V. SUMMARY AND CONCLUSIONS
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In this chapter the summary of the study conducted is given in detail and the conclusions drawn and contribution of the study are also cited. The study has been conducted during the year 2003–06.

Cotton is undisputed ‘number one fiber’ used for clothing purpose. The reasons are its softness, air permeability and pliability. Cotton can be worn all the way around the clock. As the fiber strength increases when wet, it is washable, durable and holds up well after many launderings. It is more tolerant of combined effect of hot water; detergent, alkali, bleaches and agitation involved in the process of washing. Cotton is up against man made fibers contributing over 60% of fiber consumption today. Today we are living in the world of eco-friendly textiles. Luckily we are cotton oriented in our textile industry and being a natural fiber, cotton is considered to be eco-friendly. However cotton suffers from the drawbacks of low crease recovery and poor dimensional stability. As the resiliency and elastic recovery of cotton is low and also elongation, fabric wrinkles easily and also do not recover from creasing. Cotton makes a very limp fabric. It has property of holding the surfaces it comes in contact with and of clinging to the surfaces. These drawbacks of cotton can be corrected with finishing. Cotton can be given stiffness, smoothness and strength by immersion in the solution of starch and the processes is commonly known as starching. 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. (Corbman, 1983). Starch fills in the openings in the constructed cloth creating an appearance of greater
compactness. Vegetable starches are applied on textiles for adding weight to the fabric. Besides building weight of the fabric, starching imparts thickness and also improves luster of the cotton fabric.

The mango kernels are rich in starch content which can be used as substitute for cereal starches in the preparation of stiffening agents. Mango kernel contains 69 –79 percent carbohydrates. Out of which starch alone accounts 92 percent, which could be extracted by a simple laboratory method. Annually approximately 0.13 million tones of starch can be isolated from mango kernels (Mehta P. C, 1981). It is observed that mango starch like tapioca starch has high viscosity and the starch gel gets attached to fabric surface, enters into the fiber thus makes the fabric stiffer on drying. Keeping in view the application of starch as stiffening agent on cotton fabric and limitation of availability of food grain starch for the textile industry, the work on extraction of starch from mango kernels and utilizing it as a stiffening agent on cotton fabric was conducted. Mango kernel starch is a low cost non-conventional starch. Starch is white odorless and has good pasting and film forming property. Hence the study was undertaken with the aim of developing environment friendly and economical stiffening agent from mango kernels which is nothing but agro waste. But there are problems in collection of mango kernels from widely distributed mango crop area. Protection of mango kernels from microbial infestation in highly humid conditions is a difficult task. Mango kernel starch is not suitable for cold method of starching. There is reduction in the whiteness of mango kernel starch on storage for long period. It acquires pinkish tint.
The material used for conducting the study consisted of material used for survey and material used for experiment. Material used for survey was a survey schedule. The material used for conducting the experiment were muslin fabric, different starches, chemicals, and glassware required for starch extraction and equipments for testing the properties of stiffened samples. The methods used for conducting the study consisted of method used for survey and for experiment. The survey schedule was formulated to study the practices adopted by the housewives for stiffening clothes at home. The location for the survey was selected keeping in view the families who wear stiffened clothes and the housewives who stiffened their family clothes at home. Survey was conducted among housewives of Parbhani town. A purposive sample of five hundred housewives formed the universe of the study. The method of data collection was personal interview method. The researcher had conducted door-to-door visits to the housewives for collecting the data. The information regarding socio-economic status of the families of the housewives and about the clothes stiffening practices i.e. types of fabrics stiffened at home, different stiffening agents used, types of garments stiffened at home, methods adopted for preparing stiffening solution and additives used in stiffening solution, stiffening season, frequency of using stiffened clothes prior to next stiffening, stiffness desired according to type of fabric, steps followed for stiffening clothes at home etc. was collected. The collected information was then tabulated. The tabulated data was analyzed applying Line Chi-Square test in order to find out the significance of analyzed data statistically.
The cotton fabric selected for experiment was white muslin fabric in plain weave with count of 72 ends and 72 picks per inch. For conducting the experimental trials of different concentrations of mango kernel starch and its blends with other starches as a stiffening agents on cotton fabric, it was required to have muslin fabric free from starch or from any other stiffening agents. Hence a laboratory procedure of desizing prescribed as IS: 1967-1961 was conducted.

The simple starch extraction method involves steeping of stones of mango kernels in dilute alkali, grinding in paste, neutralization, straining and ambient air drying without using expensive or highly hazardous chemicals. Dr. D. M. Shere in his Ph.D. research adopted simple method of starch extraction which was followed for extraction of starch. Other starches used in blends with mango kernel starch were procured from Food Technology department of college of Agricultural Technology, MAU, Parbhani.

Different concentrations of mango kernel starch ranging from 3% to 6% were prepared. Different mango kernel starch blends were also prepared using mango kernel starch, tapioca starch and corn starch. Proportion of tapioca starch and corn starch was kept constant at 1 percent in all the mango kernel starch blends and the proportion of mango kernel starch in these blends was increased from 1 percent to 4 percent with the increase of 0.5% in every blend. Thus a total of seven blends were prepared. The mango kernel starch in four concentrations and seven mango kernel starch blends were applied on desized muslin by the boiling method.

A panel of judges comprised fifteen members with five members who make use of starch as stiffening agent on commercial level i.e. laundry-men, five
members from the field of Clothing and Textiles or rather subject experts and remaining five were housewives who make use of starches at home for starching their family clothes was constituted. The organo-leptic evaluation of fabrics stiffened with different concentrations of mango kernel starch and also the fabrics stiffened with mango kernel starch blends were carried out by these members. The members of the panel judged the starched fabrics on the basis of stiffness, texture, whiteness and overall appearance. The evaluation was done using ranking system. The scores obtained were statistically analyzed by Analysis of Variance.

In order to study wearing quality of the fabric stiffened with mango kernel starch, three sets of scarf were used. Each set consisted of two scarves (Duppatta) of 2.25 mt. in length and made up of muslin fabric. Each scarf from all the three sets was used for eight hours every day. After each use the scarf was hand washed with simple household method of washing and then starched with 4% concentration of mango kernel starch. The washing was done in tap water using soap and applying light hand friction. The starching of the scarf was done by boiling method and after starching the scarf was dried in direct sunlight in open form. The first set was used for ten days, second set for twenty days while third set was used for thirty days. Hence wear study was carried out in all for two months.

The testing of the textile properties of the stiffened samples was done in the Textile Testing laboratory of Textile Technology Dept., SGGS college of Engineering, Nanded to learn weight per square meter, thickness, stiffness, tensile strength and resistance to abrasion of samples stiffened with different
concentrations of mango kernel starch, mango kernel starch blends and of the garments after wear study.

For conducting storage study the mango kernel starch was stored for different periods in polythene bags at room temperature. The first polythene bag was opened after completion of six months and other polythene bags were opened one after another with interval of six months. The moisture content and viscosity of the starch was tested after every opening of the bag and also the scores for acceptability of the starch were noted.

The findings of the survey revealed that most the surveyed housewives were of 21-30 years age, graduate and were from nuclear families having monthly income from Rs. 10,001 to 20,000. Cent percent housewives stiffened cotton clothes at home followed by 70 percent housewives stiffened synthetic clothes, while 58.2 percent housewives stiffened silk clothes at home. Cotton clothes were stiffened mostly with sago, commercial starches and aerosol stiffeners while silk clothes were stiffened mostly by commercial starches and aerosol stiffeners. Stiffening agents used for stiffening synthetics were sago and commercial starches. Other starches were used in very meager amount for stiffening clothes at home. Housewives mostly stiffened sari, Punjabi suits, Duppatta and Kurta-Pajama of cotton at home. Among silk clothes they stiffened sari, Punjabi suits, shirts and scarves at home. The housewives at home stiffened clothes like sari, blouse, Punjabi suits, Duppatta, Kurta-Pajama, shirts and scarves of synthetic fabric. The housewives stiffened furnishing materials like tablecloth, bedcover and sofa cover of cotton and synthetic fabric at home. Among silk clothes housewives stiffened white and light coloured clothes at
home. The housewives gave medium and heavy stiffness to the cotton and synthetic clothes but they preferred to impart light stiffness to silk clothes. The housewives for stiffening cotton and synthetic clothes at home adopted boiling and instant methods of stiffening. For stiffening silk clothes they used instant and aerosol spraying methods. In order to cover up the white mask applied by the stiffening agent to the coloured clothes, the housewives while stiffening cotton, silk and synthetic clothes at home sometimes used tea extract and mostly bluing agent. Housewives stiffened cotton clothes generally in summer or whenever required. Silk clothes were stiffened in summer and spring while synthetics were stiffened during summer, spring and whenever required. Cotton and synthetic clothes were used three to six times by the housewives prior to next stiffening. Silk clothes were used for 5-6 times or sometimes 7 and more times prior to next stiffening. It was noteworthy from the data that cotton, silk and synthetic clothes were sorted on the basis of colour, texture, use and stiffness desired prior to stiffening. Washing, wetting and bluing were the operations done by the housewives before stiffening. Starch paste was made in cold water for preparation of stiffening solution by most of the housewives for stiffening cotton, silk and synthetic clothes. Housewives mostly used boiling method of preparing starch solution for cotton clothes than cold method while for silk clothes cold method of preparing starch solution was mostly followed by the housewives. Starch solution was prepared by both, boiling and cold method for stiffening synthetic clothes. Soaking of the clothes in starch solution was done for cotton, silk and synthetic clothes by most of the housewives while spraying of starch solution was mostly done for silk clothes. The housewives mostly did wringing of
stiffened cotton clothes than silk and synthetic clothes. Sun-drying in open form
was done by majority of the housewives for drying stiffened cotton and synthetic
clothes while fifty percent housewives dried stiffened silk clothes in sunlight and
remaining fifty percent housewives dried stiffened silk clothes in shade either in
opened or in folded form.

Cent percent housewives used stiffened cotton clothes because stiffening
makes clothes stiff, improves appearance, imparts attractiveness and maintains
shape of the clothes while more than 80% housewives opined that stiffening
removes wrinkles, provides smooth, shiny surface and provides imitation to high
quality cotton clothes. Most of the housewives expressed that stiffened silk
clothes were used as stiffening makes clothes crisp, improves appearance,
maintains shape of the clothes and gives clothes up-to-date look. Stiffening
makes clothes stiff, improves appearance, maintains shape of the clothes, gives
clothes up-to-date look and loved to wear stiffened clothes were the reasons
expressed by the housewives for stiffening and using stiffened synthetic clothes.

The results of the experiment showed that the scores for colour, texture
and odor are highest for tapioca starch as compared to the scores obtained by
corn starch and mango kernel starch which was followed by corn starch and then
by mango kernel starch while for free flowing behavior corn starch had maximum
score followed by mango kernel starch and then tapioca starch. The highest
mean scores for the stiffness and texture were obtained by samples treated with
5% concentration of mango kernel starch while highest mean scores for
whiteness was obtained by sample treated with 3% concentration of mango
kernel starch. The highest mean score for the overall appearance was obtained
by the sample treated with 4% concentration of mango kernel starch. It was observed that as the concentration of mango kernel starch applied to the cotton fabric increased there found to have loss of whiteness of the samples which resulted to low scores for whiteness as well as for overall appearance of the samples treated with different concentrations of mango kernel starch.

With the increase in the concentration of mango kernel starch applied on the cotton fabric there was increase in weight per square meter of the treated samples. The weight per square meter of the stiffened samples raised from 41.05 g/m² to 53.73 g/m² and the percent increase in the weight per square meter over the original was from 12.07% to 30.88%. There found to be increase in fabric thickness from 0.20 mm to 0.28 mm and the percent increase in the thickness of fabric over the original sample found to be from 11.11% to 55.55%. When the concentration of mango kernel starch increased from 3% to 6% there found to be increase in warp wise bending length from 1.5 cm to 3.1 cm and increase in weft wise bending length from 1.4 cm to 2.8 cm. The increase in the bending lengths both warp wise and weft wise was found to be doubled than the bending lengths of original sample due to the application of 6% mango kernel starch on cotton fabric. When the concentrations of mango kernel starch increased from 3% to 6% there found to be increase in warp wise breaking load from 17.9 kg to 21.0 kg and percent increase in breaking load was 10.4% to 29.6% while increase in weft wise breaking load was from 16.7 kg to 19.7 kg and the percent increase was from 5.6% to 26.6% over the original. It is essential to note that when concentration of mango kernel starch applied on cotton fabric increased from 3% to 5% there found to be increase in breaking load in both warp wise and weft
wise direction but when 6% concentration of mango kernel starch was applied on the cotton fabric there found to be slight decrease in breaking load in warp wise direction. There was decrease in warp wise breaking elongation from 4.1 cm to 2.9 cm and the percent of decrease over the original was from 18% to 42% while weft wise breaking elongation from 4.0 cm to 3.0 cm and the percent of decrease over the original was from 16.6% to 37.5%. It is confirmed from the above findings that with the increase in the concentration of mango kernel starch applied on the cotton fabric there found to be increase in the strength in terms of breaking load but decrease in breaking elongation of stiffened cotton fabric. But when 6% concentration of mango kernel starch was applied on the cotton fabric there found to be slight decrease in breaking load in warp wise direction. The reason attributed for the decrease may be that due to excessive coating of mango kernel starch on sample, there was restriction on yarn movement, which resulted to isolation of yarns and thus decreased the sample strength. The loss of weight caused due to abrasion of the samples starched with different concentrations of mango kernel starch reduced noticeably with the application of higher concentration of mango kernel starch. There was 12.5% loss of weight observed in the original samples while it was 7.69% in the samples starched with 3% concentration of mango kernel starch and it was 5.79% in the samples starched with 4% concentration of mango kernel starch. Samples starched with 5% and 6% concentration of mango kernel starch exhibited nearly equal loss of weight due to abrasion i.e. 4.05% and 3.70% respectively. With the rise in the concentration of the mango kernel starch there was decrease in the loss of weight caused due to abrasion.
The results of the cotton fabric treated with mango kernel starch blends showed that the highest mean scores for the stiffness was secured by the samples treated with MB4 and MB5 blends of mango kernel starch and the least mean score for the stiffness was noticed for the sample treated with MB1 mango kernel starch blend. Similar trend of mean scores was marked for the texture. The mean score for the whiteness was highest for the sample treated with MB1 blend of mango kernel starch and the least score for the whiteness was noticed for the sample treated with MB7 mango kernel starch blend. Similar trend of mean scores was seen for the overall appearance. It can be inferred that with the increase in the concentration of mango kernel starch from 1% to 4% in the mango kernel starch blends applied on the cotton fabric there was increase in mean scores for stiffness and texture but decrease in mean scores for whiteness and overall appearance.

With the increase in the concentration of mango kernel starch from 1% to 4% in the mango kernel starch blends applied on the cotton fabric there was increase in weight per square meter. The weight per square meter of the stiffened fabric raised from 46.08g/m² to 53.89g/m² and the percent increase in the weight per square meter of the samples treated with mango kernel starch blends over the original was from 11.19% to 30.04%. There was increase in fabric thickness from 0.18mm to 0.30mm and the percent increase in the thickness of samples treated with mango kernel starch blends over the original sample found to be from 27.7% to 66.6%. It is interesting to note that when MB6 and MB7 blends were applied on fabric the weight gain was almost same. With the increase in the concentration of mango kernel starch in the blends applied on
the cotton fabric there found to be noteworthy increase in thickness of cotton fabric but only to certain extend. There found to be increase in warp wise bending length from 1.9 cm to 3.3cm and increase in weft wise bending length from 1.6cm to 3.1cm. There was increase in warp wise breaking load from 18.1kg to 21.8kg and percent increase in breaking load was 11.7% to 34.5% and increase in weft wise breaking load was from 17.9 kg to 21.3 kg and the percent increase was from 13.2% to 34.7% over the original samples, when the concentration of mango kernel starch in the blends was increased from 1% to 4%. Decrease in warp wise breaking elongation was observed from 4.1 cm to 2.7 cm and the percent of decrease over the original was from 18% to 46% while weft wise breaking elongation from 4.0 cm to 3.1 cm and the percent of decrease over the original was from 16.6% to 35.4%. It is confirmed from the above findings that with the increase in the concentration of mango kernel in the blends applied on the cotton fabric there found to be increase in the strength in terms of breaking load but decrease in breaking elongation of stiffened cotton fabric. The loss of weight caused due to abrasion in the samples stiffened with mango kernel starch blends reduced noticeably with the application of mango kernel starch blends. There was 14.28% loss of weight observed in the original sample due to abrasion while it was 3.70% in the sample starched with MB7 blend of mango kernel starch. There was decrease in the loss of weight caused due to abrasion with the increase in the the mango kernel starch in blends applied on cotton fabric.

The findings of the wear study showed that when the first five wears, washes and stiffening were done to the scarf, the thickness of the scarf
increased by 7.4% and with the adding up of wears, washes and stiffening to become ten times, the thickness was more by 11.1%. There was gain in the thickness of scarf by 14.8% over the original fabric when fifteen washes were applied. As the frequency of uses, washes and stiffening with mango kernel starch applied on scarf increased there found to be increase in stiffness of scarf which was studied in terms of increased warp-wise and weft-wise bending lengths. The increase was from 2.3cm to 2.6cm warp-wise and 2.0cm to 2.3cm weft-wise directions after fifteenth wash. The tensile strength of the garment decreased with the increase in the number of wears, washes and stiffening given to the scarf. The breaking load declined from 21.3kg to 17.9 kg warp-wise and from 19.4kg to 16.8kg weft-wise after fifteenth wash. The breaking elongation of the tested scarf reduced from 3.4cm to 3.0cm both warp-wise and weft-wise directions. There was loss of weight due to abrasion which seemed to be added with the more number of wears, washes and mango kernel starch application. The loss of weight increased from 3mg caused in original to 7mg after fifteenth wash. After the first five wears, washes and mango kernel starch application the loss of weight was more by 1.35% over the original which was raised to 2.61% on ten wears, washes and mango kernel starch application and resulted to 4.92% more loss of weight than the original sample after fifteen wears, washes and mango kernel starch application.

The storage study of the mango kernel starch disclosed that different store period had a definite effect on the acceptability scores for the mango kernel starch. As the store period increased the scores for colour and odor decreased but the scores for free flow behavior increased while the scores for texture were
the same. Mango kernel starch had increased loss of moisture as its storage period was increased. The loss of moisture of mango kernel starch ranged from 0.15% to 1.45% than original mango kernel starch and the percent loss increased from 1.57% to 15.26% when stored up-to twenty four months. It is obvious from the study that mango kernel starch had increased loss of the viscosity as its storage period was increased. The relative viscosity of stored mango kernel starch reduced from 1.94 to 1.18 when stored up-to twenty four months and the percent loss increased from 18.55% to 39.15% over the original mango kernel starch due to storing up-to twenty four months.
CONCLUSION

✓ Cent percent housewives did stiffening of cotton clothes at home while seventy percent housewives stiffened synthetic and 58% housewives stiffened silk clothes at home.

✓ Sago, commercial starches and aerosol stiffeners were the most common stiffening agents used at household level.

✓ Housewives stiffened cotton clothes adopting boiling method and silk clothes with instant method. Boiling and instant methods of stiffening were followed by the housewives for stiffening synthetic clothes at home.

✓ The method of mango kernel starch extraction is very simple.

✓ Mango kernel starch is not as white as tapioca starch and acquired pinkish shade on storing.

✓ The highest score for the stiffness and texture was obtained by sample treated with 5% concentration of mango kernel starch.

✓ Sample treated with MB5 mango kernel starch blend was found to be more preferred as stiffening agent for starching cotton fabric.

✓ As concentration of the mango kernel starch and of its proportion in the mango kernel starch blends applied on cotton fabric increased there was increase in weight per square meter, thickness, stiffness, tensile strength and resistance to loss caused by abrasion of the stiffened cotton fabric.

✓ With the increase in the use, stiffening and number of washes applied on cotton scarves stiffened with mango kernel starch there was increased weight per square meter, thickness and stiffness while decrease in tensile strength and resistance to loss caused by abrasion.
✓ As the store period increased the scores for colour and odor decreased but the scores for free flow behavior increased while the scores for texture were the same.

✓ With the increased store period there was decreased moisture content of the mango kernel starch.

✓ As the storage period increased there was decrease in viscosity of the mango kernel starch.
CONTRIBUTION OF THE STUDY

A good amount of white, free flowing starch can be extracted from mango kernels which are nothing but an agro waste. It can be one of the important starches used for different purposes and the starch can be a boon for the different sectors.

Environment - Disposal of mango kernel after extraction of juice in the food industry is big problem and can successfully be solved by utilizing mango kernels as a best source of starch. Mango kernel starch is environment friendly and it is biodegradable. Eco-standards relating to production and utilization of starches can be suitably adopted with use of mango kernel starch.

Industry - Mango kernel starch is an agro waste starch. It can be used as substitute for cereal starches in the preparation of stiffening agents. In the textile industry it can be used as a size to strengthen the warp yarns, in finishing for changing the hand, feel and appearance of the fabric after it processed, in textile printing to hold the dyestuff and chemical in specific area and their diffusion and to glaze and polish sewing thread. Besides textile industry, it can be used in paper industry, paint or dye industry. Mango kernel starch can meet consumer production requirements and can enter into the consumer market as effective stiffening agent. An industry for extraction of mango kernel starch can be set up with meager infrastructure and minimum investment.

Housewives - As starch can be easily extracted from mango kernels with simple method without using sophisticated machineries and high cost chemicals. Housewives can extract the starch from mango kernels after taking out mango
pulp from ripe mangoes and can use it for starching clothes at home. It will be a money saving activity for them as they need to pay a good amount for getting stiffening agent from cereal starches or commercial stiffening agents from market.

**Laundry person** - The method of mango kernel starch application is very simple. It can be applied by the boiling method of starching and starch can be easily removed from the fabric. The viscosity of mango kernel starchy is good as tapioca starch. Hence mango kernel starch which is economical can be an cheap stiffening agent for commercial laundry persons.

**Farmers**- Farmers can be encouraged to grow more and more mango trees because not only the fruits but the kernels of mango which are nothing but an agro waste can fetch money for them. Growing of trees leads to forestation which is beneficial for our eco system. As the residue left after the extraction of starch from mango kernels is biodegradable it can be used as manure by the farmers.

**Rural masses**- Rural masses can be engaged in collection of mango kernels after extraction of pulp and can supply them to the industry resulting in an income generating activity for them.