recovery angle and this formula indicates stiffness of the fabric. In other words stiffer the fabric greater the recovery angle. The results indicated in Table 42 are in support to this equation. The warp and weft crease recovery angle at control is relatively lower than at 1:1 and 1:2 dilution levels. Though the recovery angle at 1:2 is lower than 1:1 level, these values are higher than that of control.

The test samples exhibited higher warpway crease recovery when sized with both arrowroot and revive than its corresponding weftway recovery, which indicated that the sample is stiffer in warp direction than weft. These results are supportive to the correspondingvalues of cloth bending length.

5.2.2.3 Effect of sizing on cloth drape co-efficient (%)

Drape quality of a fabric is determined by the interaction of both ends and picks when hung freely on its own weight. Drape of a fabric does generate information on its stiffness and expresses whether the fabric is stiff and hard or soft and limp. From the results presented in Table 42 it is clear that there is not much variation in drape quality of the test samples when sized with either arrowroot or revive.

Hence, the null hypothesis that, the structural properties do not influence the performance parameters of the test sample on sizing is rejected, *i.e.* the structural properties did influence the bending length, crease recovery and drape coefficients of the test samples on sizing.

5.2.3 Effect of sizing on durable properties

The test samples were assessed for durable properties *viz.,* abrasion resistance (cycles), tensile strength (g) and its corresponding elongation on sizing and compared these values with its control (Table 45).

5.2.3.1 Effect of sizing on abrasion resistance (cycles)

Abrasion resistance is one of the fabric properties that determines the level of durability. The unit for expressing cloth abrasion is 'cycles' *i.e.,* higher the number of cycles greater the resistance is. It is evident from Table 45 that, at 1:1 level of dilution, the fabric expressed better abrasion resistance when compared to 1:2 dilution. This is mainly due to the higher concentration rather viscosity of the sizing material at 1:1 dilution, and this formed relatively a thicken layer on the fabric surface, thus giving better resistance to abrasion than 1:2 dilution. The viscous stiffening agent coated the fabric surface, in fact a protective layer for the cotton fabric. The sizing solution when diluted, naturally the viscosity get diluted and on application to fabric, form remarkably a thin layer compared to 1:1 dilution, thus giving resistance to abrasion not as much as that of 1:1 concentration.

5.2.3.2 Effect of sizing on tensile strength (g) and elongation (%)

A cursory look at Table 45 reveals that the warpway tensile strength, in general is higher when sized in 1:1 dilution compared to 1:2. This is mainly due to there is possibility of deposition of greater amount of sizing material on the fabric surface, that bound the adjacent yarns more securely than in dilute form. Apart from giving finer body to the fabric, the sizing material supported the stretchability of the yarns too. In fact the ends per inch is greater than picks per inch thus, the warpway strength is greater than weftway. In a nut shell it may be stated that sizing not only improved the textural and structural properties but also the durability parameters too.

In support to the tensile strength of the sized material, the elongation (%) is also increased. This may be interpreted as when higher load is required to break the sample which in turn resulted in greater per cent elongation compared to control value. It is also proved from the results that greater the tensile strength higher the percentage elongation.

Hence, the null hypothesis that the structural properties do not influence the durable properties of the test sample on sizing is rejected, *i.e.* the structural properties did influence the abrasion resistance, tensile strength and elongation of the test sample on sizing.

5.2.4 Effect of sizing on comfort properties

Air porosity or permeability of the cloth is one of the important contrast properties and effect of sizing on this parameter is assed and compared with its control values.

5.2.4.1 Effect of sizing on cloth air permeability ($m^3/cm^2/min$)

The porosity of a fabric indicates the density of yarns, yarn structure and finish applied. The air permeability of the fabric is reduced on sizing due to closure of fabric pores.

In fact the porosity is reduced due to deposition of the sizing agent on the fabric surface. However, the air permeability is directly proportional to air porosity and air porosity in turn directly proportional to dilution levels as well as size of the sizing particles. The air permeability though in higher at 1:2 dilution level but is relatively more with revive than arrowroot which may be due to larger particles of arrowroot that covered the pores more densely than that of revive. In other words the revive nano particles are much finer than its counter reagent, thus its slimy and gelatinized structure is simpler than arrowroot. However, at 1:1 dilution the air porosity is higher because of the consistency, its level of spreading and deposition on the fabric surface. In fact the layer of starch on cottons protects the fabric from being getting soiled and dusted (Table 45).

Hence, the null hypothesis that the structural properties do not influence the comfort properties of the test sample on sizing is rejected, *i.e.* the structural properties did influence the air permeability of the test sample on sizing.

5.2.5 Effect of hand washing on structural properties of sized samples

The sized samples were hand washed and impact of hand washing on structural properties of sized sample is assessed and evaluated (Table 46)

5.2.5.1 Effect of hand washing on cloth count (threads per unit) of sized samples

It is evident from Table 46 that there is change in structural parameters on washing the sized sample. However, the sized sample was subjected for only one hand washing before assessing and evaluating the physical characteristics.

On washing there is an increase in the threads/unit area which due to further consolidations of yarns. This yarn consolidations was mainly due to desizing of the micro molecules of starching material, mechanically (temporarily) held on the yarn as well in between the yarns.

5.2.5.2 Effect of hand washing on cloth thickness (mm) of sized samples

Similarly washing off of the nano starch particles reduced the cloth thickness, which indicated that the cloth is gradually turning into pliable structure. Greater reduction in cloth thickness (%) is observed with arrowroot sample may be because washing off of much of the starch particles that were held mechanically and temporarily on fabric surface during hand washing, making the fabric soft and pliable.

5.2.5.3 Effect of hand washing on cloth weight (GSM) of sized samples

The reduction in cloth thickness directly indicates the loss in GSM after the wash. There was increase in cloth thickness after sizing mainly which is due to deposition of the sizing material and this deposition is temporary. Much of the starch particles were washed off during washing not only reduced the thickness but also brought down the GSM.

Hence, the null hypothesis that, hand washing does not alter the structural properties of size sample is rejected, *i.e.* hand washing did alter threads per unit area, cloth thickness and cloth weight of the sized sample.

5.2.6 Effect of hand washing on performance properties of sized samples

The performance properties of the washed sample showed change in bending length (cm), crease recovery (angle) and drape coefficient (%) due to partial desizing. There is decrease in the bending path both in warpway and weftway, reduction in the crease recovery angle as well drape coefficient values. This clearly indicates that the superficially deposited starching material was partially removed on washing and that inturn reduced the stiffness of the sized sample. It is true that there was change in the structural characteristics of the test sample on washing, which had direct impact on the performance properties. However, the bending length, crease recovery and drape coefficient of washed sample was higher than its control values, which indicate that the sample has not attained the soft and pliable texture as that of control.

Hence, the null hypothesis that hand washing does not alter the performance of the size sample is rejected, *i.e.* on hand washing there was variation in the performance of cloth bending length, crease recovery and drape coefficients of the sized sample..

5.2.7 Effect of hand washing on durable properties of sized samples

Effect of hand washing on the durable properties of sized samples *viz.,*abrasion resistance and tensile properties is assessed and compared with its corresponding control values (Table 53)

5.2.7.1 Effect of hand washing on cloth abrasion resistance (cycles) of sized samples

The abrasion resistance of sized sample on washing gradually reduced as compared to its resistance when sized. This invariably indicated that resistance to abrasion was mainly due to a the temporary layer formed by the nano starch particles. The release of these particles on washing did reduce the abrasion resistance because the starch layer formed a coating that protected the fabric from wear test. Starching indeed acts as a durable coating but is a temporary one.

5.2.7.2 Effect of hand washing on cloth tensile strength (g) and elongation (%) of sized samples

Washing did affect the tensile strength negatively, which is evident from Table 53, *i.e.,* a trend of decrease in breaking strength in observed on washing. However, warpway breaking strength at 1:1 and 1:2 dilution is relatively encouraging to that of its corresponding weftway strength. Moreover, the breaking strength of revive at both dilutions is higher than arrowroot samples. The main reason for decrease in the tensile strength is the withdrawal of binding support of nano starch particles on washing. Due to release of the sizing particles the yarns became more soft, pliable and free, which could be broken at a lower load. In other words, the fabric acquires temporary strength by the starch particles as long as it is held on the fabric surface.

Hence, the null hypothesis that hand washing does not alter the durability of the sized sample is rejected, *i.e.* on hand washing there was variation in the abrasion resistance, tensile strength and elongation of the sized sample.

5.2.8 Effect of hand washing on comfort properties of sized samples

Effect of hand washing on comfort properties *viz.,* air permeability is assessed and compared with its corresponding control values (Table 53)

5.2.8.1 Effect of hand washing on cloth air permeability (m3/cm2/min) of sized samples

Washing ultimately improved the air permeability of the fabric. The air permeability at 1:2 dilution was better than 1:1 level on washing, since and the consistency and concentration of starch at 1:1 dilution is higher and amount of starch deposition is relatively more than at 1:2 level. It is but natural that the percentage of starch particles in 1:2 dilution is much lower and possibly these particles are released from fabric and moved to liquid media during washing. However, it may be stated that higher the starch concentration, greater the deposition on fabric surface and lower the impact of washing on it release. Further the type of sizing materials did not show much impact on the air permeability at both 1:1 and 1:2 dilutions, after hand wash (Table 53).

Hence, the null hypothesis that, hand washing does not alter the comfort property of the sized sample is rejected, *i.e.* on hand washing there was change in air permeability of the test sample.

5.2.9 Effect of sizing on aesthetic appearance (2D effects) of the cotton fabric of sized samples

On comparing the starched samples with control, the textile experts did observes certain changes in hue (colour), value (brightness) and lustre (brightness). It is but true that when a gel like substance is coated on to a fabric surface, how much transparent ever it may be the fabric appears either brighter or duller and lighter or darker. This is mainly because the coating of gel suspension hides the original appearance of the fabric. In fact size, shape and colour of the starch granules bring variation in the hue, value and saturation of the starched fabric. Further, the gelatinization and viscosity of cold and hot starches do have impact on the chromatic attributes of the sized cloth. In fact, pure starch is a white, coloureless, tasteless and odorless powder which is insoluble in cold water.

But on heating the granules swell and burst, the semi crystalline structure is lost and the molecules leach out forming a net work that holds water and increases the viscosity (Table 54).

Looking in to a comprehensive result on hue, value and saturation, it may be inferred that all the three attributes are inter related and inter dependent, hence the general discussion on chromatic attributes is a product of these three factor. In a nut shell it may be said that there is increase in the saturation at 1:1 and 1:2 dilutions which indicates that the degree of departure of colour and lightness from grey (control samples) is higher because of high viscosity of arrowroot gel compared to that of revive, the instant cold water starch.

Sizing the test sample involved spreading either transparent or translucent gel or stiffening agent on fabric top, which invariably covers the original colour, value, texture, luster and appearance to some extent. However, some of the starching agents though from a layer on the fabric face, do add to the glossyness, in fact a plus point of starching. On observing and evaluating the geometric attributes of the sized sample, the experts expressed that there is increase in the luster as well as cloudyness but decrease in directionality at 1:1 dilution of arrowroot sample. These results indicated that there was cloudy appearance because of deposition of sizing material due to which the ends and picks were not clearly visible compared to revive, wherein there was clarity in the direction of ends and picks. And these results are supported with the rating zero given by the experts for cloudy appearance indicating decrease in the attribute. In a nut shell it may be indicated that though the luster is improved on sizing, the cloudy appearance is obvious when the viscosity is high at 1:1 dilution and this lead to patchy appearance which inturn hidden the directionality of the yarns. But at higher dilution level (1:2), the luster and haziness were relatively low with better visibility of yarn direction.

5.2.10 Effect of sizing on the tactile properties (3D effects) of sized samples

On stiffening, the fabric becomes rough, hard and crisp, however, the strength or level of these attributes vary with the strength of the starch i.e., the viscosity of the starchwhich may be indicated by level of dilution, 1:1 dilution has higher viscosity than 1:2. The results indicated that at higher viscosity level the respective samples were crisp, hard and rough but this level gradually decreased upto 50 per cent on dilution at 1:2 level. Higher the concentration, greater the viscosity, greater the percent of size deposition, is the equation derived from the present study. Arrowroot contain about 23 per cent starch, when extracted in pure form is insoluble in cold water. But on boiling in water, it swells and results into perfect jelly like substance, further diluted in cold water before sizing the sample; whereas revive conveniently dissolved in cold water, whose viscosity though lower is better stable than conventional starches (Table 55).

5.2.11 Effect of sizing on the visual appearance of black cotton sample

In a routine sizing process, consumers do complain about the blotchy appearance on dark coloured cottons especially black, purple, navy blue sometimes red, maroon and other similar shades. In fact tints of any colour could safely be starched without adversely affecting the visual appearance. As already discussed, the strength of the starch solution and its stiffening quality are not only the criteria to select rather choose the sizing agent but its impact on visual appearance also counts a lot. However many time the consumers do compromise with stiffening quality but very particular about aesthetic appearance. From the present study it is inferred that the patchy effect is on higher side with arrowroot than that of revive. This may be because of higher viscosity of the granules resulting on boiling as well as handling of test sample during sizing process. In fact the decrease in colour and luster may be due to percentage of blotches on the fabric surface. However, both the starching solutions were separately strained through fine muslin cloth to avoid the lumps, before stiffening the test sample.

6. SUMMARY AND CONCLUSIONS

The study on 'Efficiency of sizing materials on cottons' was carried out in Hubli – Dharwad Corporation area. The investigation comprised of two parts – survey and experimental procedures. Under survey method three separate self structured questionnaire were prepared and administered to three categories of respondents *viz*., local grocery shop owners (50), *dhobis* (30) and women consumers (each 50 working and non working) to elicit the information on different starching materials locally available, varieties of cotton garments laundered starched by commercial *dhobis* and method of laundering and finishing of cottons adopted by the women respondents, respectively. On the basis of the results, the popular sizing materials sold by the shop owners and used by both *dhobis* and women consumer were chosen for the present study. A fine quality specially handwoven kora muslin cloth material suitable for sari having 70 ends x 60 picks per inch with 34.80 GSM was selected as test sample for sizing.

On the basis of the results of pilot study 10 per cent each arrowroot (hot starch) and revive (cold starch) was prepared and diluted to 1:1 and 1:2 levels. The diluted sizing solution was then strained through fine muslin. The test samples were soaked in each dilution separately, dried at room temperature, ironed flat manually and then assessed for various structural, performance, durable, comfort properties as well as aesthetic appearance of the sized samples. The test samples were subjected to one hand washing to evaluate the impact of hand washing on structural, performance, durable, comfort properties of the sized samples. The result of both survey and experimental study are presented below:

Shopowners opinion/view on promotion of starching materials

- Varieties of natural and instant starching materials were available in the local market. Arrowroot and revive among natural and ready to use respectively were most preferred by the respondents
- Sago and inna were least preferred
- Maida produced patchy effect and predominantly visible on dark colour clothes
- The purchasing practice of sizing material is harnessed by cost
- The commercial *dhobis* used instant starches and the purchasing practice is influenced by brand, advertisement and packing style
- Instant starches were found to be easy, simple, effective, time and labour saving in contrast to natural starches are time consuming and labour intensive
- Informative labels on the package of instant starches acted as a guide for the consumers to know the recipe and method of preparation, application and finish

Opinion of the local *dhobis* on starching cotton clothes

- The local *dhobis* under take sizing of variegated cotton clothes
- Starching is a means of value addition to cotton, that adds sheen, improves fabric geometry as well the drape and aesthetics
- Almost 2/3rd of the *dhobis* used natural sizing material because of easily available, inexpensive, quality as desired, simple and easy to prepare and biodegradable
- *Dhobis* opined that starching with natural agents is elaborate and time consuming
- Greater percent of *dhobis* used revive and arrowroot for white cotton
- The diluted starch was applied to dyed/dark coloured cottons to avoid patchy effect
- Sometimes the *dhobis* strained the starch solution before using on dyed/ dark coloured cottons

Demographics of working and non working women

- Majority of the working and non working women belonged to older age (above 44 years) group

- The entire samples in the present study were literates. However, majority of working women were either graduates or post graduates but non working women had education upto intermediate level
- Irrespective of categories of the respondents greater per cent of them belonged to large family size with more than 5 members
- Majority of non working women belonged to joint family system where as each 50.00 per cent of working women belonged to nuclear and joint families
- More than 50.00 per cent present of the working women belonged to middle income group where as almost 1/3rd of non working women each belonged to low, middle and large income groups

Type of clothes used by working and non-working women

- Majority of working women used western clothes at home but the traditional wears like sari, salwar-kameez and kurta at work. Mean while housewives commonly found in nighties and other traditional dresses at home rather than western outfits
- Majority of the working women possessed cotton garments followed by the synthetics where as the trend is reverse with non-working women. None of the respondents possessed woollen garments
- More than 75.00 percent of the respondents irrespective of the category preferred cotton for sari, salwar – kameez and nighty
- Majority of the working and non-working women preferred to starch cotton clothes at domestic level since it is possible for them to take special care of the clothes, as well select the starch and its strength according to individual choice; on the contrary working women preferred to send to commercial unit because of time constraint, quality starching and finishing

Selection of starching materials by working and non-working women

- Non-working did starch clothes of small, medium and large sizes, all colours of light and medium weight at home, but majority of working women sent large size, light and medium weight, dark colour cotton dresses to commercial units
- The starch materials popularly used by the respondents were revive (instant), arrowroot, sago and maida (natural)
- The important factors considered while selecting starch materials by working women were brand, label and efficiency; whereas non-working women highlighted on cost, brand and style of package
- Instant starch materials always carry labels which provide information on recipe, method of preparation and mode of finishing

Starching and finishing of cotton clothes by working and non-working women

- Cotton clothes need special and extra care and maintenance. After every wash the clothes demand sizing. Therefore, each dress is worn atleast 2-3 times depending on amount of soil, length of wear, amount of sweat released, gender, type of work, locality and season
- Respondents indicated that the cotton clothes are washed and starched as and when necessary
- The respondent preferred detergents to that of soaps
- The factors considered while selecting detergents by the respondents were cost, efficiency, fragnance, texture, durability, brand and personal taste of liking liking
- Working women usually starched the clothes in commercial units where as non-working women at home

- The commercial units/*dhobis* and domestic level starching may adopt either cold or hot or both processes according to the stiffness to be achieved. The clothes need to be ironed in damp and complete dry conditions if starched by cold and hot processes, respectively
- Ironing adds value to dresses by imparting softness, smoothness, sheen and making them crease and wrinkle free. Ironing clothes add value to dresses by flattening the texture
- The use of charcoal iron box has become almost extinct today, and thermostatic irons are most popular at domestic as well as commercial levels
- Starching and maintenance of cotton clothes is an expensive affair. Further, the starched clothes can generally worn 2-3 times before laundering and the number of wears depended on amount of soil and desire of the user

Effect of sizing on structural properties

- There was progressive yarn consolidation on starching, which indicated increase in yarn density in both directions
- There was increase in pick density on sizing compared to that of ends
- The pick density at 1:2 dilution level was higher than at 1:1 level
- In general cloth thickness increased on sizing however, greater percent of thickness was observed with 1:1 dilution level when compared to 1:2 level
- Increase in both yarn density and cloth thickness collectively influenced the GSM of sized sample

Effect of sizing on performance properties

- The warpway bending path was longer than its corresponding weftway path
- The warpway bending path of the sample did not change with change in sizing agents at 1:1 dilution level
- The stiffnessof sample was greater at 1:1 dilution than 1:2 because of higher consistency or concentration of sizing solution, that deposited mechanically on the fabric surface
- There was no change in warpway bending length when sized with 10 per cent each arrowroot and revive at 1:1 dilution level
- In general the warpway crease recovery was greater than the corresponding weftway recovery, indicated greater stiffness in warpway than weftway
- Higher the dilution level lower the recovery angle
- There was greater percent deposition of sizing material on fabric surface at 1:1 dilution
- The test sample was soft, supple and pliable at 1:2 dilution however was relatively stiffer than at control
- Crease recovery angle was directly proportional to its bending length
- There was increase in the drape co-efficient (%) values on sizing compared to control, however it was higher at 1:1 dilution than at 1:2 dilution
- The sizing agents did not bring much change in the drape quality of the fabric

Effect of sizing on durable properties

- The abrasion resistance was better at 1:1 dilution than that of 1:2 compared to control
- At 1:1 dilution the consistency, concentration and viscosity of sizing solution is higher that gave better resistance against abrasion
- The warpway tensile strength (g) was higher than its corresponding weftway strength

- The tensile strength was higher at 1:1 dilution than that of 1:2, this was mainly because of the yarns were bound with viscous solution of starch and held together more securely at 1:1 dilution
- Sizing, in general brought improvement in durability parameter
- A trend of increase in elongation (%) was observed at 1:1 dilution level
- Higher load was needed to break the sized sample, that yielded greater elongation

Effect of sizing on comfort properties

- On starching the air permeability of the fabric was reduced due to closure of pores
- The porosity was reduced when starched at 1:1 dilution than 1:2
- Test samples showed better air permeability when starched with revive than arrowroot
- Test samples were relatively less stiffer when sized with revive than arrowroot

Effect of hand washing on structural properties of sized samples

- Desizing of nano starch particles lead to meager progressive consolidation of yarns especially at 1:2 dilutions
- On washing some percent of sizing material was washed off, due to which the cloth thickness was reduced
- On washing the sized sample gradually became soft and pliable
- Washing invariably lead to desizing because these nano particles have better affinity for liquid (water) than solid (cloth)
- Invariably the cloth thickness of sized sample reduced on washing because of partial desizing
- It is proved that in a single wash, the entire size present in any cotton garment/made ups/ yardage cannot be removed. Some percent of starch still remains within the material
- Reduction in the cloth thickness is directly proportional to GSM. However, on washing the GSM of the treated sample was not as that of control sample
- The percentage of desizing is higher when starched with revive than arrowroot
- Hot process of starching has greater impact on mechanical binding than cold process

Effect of hand washing performance properties of sized samples

- A gradual decrease in bending length was observed on hand washing.
- There was not much variation noticed in waryway and weftway bending length, however the warpway bending length was longer at 1:1 dilution than 1:2
- There was reduction in the crease recovery angle of the test sample on washing
- The warpway recovery is greater than weftway irrespective of sizing materials and dilution levels
- The recovery angle is greater at 1:1 dilution than that of 1:2 level, irrespective of the direction of the sample
- Decrease in recovery angle indicated the soft and pliability of the test sample on washing
- On washing the sizing material is partially removed thus making the fabric relatively soft and resilient
- Drape coefficient gradually reduced on washing the sized sample
- Reduction in drape coefficient value indicated the becoming of softness of the fabric

- Desizing turns the fabric into limpy and resilient texture.

Effect of hand washing on durable properties of sized samples

- The sized sample exhibited reduction in the abrasion resistance on washing
- The starch granules gradually released from the fabric and entered the liquid media, during washing
- Starch formed a protective layer for the fabric, thus indicated better resistance for abrasion
- But this protective layer is temporary and therefore the resistance ultimately decreased on washing
- On washing the tensile strength of the sized sample is reduced
- However, the warpway tensile strength is greater than its corresponding strength weftway
- The tensile strength at 1:1 dilution is better than that of 1:2 dilution, irrespective of yarn directions and sizing materials
- The sizing materials did form a thin film on fabric surface mechanically thus enhanced the tensile strength by encasing the yarns
- The elongation (%) of the test sample was inversely proportional to the corresponding tensile strength
- There was an increase in the elongation percentage of washed sample, which was higher than that of sized sample
- Remarkable variation was not found in the warpway percentage elongation to that of the corresponding weftway elongation
- However, the elongation percentage is greater at 1:1 level of dilution than that of 1:2

Effect of hand washing on comfort properties of sized samples

- On washing the level of air permeability was increased compared to starched condition
- The air permeability was better at 1:2 dilution than that of 1:1
- There was no remarkable variation in the level of air permeability of test samples sized with arrowroot and revive
- The sized samples exhibited better porosity with better air permeability on washing

Effect of hand washing on aesthetic appearance (2D effects) of test samples

Chromatic attributes

- The size, shape and colour of the starch granules brought down the level of hue, value and saturation of the sized samples compared to kora fabric
- The saturation (degree of departure from gray) was higher at 1:1 and 1:2 dilution of arrowroot, basically a hot water starch
- There was an increase in all the three attributes *i.e.,* hue, value and saturation when starched with revive, basically a cold water starch
- Hot water starch was greater viscosity than that of cold starch
- Arrowroot was not much sticky because of lack of gluten
- Chromatic attributes *viz.,* colour (hue), lightness (value) and saturation were inter related and inter dependent
- Higher the saturation lower the level of hue and lightness

Geometric attributes

- There was increase in the glossy appearance of the test sample when sized at 1:1 dilution
- Because of high viscosity at 1:1 dilution the sized samples appeared to be cloudy because of blotches due to uneven deposition of sizing agent on fabric surface
- The direction of warp and weft yarns was covered or hidden due to cloudy appearance at 1:1 dilution
- There was no change in luster, cloudy appearance and visibility of yarn direction at 1:2 dilution because of low viscosity and strength of the starch

Effect of sizing on tactile properties (3D effects) of test samples

- Sizing modified the tactile properties of test sample
- The fabric became rough, hard and crisp on sizing. Lower the dilution level (1:1) greater was the roughness, hardness and crispness
- The fabric became smooth, softer and slippery with increase in the dilution level
- Lower the dilution percentage, higher the viscosity and stiffer the fabric is

Effect of sizing on visual appearance of black cotton sample

- There was slight change in the colour and luster of the black colour cotton sample at 1:1 dilution level
- The change in colour and luster is due to deposition of viscous sizing material (blotches) on black cotton
- There was greater extent of deposition of sizing material at 1:1 dilution than 1:2
- Change in visual appearance was independent of physical stiffening
- Arrowroot yield greater patchy effect than revive because of higher viscosity
- Among the two selected sizing materials revive did not yield remarkable blotches on black cloth, however arrowroot gave better stiffening properties

Implications and recommendations

The present investigation entitled “Efficiency of sizing materials on cottons” has provided information on the various types of sizing materials available in the local market and among those the most readily promoted and adopted by commercial dhobis and common consumers are arrowroot and revive, respectively belonging to natural and ready-made ones. For fine the quality muslin cloth, the most suitable consistency recommended is 10 per cent starch, irrespective of its origin; however the ultimate consumer may agree to either 1:1 or 1:2 dilution levels, according to the amount of stiffness desired. The natural starch is prepared by not process and instant by cold; but the cloth should be completely dried before ironing when natural starch is used and should be damp for instant. The structural, performance, durable and comfort properties are altered by starching. The starched clothes can definitely be worn at least a minimum of three times before washing. The starched clothes protect the cotton clothes from getting and dirty. After one hand wash (by kneading and squeezing) the cloth can be not be desired completely. Though there is alteration in structural, performance, durable and comfort recommended that starched clothes can be reused after one hand washing. It is always recommended to strain the starch solution through fine sieve or cloth to separate the undessolved starch granules, lumps or other kind of impurities; and result into even, smooth and uniform spread of starch. It is better to starch dark colour cottons especially the black with lower per cent of concentration/viscosity/strength to minimize patchy crease recovery and drape; durable properties like abrasion resistance, strength along with elongation; hand, feel, body, texture, luster and aesthetic appearance of the cottons. Consequently, it is suggested to always starch the cottons that add to the elegance of the wearer.

Suggestions for further study

Further studies can be taken up in the areas of

- Impact of sizing on the structural, performance, durable and comfort properties of sized fabric with
  - Blending any tow natural sizing materials
  - Blending any two ready to use sizing materials
  - Blending one each natural and ready-to-use sizing materials
- Impact of sizing on the visual appearance of fabric sized with
  - A combination of two natural sizing materials
  - A combination of two ready-to-use sizing materials
  - A combination of one each natural and ready-to-use sizing materials
- Impact of sizing on the structural, performance, durable and comfort properties and visual appearance of fabric sized with different viscosity/concentration or strength

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Appendix I: Schedule on market survey of shop owners of sizing materials

I. General information

1. Name of the respondent :
2. Name of the shop :
3. Age :
4. Occupation :
5. Year of establishment :
6. Annual turnover :

II. Specific information

1. Mention the sizing materials available in the shop

Sl. No.	Types of sizing materials	Tick (√)
1.	Instant	
a)	Inna	
b)	Revive	
	i) Liquid	
	ii) Powder	
c)	Vanish	
2.	Natural	
a)	Arrowroot	
b)	Maida	
c)	Sago	

2. Name the size materials, which is better preference (conception of the shop owners) Give ranking

Sl. No.	Types of sizing materials	Ranking		
		1	2	3
1.	Instant			
a)	Inna			
b)	Revive			
c)	Vanish			
2.	Natural			
a)	Arrowroot			
b)	Maida			
c)	Sago			

3. Which of the following sizing materials preferred by the dhobis and consumers?

Sl. No.	Types of sizing materials	Tick (√)
1.	Instant	
a)	Inna	
b)	Revive	
c)	Vanish	
2.	Natural	
a)	Arrowroot	
b)	Maida	
c)	Sago	

4. Mention the factors considered by the buyers while purchasing sizing materials

Sl. No.	Factors	Tick (√)
1	Advertisement	
2	Brand	
3	Cost	
4	Efficiency	
5	Labels	
6	Packages	
7	User friendliness	

Appendix II : Questionnaire administered to the dhobis to find out sizing materials commonly chosen for starching cotton articles

I. General information

1. Name of the respondent :
2. Name of the shop :
3. Age :
4. Place :
5. Year of establishment :

II. Specific information

1. Types of cotton dresses/made ups commonly starched

Sl. No.	Types of dresses	Tick(√)
1	Kurta	
2	Salwar kameez	
3	Sari	
4	Shirt	
5	Veils	

2. Which sizing materials do you prefer?

1. Instant
2. Natural

Why? Give reason

Sl. No.	Sizing materials	Tick(√)
I	Instant	
a)	Time saving	
b)	Expensive	
II	Natural	
a)	Easy care	
b)	Time consuming	
c)	Quality starch	
d)	Neat finish	
e)	Easily accessibility	

4. Do you use same starching materials for coloured and white cottons? Yes/No

If no, then why

1.
2.
3.

4. Mention the sizing agents used for white/dyed cottons

Sl. No.	Types of sizing materials	White cotton	Dyed cotton
1.	Instant		
a)	Inna		
b)	Revive		
c)	Vanish		
2.	Natural		
a)	Arrowroot		
b)	Maida		
c)	Sago		

6. Number of clothes articles starched per day

Sl. No.	Types of dresses	Numbers
1	Kurta	
2	Salwar kameez	
3	Sari	
4	Shirt	
5	Veils	

7. Charges for ironing the starched cotton clothes

Sl. No.	Dresses/made ups	Rate(Rs)
1	Kurta	
2	Salwar kameez	
3	Sari	
4	Shirt	
5	Veils	

8. Charges for starching and ironing cotton clothes

Sl. No.	Dresses/made ups	Rate(Rs)
1	Kurta	
2	Salwar kameez	
3	Sari	
4	Shirt	
5	Veils	

9. Charges for washing, starching and ironing cotton clothes

Sl. No	Dresses/made ups	Rate(Rs)
1	Kurta	
2	Salwar kameez	
3	Sari	
4	Shirt	
5	Veils	

Appendix III: Questionnaire to elicit information on preference and selection of starch for household laundering.

I. General information

1. Name of the respondent:
2. Place :
3. Age:
4. Education:
5. Locality :
6. Type of family: Nuclear/Joint
7. Annual income of the family:
8. Family size: 1-4/5-7/more than 7
9. Family composition:

Sl. No.	Name of the family member	Relation with the respondent	Age	Gender	Education	Occupation	Income per month
1							
2							
3							
4							
5							

II. Specific information

A) Types of clothes/dresses in her wardrobe

1. Mention the type of clothes you wear

Sl. No.	Types of clothes	Casual wear	Daily wear	Night wear	Occasional wear
1	Bermuda				
2	Capri				
3	Ghagra-choli				
4	Jean-tops				
5	Leggings				
6	Kurta				
7	Nighty				
8	Salwar kameez				
9	Sari				
10	Skirt				
11	Tights- top				
12	T – shirt				

2. Mention the fibre content of the clothes

Sl. No.	Types of clothes	Cotton	Silk	Wool	Synthetics /fancy	Blend
1	Bermuda					
2	Capri					
3	Ghagra-choli					
4	Jean-tops					
5	Leggings					
6	Kurta					
7	Nighty					
8	Salwar-kameez					
9	Sari					
10	Skirt					
11	Tights- top					
12	T – shirt					

3. Mention the cotton clothes used by you

Sl. No.	Types of clothes	Tick (√)
1	Bermuda	
2	Capri	
3	Ghagra-choli	
4	Jean-tops	
5	Leggings	
6	Kurta	
7	Nighty	
8	Salwar-kameez	
9	Sari	
10	Skirt	
11	Tights- top	
12	T – shirt	

B) Question pertaining to care and maintenance of cotton clothes

4. Do you size the cotton clothes? Yes/No

If yes then, where

Sl. No.	Mode of sizing	Always	Sometimes	Never
1	Domestic level			
2	Commercial laundering			

5. Reasons for starching clothes at home

SL. No.	Reason	Tick (√)
1	Easy care	
2	Time saving	
3	Inexpensive	
4	Type of starch as desired	
5	Amount of starch as desired	
6	Better handling of the garment	
7	Special care	
8	Better durability	
Problems faced with the dhobis		
1	Non availability of good dhobi	
2	High charge	
3	Late service	
4	Poor quality	

6. Reasons for starching at commercial laundering

SL. no.	Reason	Tick (√)
1	Time constraint	
2	Unaware about starching technique	
3	No interest in starching	
4	Space constraint	
5	Easily accessible	
6	Quality starching	
7	Quality finishing	
8	Quick services	

7. Do you starch all types of cottons at home? Yes/No

Sl. No.	Garment details	Tick (√)
Garment colour		
1	White /light cotton clothes	
2	Dark cotton clothes	
Garment size		
1	Small size	
2	Medium size	
3	Large size	

Contd….

Garment weight		
1	Light cotton clothes	
2	Medium cotton clothes	
Types of the garments/made-ups		
1	Bermudas	
2	Salwar – kameez	
3	Sari	
4	Tops	
5	Veils	

8. Which of the following starches do you use for starching cotton garments/saris?

Sl. No.	Sizing materials	White cotton	Dyed cotton
1	Instant		
	a) Inna		
	b) Revive		
	c) Vanish		
2	Natural		
	a) Arrowroot		
	b) Maida		
	c) Rice		
	d) Sago		
	e) Any other		

7. Which factors do you consider while purchasing starch?

Sl. No.	Factors	Tick (√)
1	Brand	
2	Cost	
3	Efficiency	
4	Labels	
5	Package	
6	User friendliness	

8. Do you check for the labels on the sizing agents while purchasing?

Sl. No.	Types of labels	Always	Sometimes	Never
1	Information labels			
2	Care labels			
3	Brand labels			

9. Which is the source of information for purchasing the sizing agents?

Sl. No.	Sources	Tick (√)
1	Experience	
2	Magazine	
3	Newspaper	
4	Television advertisement	
5	Suggestion by friend / neighbor	
6	Suggestion by shopkeeper	

12. Have you discontinued the use of any particular starch? Yes/No
    1.
    2.
    3.

13. Reason for discontinuing
    1.
    2.
    3.

14. Do you try new starches? Yes/No

If yes, why
    1.
    2.
    3.

C) Laundry practices

15. How frequently do you wash cotton garment at home?

Sl. No.	Types of cotton clothes	Frequency of wearing		
		Once	Twice	Thrice
1	Bermuda			
2	Salwar – kameez			
3	Sari			
4	Tops			
5	Veil			

16. Mention the mode of washing cottons at home

Sl. No.	Garment details	Mode of washing		
		Hand	Machine	Both
Garments colour				
1	White /light cotton clothes			
2	Dark cotton clothes			

Contd…

Garments size				
1	Small size			
2	Medium size			
3	Large size			
Garments weight				
1	Light cotton clothes			
2	Medium cotton clothes			
Types of garments/made-ups				
1	Bermudas			
2	Salwar – kameez			
3	Sari			
4	Tops			
5	Veils			

17. Mention the cleansing agents selected for cottons

Sl. No.	**Colour of cotton garments**	**Name of the cleansing agent**
1	White/light cotton clothes	
2	Dark cotton clothes	

18. Which of the sizing methods do you preferred?
    1. Cold process
    2. Hot process
    3. Both

19. Which of the starching agent do you employ for cotton garments?

Sl. No.	Garment details	Cold process	Hot process
Garment colour			
1	White /light cotton clothes		
2	Dark cotton clothes		
Garment size			
1	Small size		
2	Medium size		
3	Large size		
Garment weight			
1	Light cotton clothes		
2	Medium cotton clothes		
Types of the garment/made ups			
1	Bermudas		
2	Salwar – kameez		
3	Sari		
4	Tops		
5	Veils		

20. Mention the mode of drying starched clothes

Sl. No.	Garment details	Method of drying	
		Dry	Damp
Garment colour			
1	White /light cotton clothes		
2	Dark cotton clothes		
Garment size			
1	Small size		
2	Medium size		
3	Large size		
Garment weight			
1	Light cotton clothes		
2	Medium cotton clothes		
Types of the garment/made-ups			
1	Bermudas		
2	Salwar – kameez		
3	Sari		
4	Tops		
5	Veil		

21. Mention the mode of finishing

Sl. No.	Garment details	Mode of finishing (ironing)	
		Home	Dhobi
Garment colour			
1	White /light cotton clothes		
2	Dark cotton clothes		
Garment size			
1	Small size		
2	Medium size		
3	Large size		
Garment weight			
1	Light cotton clothes		
2	Medium cotton clothes		
Types of the garment/made-ups			
1	Bermudas		
2	Salwar – kameez		
3	Sari		
4	Tops		
5	Veils		

22. What type of iron box do you use?

Sl. No.	Type of iron box	Tick(√)
1	Charcoal	
2	Steam iron	
3	Thermostatic iron	

23. How often do you starch the clothes?

Sl. No.	Frequency of starching	Tick(√)
1	Monthly	
2	Bimonthly	
3	Whenever necessary	

24. Do you store the starched clothes?

Yes/No

Sl. No.	Duration of storage	Tick(√)
1	One week	
2	One month	
3	6 month	
4	A year	

25. How many times do you wear the starched clothes before washing?

Sl. No.	Frequency of wearing	Types of starched clothes				
		Kurta	Salwar - kameez	Sari	Tops	Veils
1	Once					
2	Twice					
3	Thrice					
4	More than 3 times					

EFFICIENCY OF SIZING MATERIALS ON COTTONS

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ABSTRACT

The present study entitled “Efficiency of sizing materials on cottons” was carried out in 2010-12 at Dharwad with the objectives, to study the effect of sized and hand washing on physical parameters. The study consisted of survey and experimental procedure. On the basis of the survey results, two sizing materials one each from arrowroot and revive were selected for the present study.

Cotton muslin suitable for sari having 70 ends x 60 picks per inch with 34.80 GSM was selected and starched separately with 10% concentration of each arrowroot and revive with 1:1 and 1:2 dilution levels and were assessed for various physical parameters. Further samples were hand washed to assess its impact on these physical parameters, visual appearance and tactile properties. There was increase in physical parameters when sized with both arrowroot and revive. The stiffness was greater at 1:1 dilution than 1:2 because of higher concentration of sizing solution that deposited mechanically on the fabric surface. The chromatic and geometric attributes improved when sized at 1:1 than 1:2 dilution. But there was no change in luster, cloudy appearance and visibility yarn directionality at 1:2 dilution because of low viscosity and starch strength. The fabric texture became rough, hard and crisp on sizing at 1:1 dilution level than 1:2. Greater patchy effect was observed with arrowroot than revive because of larger starch particles and viscosity.

Improvements in physical parameters attained temporarily on sizing were lost some extent after first hand washing due to gradual softness and pliability imparted on partial desizing. The sized clothes can be used after one wash, a means to ‘cutting cost’ starching the clothes. The fabric expressed better stiffening properties at 1:1 dilution of arrowroot than revive 1:1 dilution and 1:2 dilutions.