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Colocasia starch: an alternate natural sizing agent for textile application

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Abstract

As the humanity is again turning toward natural products instead of synthetics, the purpose of the experiment was to study the textile application of extracted Colocasia starch as natural stiffening agent on cotton fabric. A comparative testing of colocasia extracted starched samples with commercially available starch showed that the extracted starch was as good as control and can be safely applied on textiles as stiffening agent. Extracted Colocasia starch was stored at room temperature in air tight container. Even after one year it was observed that the starch was in good condition without change in colour and texture. Application of sizing agent leads to an increase in stiffness, strength and weight of the fabric. Study revealed that the starch extracted from Colocasia tubers can successfully be used as natural stiffening agent on cotton fabric.

Key words: Colocasia, extraction, application, fabric, starch

Fabric finishes are wet or dry treatments that complete a textile. In the sequence of textile processes, sizing has continued to retain its importance in the value chain and has proved necessary even with today's demanding requirements. Sizing is a process used for the application of a film forming polymer to provide temporary protection to the textile material. Sizing is the most common finish applied on to a textile. Starch is probably the commonest finishing agent for cotton fabric goods and it may be applied as a stiffening or binding agent. Starches are used in different strength for different fabrics depending on the thickness of fabric and stiffness required for it (Kusum and Rena, 2012). Various sizing agents such as poly vinyl alcohol, carboxyl methyl cellulose (synthetic), roots and tubers like potato, sago, rice, corn etc. (natural) are commonly used on textiles. The utilization of starch in industries is on the rise. The highest utilization of the biopolymer is in the paper, textile, and chemical industries, where it serves as the raw material for the production of many items (Saikia and Konwar, 2012).

Colocasia esculenta is one of the earliest cultivated tuber plant and can be used as natural sizing agent on cotton fabric. It is a perennial, tropical plant primarily grown as a root vegetable for its edible starchy corm and as a leaf vegetable most commonly known as taro. It is an erect herbaceous perennial root crop wildly cultivated in tropical and sub-tropical world belonging to the genus Colocasia in the plant family called Araceae (MercyMacharia *et al*. 2014). It is a tropical perennial starchy plant that is native to Asia and the Pacific region (Kaensombath & Lindberg 2013). Taro has been reported to have 70–80 per cent starch with small granules. Because of small size of its starch granules, taro is highly digestible. Carbohydrate is the major component of *C. esculenta* tuber. The plant has rhizomes of different shapes and sizes. Taro can be grown in paddy fields where water is abundant or in upland situations where water is supplied by rainfall or supplemental irrigation. Taro is one of the few crops (along with rice and lotus) that can be grown under flooded conditions. Like most root crops, taro does well in deep, moist or even swampy soils where the annual rainfall exceeds 2,500 mm. Harvesting is usually done by hand tools, even in mechanized production systems. First, the soil around the corm is loosened, and then, the corm is pulled up by grabbing the base of the petioles. It is also known as Arvi in Urdu/Hindi in Central & North India, which is often mispronounced as Arbi. In Himachal Pradesh, root of taro is known as ghandyali and plant is known as "Kachalu" in Kangra and Mandi districts. Due to production and availability of this tuber in local areas, present study was planned to develop an alternative, environment friendly sizing/stiffening agent having superior sizing properties, good storage qualities and at the same time have biodegradable properties (Aron and Selamu, 2019).

Materials and Methods

Procurement of raw material: *Colocasia esculenta* corms were procured from local farmers of districts Kangra and Hamirpur, Himachal Pradesh.

Extraction of starch

Starch tubers after cleaning and removing outer skin, was steeped in tap water for twenty four hours with change of water for every six hours. The supernatant liquid containing tannin was discarded. The steeped source was then washed with water and then ground in grinder with addition of 1 per cent potassium meta-bisulphate. The paste was mixed with water with MLR 1:20. The milky suspension was then passed through double fold muslin cloth. The residue was again ground and process was repeated until no starch passes through muslin cloth. The milky water was then allowed to settle. The supernatant was siphoned off after six hours of sedimentation. The sediment was washed with water. The crude starch was then treated with 0.1 N Sodium Hydroxide solution. The suspension was stirred from time to time and allowed to settle. The supernatant was siphoned off again and the residue was washed with distilled water. The washed residue was then treated with 0.1 N Hydrochloric acid to get white starch. The decolorized starch was washed with distilled water again and again. Finally, the starch was made free from moisture by treating it with Acetone and by drying under the shade in open air. The free flowing starch was white and powdery.

Quantitative analysis/composition

Moisture content of the samples was measured by oven dry method given by Grover and Hamby (1988). Sample of 1g weight was kept in oven at 110°C for one hour. After removing the sample from the oven it was placed in desiccators for 10 minutes and then weighed. This procedure was repeated until a constant weight was obtained.

Crude protein, ash, fat and crude fibre were analysed by using AOAC (1995) method, whereas, carbohydrates were calculated by adding up the values of moisture, crude protein, crude fat, crude fibre and ash and subtracting from 100. The difference obtained was observed as carbohydrates present .

Application of extracted starch on cotton fabric

Preparation of fabric

Scouring of cotton fabric was done for removal of natural and added impurities like oils, fats, waxes and other adventitious dirt. For this cotton fabric was treated in 2g surf/ezee in 100ml lukewarm liquid detergent solution for 45-60 minutes with material to liquid ratio 1:50. Fabric was rinsed thoroughly to remove any residues, thereafter dried and ironed.

Application of starch

Starch solution was prepared by pouring the measured quantity of starch in small quantity of lukewarm water and mixing thoroughly until all the starch granules dissolve in water. Now adding the rest amount of water in it and heating the solution up to 60-70°C. Dipping the scoured cotton fabric in it and treating till the fabric sample get saturated with starch. The samples were taken out and pressed between the palms so that excess of starch solution is squeezed out. The sized sample is then dried in open air. Ironed the starched fabric before complete drying it. Different concentrations viz. 10g/l, 15g/l, 20g/l and 25g/l of prepared colocasia starch solution were used to study the sizing / stiffening quality of the cotton fabric. The sized samples were then subjected to physical testing.

Evaluation of starched samples

Starched fabric samples were tested using various parameters like color, weight, thickness, tear strength, stiffness and crease recovery etc.

Fabric GSM

Determination of fabric weight in grams per square meter was done using GSM cutter. The sample was cut with the Paramount GSM cutter and weighed to determine the weight.

Thickness test

Fabric samples were subjected to Shirley's thickness tester for determination of the variation in the thickness of the sized samples. Sized sample was cut and were placed on the Anvil. Pressure foot was gently powered on the sample. Thickness in mm was measured after 30 seconds.

Drape / stiffness test

Stiffness of the sized sample was determined by cutting the sample of 2.5x15cm. Sized sample was placed in the Laboratory model of Paramount drape Tester and readings were calculated as drape coefficient.

Tensile Strength

Sized Sample was cut 10x12(warp/weft) then the Samples were fit in Paramount Tensile Tester .The Load /Elongation curve was procured from the readings obtained from the tensile strength tester.

Results and Discussion

The extracted colocasia starch was white in colour which was found to be best suitable stiffening agent for application on any type of textiles without any harm on colour, shape and size of fabric. Starch content in Colocasia tubers were analysed as 20.69 per cent on fresh weight basis. Taro corn has been reported to have 70-80 per cent (dry weight basis) starch with small granules. (Melese and Negussie 2015). Moisture content in fresh Colocasia tubers were observed as 70.86g per 100g approximately whereas ash content was analysed as 1.28 per cent followed by fat 0.39 percent, crude protein 5.16 per cent, respectively. Crude fibre was analysed as 1.19 per cent whereas total carbohydrates were calculated as 21.12 g per 100g (Table 1).

Evaluation of starched cotton fabric samples

After application of extracted starch on cotton fabric, it was observed that fabric became stiff. The physical parameters of starched cotton fabric were studied (Table 2). A comparison study between colocasia starched fabric and commercially available synthetic starch i.e. revive was also carried out.

Table 1. Quantitative analysis of *Colocasia esculenta* tubers

Sr.No.	Parameters	Value (%)
1	Starch contents	20.69 on fresh wt. basis
2	Moisture	70.86
3	Crude protein	5.16
4	Ash content	1.28
5	Fat	0.39
6	Fibre	1.19
7	Carbohydrates	21. 12

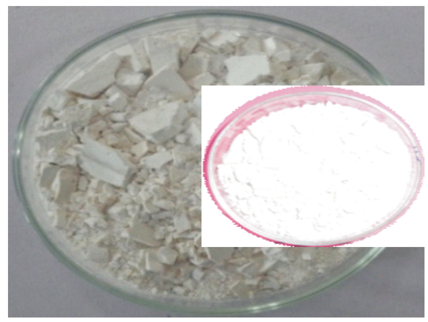
Table 2. Physical testing of Colocasia starched fabric and comparison with commercial starch

Sr.No.	Evaluation / Tests	Colocasia starched fabric					Revive starched sample
		Control fabric	1%	1.5%	2%	2.5%	2%
1	Color	White	White	White	White	White	White
2	Fabric weight (g)	1.76	1.84	1.93	2.01	2.09	1.86
3	Thickness (mm)	0.25	0.26	0.27	0.29	0.31	0.29
4	Stiffness (mg/cm)	27.79	38.26	41.92	44.02	47.72	38.65
5	Drape area (cm^2)	235.60	240.59	254.30	309.15	315.38	238.19
6	Drape coefficient (%)	30.63	31.98	35.71	50.59	52.29	50.48
7	Tear strength (gm. /cm) (6400kg)						
	Warp	10	11	12	12	11	10
	Weft	8	11	11	12	10	8
	Tear strength (gm. /cm) (3200kg)						
	Warp	10	15	16	14	12	15
	Weft	9	15	13	13	12	12
8	Crease recovery (angle^0)						
	Warp	68.25	55.25	34.50	28.75	30.00	54.50
	Weft	55.5	51.25	39.50	37.50	24.25	74.25

The extracted starch was white in colour so all the fabric samples remained white even after the application of starch in different amount. In case of fabric (5"x5") weight, slight increase in fabric weight was observed which could be due to the starch granules stuck / remained in the fabric even after drying. As the amount (percentage) of starch increased, the thickness of the fabric was also increased (0.25 to 0.31 mm). Thickness of the sample varied in considerable amount with the increase of temperature. This could be due to more absorption of the starch with rising temperature and concentration because of increased kinetic energy of the particles that resulted in thick film formation on the fabric samples (Kusum and Rena 2012).

Application of any sizing agent leads to an increase in strength of the fabric and same observations were made in case of Colocasia sized fabric. The stiffness of the starched fabric varied from 27. 79 mg/cm (standard fabric) to 47.72 mg/cm (sized fabric). Drape area of starched fabric ranged between 235.60 cm^2 to 315.38 cm^2 whereas drape coefficient was analysed as 30.63 to 52.29 per cent (Table 2). A comparative testing of colocasia extracted starched samples with commercially available starch showed that the extracted starch was as good as revive and can be safely applied on textiles as stiffening agent. Extracted Colocasia corm starch was stored at room temperature in air tight container and observed time to time for studying its storage. Even after one year it was observed that the starch was in good condition without change in colour and texture.

Application of sizing agent leads to an increase in stiffness, strength & weight if the fabric. Study revealed that the starch extracted from Colocasia corms can successfully be used as natural stiffening agent on cotton fabric.



***Colocasia esculenta* extracted starch**

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Conflict of interest: The authors declare that there is no conflict of interest in this research paper.

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