II. REVIEW OF LITERATURE
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In this chapter the review of the literature relating to the different aspects of the study 'Extraction and utilization of mango kernel starch and its blends as stiffening agents on cotton fabric' is given in detail. The study has been conducted during the year 2003 – 06.

A research work which was done before, regarding mango kernel starch, had been concentrated mainly on the extraction of starch from mango kernels and on studying its different properties such rheological properties, pasting properties, film forming properties, viscosity so as to make use of mango kernel starch in food industry. Though there were few mentions about use of mango kernel starch in textile industry. No concrete information about the use of mango kernel starch as stiffening agent in textile industry or of its use as starch for stiffening clothes at home is available. There are no evidences of using mango kernel starch on fabric for starching.

Therefore the literature dealt in this study was mainly focused on the different aspects related to stiffening of cotton fabric. The properties of cotton relating to its multitude uses and the drawbacks of cotton fabric that made it necessary to have some sort of stiffness so as to overcome these disadvantages were studied. The literature relating to the most essential properties which are must to use different starches as stiffening agents like starch should be safe for fabric, colour-less, free from odor and easy to apply, required to give a solution with certain viscosity that will penetrate the fabric, will make the fabric stiff but at the same time make fabric pliable and give smooth finish and many others were studied.
The starches from various plants differ in their form, size of granules, and also gelatinisation temperature. Hence there are different methods of extraction and application of starches to the fabric. The techniques suitable for extracting starch from different sources available in nature and the laboratory methods standardized for extraction of common starches were reviewed. Appropriate procedures for the application of different starches for stiffening clothes were also studied.

Wearing of clothes causes stress and friction on its different parts due to body movement while performing various activities. The clothes have to undergo the effect of hot water; detergent, alkali, bleaches and agitation involved the process of washing for restoring the freshness of clothes. These combined effects of wear and wash definitely affect the wearing quality of the fabric and hence the effect of wearing, washing on different types of fabric was studied.

Application of stiffening agents causes changes in physical and textiles properties of the fabric. These changes are mostly desirable but sometimes have adverse effect on the fabric properties. The quotations relating to the changes in physical and textile properties of cotton fabric after application of stiffening agents were noted. The literature pertaining to the different aspects of the topic was reviewed and presented in this chapter under the subheadings given below.

2.1 Cotton Properties

2.2 Starch Properties

2.3 Starch Extraction
2.4 Starch Application on Fabric

2.5 Wear Studies

2.6 Properties of Stiffened Fabric

2.1 Cotton Properties

Cotton is fabric for everyday home and is most widely produced textile fabrics. (Susheela Dhangyagi, 1959)

Cotton is famous for its ideal properties such as fineness, delicacy, ready availability, versatility and simplicity, elegance, cheapness, durability, fashion rightness, ease of care, comfort and economy (Thomson H., 1968)

Cotton is fiber of choice for comfortable warm weather apparel because of its ability to transfer moisture away from the body through absorbency and wicking. Cotton is undisputed number one fiber as it is more tolerant of combined effect of hot water detergents, alkali, bleaches and agitation. (Robert J. Beaulley, 1971)

Cotton fabric is quite strong but has less elasticity than that of silk and wool. It absorbs moisture readily and can withstand high temperature, boiling water and rough handling. It is bad conductor of heat (Stella Soundararajan, 1972)

Cotton has good absorption power. It is relatively inexpensive fabric. It has pleasant, crisp handle. Cotton gives good durability and can withstand hard wear and repeated washing. They are comfortable in wear; the fact cotton absorbs moisture readily. (Ann M. Collier, 1974)

Cotton fabric soils and creases easily but can be washed, stiffened and ironed without injury. Cotton withstands much rough handling. (K.P. Hess
The versatility of cotton permits its use in many textile items that may require it to be subjected to one or more functional finishes (Jules Labarthe 1975).

Cotton has many advantages, strong, durable and serviceable fabrics and sheer, lightweight luxury type fashion may be made from cotton. Cotton absorbs, can be laundered, wet cleaned or dry cleaned and while cotton can be bleached. It dyes and prints readily and combines well with other textile fibers but untreated cotton lacks elasticity. It creases and wrinkles easily. (Dorthy Lyle, 1976)

The early popularity of cotton has continued and it accounts for the major share of textile market. It is major fiber because blends with manufactured fibers, improves some of its less desirable features. Newer finishes have been developed to cut care and thereby increase acceptability. New fabrication methods have made cotton fabric wearable during the whole year and the use of fiber in home furnishing has increased. (Pasty R. Alexander, 1977)

Cotton has very low resiliency. Wrinkling while wearing is a problem. The use of starch will overcome this problem. (N. Hollien, J. Saddler and A. Langfort, 1979)

Cotton fiber is very strong and depending upon the type of fabric into which it is made, very durable. Cotton is easily cared for since it thrives on soap and water washes. Cotton lack resiliency, which results in easily, mused cotton clothing and limp garment. Applying suitable finish to yarn or fabric can cure all these faults. (Mary Cowman and M Jungerman, 1980).

Cotton conducts heat away from the body and allows the cooler
temperature outside to reach the body. So it is a cool material for summer it can be worn all the way around the clock. A single cotton fabric can be used for house dress, summer dress, sport dress, bathing suit and it is particularly adopted of children's dresses. Cotton therefore is appropriate for wearing apparel, home furnishing, industrial uses and military supplies. (Isabel Wingate, 1984)

Cotton is strong and reasonably low in price. The fiber is called dead fiber, because it has little luster, wrinkle resistance and elasticity. However all these qualities can be greatly improved by special fabric construction and finish. (P.V. Vidyasagar, 1996)

Cotton has long been world's major textile fiber. Cotton is washable and durable, holding up well after many launderings. It also absorbs moisture, which makes it feel cool against skin in hot humid weather, for this reason cotton has traditionally been summer fabric. Cotton is very versatile and can be made in both lightweights for summer and heavier weights for winter. Cotton fabrics range from the light and sheer such as voile to heavy and thick like flannel to strong and sturdy like denim. (Gini Stephens and Frings, 1999)

2.2 Starch Properties

A starch is by far most frequently used stiffing agent. A starch is required to give a solution that will penetrate the fabric well, but at the same time leaves fabric pliable and give smooth, glossy finish that will resist dirt, thus making it look better. Dust and dirt cling starch rather than fabric. Starch should be safe for fabric, colour-less free from odor and easy to apply. (Susheela Danthyagi, 1959)
Santosh Malik (1966) conducted comparison of eight selected stiffening agents used on apparel. Starch is well known stiffening agent used in laundry wok for cotton and linen. It is important for a housewife to know the use of different starches to restore the material's natural stiffness, which has been removed in washing process, and to give additional stiffness as it is desired.

According to Fairchild Textile Dictionary (1967) Starches are the trade term for vegetable sizing agents or synthetic agents used on fabrics to give them body, to improve the hands of good.

Rita Chitkara (1968) explained that starch is most common stiffening agent which can add shine and smartness when applies to fabrics, goes deep into the fiber, on drying it gives the fabric a smooth and glossy finish. Thinness or thickness of starch required depends upon the type of fabric and stiffness desired.

The use of starch as a stiffener and adhesive on textiles has been known from time immemorial. It was used as a textile finish in 800 B. C. although it was later forgotten except as a filling material. (Depierre, 1972)

Starch can be added as a stiffening agent to give the fabric crisp, full handle although this effect will not be fast to washing. Starch is pressed into the fabric, which fills the interstices and gives body to the fabric. (Ann M. Collier, 1974)

Finishing to improve aesthetic appearance of fabric is perhaps one of the major goals of the consumer. Sizing contributes stiffness, hand and luster to the fabric. Durable sizing are chemical resins that remain within the fabric, temporary sizing are starch applied to cotton fabric. (Nancy Harries and Thomas Harries, 1974)
Sizing may be vegetable origin such as starch or flour paste or it may be organic like clay, magnesium chloride. (Jules Laborthe 1975)

A temporary stiffness can be obtained by drying into the fabric the substances such as starch. Stiffened fabric is to be understood as being fabric, which has been to added starches to coat the fabric temporarily. Starching helps to bring textiles into presentable attractive condition (A.J. Hall 1975).

Although there have been numerous recent developments in synthetic finishing agents, starch still remains the commonest and most important finishing agent for cotton and mixed fabrics. There are four main uses of starch in textile industry, 1) As a size to strengthen the warp yarns and improve their resistance to abrasion 2) In finishing to change the hand, feel and appearance of the fabric after it processed 3) In textile printing to hold the dyestuff and chemical in specific area and their diffusion 4) To glaze and polish sewing thread. (J. A. Radley, 1976)

Sizing is general term for compound that when added to fabric forms more or less continuous solid film around the yarns and individual fiber. Sizing can be applied to increase strength, smoothness, stiffness or weight. (Dorthy Lyle, 1976)

Starch helps to restore the original body or crispness to fabrics, gives smooth appearance and aids in soil removal (Pasty R. Alexander, 1977)

Starches are sizing that are added during home laundering. They help to restore body to limp fabrics. Starches also help to keep fabric cleaner as dirt tends to slide the smooth finish produced by starching (Phyllis Tortora, 1978).
Starch is a well known stiffening agent used in laundry work for cotton. A certain amount of stiffness in washed clothes gives them smooth, glossy surface, which is resistant to dirt and dust. (Durga Deulkar, 1980)

Like many other finishes which are designed primarily for crease resistance, starching contributes hand, which needs renewing with household starch products. (Mary Cowan 1980).

Starches, gums and glues are among the oldest known textile auxiliaries. They are obtained fairly ready from rather abundant natural resources all over the world. (R. N. Sharma and M.K. Gupta 1981)

Sizing is application of various materials to a fabric to produce stiffness or firmness. Cellulose fabric is sized with starch or resin. Starch gives weight to the fabric and prevents fabric from soiling quickly. (Joseph M.L. 1981)

Starches and gums are used in large quantities in various industrial applications. They are used to provide body and consistency to solutions. P. C. Mehta (1981)

Starches, gums and glues are among the best known textile auxiliaries. They are obtained fairly ready rather abundant from natural sources all over the world. Starch is the basic ingredient in cotton sizing and for viscose staple fibers. Relatively inexpensive, they need humidity control during application and are difficult to remove. (R.N. Sharma and N. K. Gupta, 1981)

A small amount of starch in the consumer's good especially cotton fabric helps to retain freshness while they are on the dealer's shelves. Cotton fabrics that are usually starched are organdy, lawn, voile and buckram. Starch fills in the gaps in the constructed cloth creating an appearance of greater compactness. (Corbman, 1983)
The use of starches in finishing of cotton clothes has been known for a very long time. The main starches used as stiffeners are corn, tapioca and to a lesser extent potato and wheat. Starches are generally applied on the cloth in presence of softeners (A.A. Vaidya and S.S. Trivedi, 1986).

In case of cotton fabric starch, oil waxes are frequently be applied to achieve desirable handle to fabric. In a way, as compound are applied to the textile material to achieve softer handle, a compound can be applied to achieve stiffer, crisper handle as it is done particularly for cotton. Starch is used domestically by far for this. (EPG Gohl and L. D. Vilensky, 1987)

As regard to sizing material it is clear that new initiatives are required from chemical manufacturers to procure cheap sizing material, which can be rapidly removed like starch. (M.J. Wadia, K.S. Taraporewalla and Dr. S.K. Shah, 1992)

Textile auxiliaries such as sizing agents are drained off after use with the effluent. The biodegradation sizes used were native and modified starches, starch ethers, cellulose esters used alone or in combinations. (Tobler et. al 1992)

Starch is a naturally occurring polysaccharide, is a mixture of amylose and amylopectin molecules in proportion ratio of 20-25, 75-80 respectively. It has good adhesion towards cotton and are difficult to wash out but are biodegradable. (Khandual, R.S. Pai, L.R. Jaipura and S. Das 1994)

Starch is the stiffening agent used on cotton and when soil does collect it adheres the starch and is removed easily with starch in laundering. (Patel 1996)

Sizing agents may drastically divided into natural and synthetic based material. (Mullick P. 1997)
Stiffening makes cotton lustrous, stiffer, crisper and shiner. The vegetable starch attach themselves to the fabric by covering pores and by making the surface smooth which prevents soil accumulation. (Yadav 1997)

A certain amount of crispness in apparel and household linen gives them fresh look. The crisp appearance is obtained by using stiffeners. In common language it is nothing but starching of fabric (Noemia ‘D’ Souza, 1998)

Starch was extracted from mango kernel and utilized on starch free cotton sample in varying concentrations (2 percent to 5 percent) to study its performance as stiffening agent. Four percent concentration of mango kernel starch with and without additive found to score more for desired stiffness and transparency. Increase in concentration of mango kernel starch did not have and effect on whiteness and overall appearance of the sample and scores for them were very low. Mango kernel starch as stiffening agent (at 4 percent concentration) on cotton fabric can impart desired stiffness and transparency to fabric but failed to maintain whiteness and overall appearance of the of the cotton fabric. (Sunita Kale, 2003)

Sizing agents are selected on the basis of the type of fabric, environmental friendliness, ease of removal and cost consideration. The typical sizing agents used are starch, starch derivatives, modified starch products and protein based starches. (C. N. Shivarankrishnan, 2005)

According to report of National Institute of Industrial Research 'Largest use, over 80 percent of starch used by the textile industry is for cotton and cotton blended fabrics where the warp yarn is strengthened by impregnating it with starch mixed with other chemicals. Native starch represents a significant proportion of starch used in sizing.
The first stage in processing is desizing which contributes more than water pollution levels. Attempt should be made to recover and use partially or fully the easily available water soluble sizes like starches and CMC. The starches are easily biodegradable.

According to Subodh kumar Aggrawal 'use of starch in textile began during middle ages, when it was very common as stiffening agent. The textile demand soon brought about the introduction of potato starch to supplement wheat starch. Starch like sugar occurs as such in the plant and requires only extraction. Although starch is known to have the approximate formula, its exact structure is still unsolved'.

2.3 Starch Extraction

Das and Banarjee (1952) utilized the mango kernel seeds as a source of starch and had described a method of preparation of starch from mango kernel seeds.

Abd-Allah et.al. (1974) prepared starch from mango kernel seeds and it was observed that mango kernel starch was characterized by low protein content and intrinsic viscosity.

Saddany et.al. (1980) carried out study on extraction of starch from mango kernel seeds. According to him the yield of starch from mango kernel seed was about 21%. The starch so produced was studied for physical and chemical characteristics. The study revealed that starch was very similar in its characteristics to tapioca starch. The viscosity of mango kernel starch was little lower while solubility was little higher than that of other starches.

Potentially a mango seed has large quantity of starch. It contains 60-70% of starch. Mango starch was isolated by macerating the kernels,
steeping in Sulphur Di-oxide solution, treatment with alkali and acid followed by centrifugation. (P. C. Mehta, 1981)

Dhingra and Kapoor (1985) Mango kernel seed is rich in carbohydrate and starch can be extracted from it. It is extensively used in food and allied industries. Moreover it is also used as industrially potential chemical in various industry such as paper, textiles, pharmaceuticals and cosmetics as it exhibits good thickening, sizing adhesiveness and thin film forming characteristics.

A simple laboratory scale method of isolation of amaranth starch has been developed by Perez et. al.(1993). The new simpler method involves steeping in dilute alkali, neutralization and ambient air drying without using expensive or highly hazardous chemicals.

Dr. D. M. Shere (1996) during his Ph. D on 'Studies on biochemical, nutritional processing and production of various products and by-products of pulp, stone and peel of mango' extracted starch from mango kernels and it was observed that good quality, white and free flowing starch can be prepared from mango kernels. The yield of mango kernel starch ranged from 20 to 22%. The starch so prepared was in close resemblance with that of tapioca starch with respect to its thickening properties, pasting characteristics and enzymatic susceptibility. The viscosity of mango kernel starch was comparatively lower than tapioca starch and there was slight drop in viscosity of the paste after cooling.

Corn starch is obtained from maize flour or corn flour which contains 53% starch. The starch as such is very white and has good keeping property. It forms a very viscose paste. It is quick congealing starch therefore it should not be allowed to cool down either in storage or during starching, otherwise it forms lumps. (Modi, 1977)
Corn starch is manufactured by soaking corns in warm water to which Sulphur di-oxide is added and is allowed to stand for two days. The soften kernels are then separated from the germ. The kernel then ground and sifted. The starch is separated from the gluten, filtered, washed, dried and packaged. (Noemia 'D' Souza, 1998)

The manufacturing process of tapioca starch consists of mashing or rasping the thoroughly washed tapioca roots. The pulp is then washed a number of times to remove the free starch. The wash water is centrifuged. The starch is further refined by washing and sedimentation. It is then dried and packed. (Noemia 'D' Souza, 1998)

The starting point in manufacturing of starch is preparation of feed i.e. corn. This preparation consists of cleaning of undesirable material and removal of solid metal particles. Cleaned corn is then steeped in warm water (45- 55c) for two days. This warm water contains 0.3 to 0.5 percent Sulphur di-oxide. This steeping is done in a mild steel tank which is equipped with a jacket and an agitator. This steeping process softens the gluten and loosens the hull. The steep water dissolves salt, soluble carbohydrate and protein. The steeped material is subjected to hull removal equipment. The cleaned and softened kernels are de-germinated. The germ is separated from the whole material with the help of liquid germ separator. The kernel then ground and sifted. (Subodh kumar Aggrawal)

2.4 Starch Application on Fabric

The starching process is simple. The articles are dipped up and down in the starch solution till they are thoroughly saturated after which they are wrung out and put to dry. (Susheela Dhanyagi,1959).
According to Fairchild Dictionary of Textiles (1967) 'Application of starch mixture and calendering treatment commonly given to the cotton fabric to give body is nothing but starching.'

Rita Chitkara (1968) explained the method of starching. Take the prepared starch solution; add water to it depending on the thickness you require. Dip the garment in water, squeeze out the extra water. Put garment in prepared starch solution for one minute. Remove the garment, squeeze out extra solution and dry in sun.

Two methods are used to add sizing to the fabric. The fabric is passed through the starch solution and then pressed the starch to the fabric or the fabric is passed over the rollers that revolve in the starch solution thus padding the starch to fabric. (Dorothy Lyle 1976)

'Starches are added in the rinse of laundering or by an aerosol spray at the time of ironing. Vegetable starches must be renewed after each washing. (Phylis Tortora, 1978).

Cotton and linen can be given stiffness, smoothness, weight and strength by immersion in the solution of starch. This process is commonly known as starching.

In some cases starch is applied to the back of the goods only in an operation called back starching. (Corbman B.P, 1983)

Research carried out in the Dept. of Clothing and Textiles by Ms. Sunita Kale (2003) revealed that good amount of starch can be extracted from stored mango kernels. Mango kernel starch can be applied only by boiling method on cotton fabric. Starch becomes translucent on application of heat transforms into perfect stiffening jelly.
2.5 Wear Studies

Santosh Malik (1966) conducted comparison of eight selected stiffening agents used on apparel. The wear study was conducted by giving the subjects a garment which was starched to wear and they were asked to judge the starch to find out the best and poorest starch.

In the wear-ability of wild and cultivated silk it observed that after conducting wear studies and testing properties of the fabrics, wild silk posses better wearing qualities than cultivated silk even though its general appearance was rated as poor by visual inspection. (M. Vijayalakshmi and A. Sundaram, 1969)

Fazeelathhnnusa and Apitha Sundaram (1969) conducted comparative study on the serviceability of tossore and Artlin. Two duppattas were used to wear, eight hours every day for fifteen days. The total period of wear worked out to be 120 hours for each duppattas. The duppattas were washed according a standardized washing method and this was repeated fifteen times. On conducting wear study it was observed that Artlin was better than tossore as it had better abrasion resistance, bursting strength, air permeability and drap-ability. The wearer was satisfied with the suiting material for maintenance of appearance and comfort.

R. Raji and B.K. Binodini, (1973) in their study on wearing quality of garments constructed on two grain lines conducted wear study of garments. In this study the two garments were worn for twelve hours a day on alternate days and washed after each wear. Washing of garment was done in lukewarm water by agitation method using detergent in 0.5 % concentration. The total number of washing and rinsing given were thirty. The garments were inspected visually before and after the wear study and the durability tests
were conducted. The results of the study showed that grain line did not have any influence on wear ability of the garment.

Evaluation of quality of collar and cuffs of bonded fabric on the basis of wear studies was conducted by Dr. A. Shadadevi (1977).

In evaluation of wearing quality of full voile material, it was studied that the full voile fabric has good wearing properties. It was light in weight and had much strength it was highly creases resistant when compared to cotton fabric. The objective to evaluate wear ability is in term of apparel purpose. (A. Shadadevi 1984)

G.E.R.Lamb, Stanislawkeka, and Bernard miller (1989) in their study on Fabric Wear part-I attrition of cotton revealed that in fabric wear aim is that, fabric can be combination of several action- three main actions are functional wear, cutting of fibers and puckering or sagging.

2.6 Physical Properties of Stiffened Fabric

The development of cotton suiting with greater resilience and therefore with greater ability to hold their shape increases with finishing with certain type of stiffening agent. Fabric given with this type of finish not only resists creasing but increases tend to hand out. It adds cotton blankets to maintain their thickness and hence their warmth. (Hess K.P. 1959)

Sizing is an operation that increases weight and texture of the cloth. The stiffening of organdy and other sheer cloths and crispness of dimity are due to sizing (Jule Labarthe, 1975)

The stiffening is intended to improve the appearance, 'feel' or 'handle' and draping qualities of material and should not crack (giving a chalky line) on flexing the material or folding it. (J. A. Radley, 1976)
Starches called sizes are applied to yarn or fabrics to give them strength and protection. When applied to fabrics sizing gives firmness and stiffness. In some cases starches are applied to cotton to give them weight and to make an inferior fabric look like it is of better quality. (Dorthy Lyle, 1976)

Starching produce sheer fabric with a crisp and attractive hand, help fabric resist sagging and yarn slippage, keep the fabric from wilting in use and care, reduces the formation of lint and help fabric maintain a smooth surface that is resistance to snag and abrasion. (Hollen N. Saddler J.and Longfort A., 1979)

A certain amount of stiffness in washed clothes gives them smooth, glossy surface, which is resistant to dirt and dust. The stiffness must not impair the pliability of the fabric. The starch solution penetrates the fabric does not coat the fabric. (Durga Deulkar, 1980)

Starch fills in the openings in the constructed cloths creating an appearance of greater compactness thus low thread count is not immediately discernible at the time of purchase. The starches give weight to the fabric. (Corbman, 1983)

V.K. Aggarawal (1987) explained in his studies that higher concentration of size paste gives thicker and more uniform size film on fabric.

Starch gives weight to a fabric and can make an inferior product look attractive until it has been laundered.

Starch helps to restore the original body or crispness of fabric gives fresh smooth surface and aids in stain removal.

The retention and distribution of parathon-methyl on 65% polyester/35% cotton fabric was studied with 4 finishes: starch and carboxy-
methyl cellulose (CMC) as non durable finishes; and durable press resin (DP) and durable press/carboxy methyl cellulose (DP/CMC) as durable finishes. Starching with an add-on of 8% (w/w) effectively reduced the area of contamination and enhanced the removal of the insecticide from polyester/cotton fabrics. Residual pesticide values for CMC, DP and DP/CMC finishes were similar to those for unfinished fabric. While distribution profiles of parathion-methyl throughout the yarn and fibre structures were similar for all the finishes, lower concentration of insecticide were observed on the cotton fibers from the starched fabric. Starch reduced the pesticide transferring by rubbing from both 100% cotton and 65% polyester/cotton fabrics. These studies support the theory that starch can act as a pesticide trap on the fabric surface to reduce pesticide transfer and enhance pesticide removal. Obendorf, S.K.; Kasunick, R.S.; Ravichandran, V.; Borsa, J.; Coffman, C.W (1991)

Fabric hand is terminology expressing the character and quality of fabric as manifested by its performance in respect of fitting to human body, feel of the surface and comfort in wearing. Hence fabric handle is more important than normal functional properties in deciding the suitability of fabric for particular end uses. In subjective assessment, the fabric handle is examined mainly by the sense of touch on the basis of individual standard of the hand feeling and then hand feeling is expressed by many kinds of expressions like stiff, soft, paper like etc. (P.V. Kadole, S.B.Akiwate and A.S. Bhide, 1995)

The effects of a renewable starch finish and chemical modification by carboxymethylation on cotton fabrics on the pesticide (methyl parathion [parathion-methyl]) retention, transfer, and decontamination by laundering were investigated. Two weights of work clothing fabrics made of 100% cotton
were used, one appropriate for shirts and the other for trousers. The amount of pesticide observed on human skin was reduced by the presence of clothing fabric. Carboxy-methylation of the shirt fabric reduced the amount of pesticide observed on human skin. This treatment also resulted in less pesticide being transferred to a second fabric layer within a clothing system. No pesticide penetrated to the second fabric layer when the heavier trouser fabric was used as the outer layer. The lighter weight shirt fabric did not retain as much pesticide as the trouser fabric. The pesticide retained on the shirt fabric was increased by the application of a renewable starch finish and by carboxymethylation; both of these finishes were found to be effective in enhancing the decontamination of cotton fabrics by laundering. Csiszar,-E; Borsa,-J; Racz,-I; Obendorf,-S-K (1998)

Starch was extracted from mango kernel and utilized on starch free cotton fabric in varying concentrations (2 percent to 5 percent) to study its performance as stiffening agent. Four percent concentration of mango kernel starch with and without additive found to score more for desired stiffness and transparency. Increase in concentration of mango kernel starch did have effect on whiteness and overall appearance of the sample and scores for them were very low. Mango kernel starch as stiffening agent (at 4 percent concentration) on cotton fabric can impart desired stiffness and transparency to fabric but failed to maintain whiteness and overall appearance of the of the cotton fabric. Sunita Kaie (2003)

Vasugi M. and Sangeeta D. (2005) studied selected starches namely maida, sago and rice, Revive to stiffen poplin material. Results have shown that in visual inspection all the samples found to be evenly stiffened. There was increase in elongation and warp and weft breaking strength. The drape
co-efficient of samples showed an increased drapability by 25 percent. Starch revive had more stiffness when compared with other starches. When number of washes increased the absorption of starch also increased.