1. INTRODUCTION

The long tresses of lovely damsel are the beauty spot in feminine figure. Hair, a part of a human body is considered as a beauty spot in women. It gives a shape to the human face, protects head and brain by maintaining temperature. Human Hair, when we say it or think of it – we treat it as wastage or an excessive growth on our heads. In today's world, when the need of the hour is recycling and saving environment, the waste remains from the main product or the scrap as the by-product are being used and recycled to manufacture a new product through effective techniques. And human hair as a biological product can be recycled in different ways by studying the sources of hair, its properties and the feasibility to recycle, as it is a bio – degradable product.

1.1 Background

Human hair – we think it is of no use. Certainly not! Human hair is of great importance. Recycled human hair in India is used either in the manufacturing of wigs and hair extensions, or is exported to different countries. Indian human hair which is globally called as VIRGIN HAIR is rich in its texture and quality which is used as a material in other countries.

India's human hair trade has grown into a multibillion-dollar industry. Human hair from Tirumala, in South India is said to be the finest in the world. Hair, collected from temples is the most abundant source available in India. Each year, lakhs of people make pilgrimages to temples where they tonsure their hair as an act of religious offering or thanksgiving. Hundreds of barbers work round the clock, so that the pilgrims can offer their hair to their almighty Lord Venkateswara in Tirupathi.

According to the United Nations Trade statistics, India exported more than $154 million worth of human hair in 2009. The profit margins were only 15% - 50%. There is a huge demand for Indian human hair in France, UK, US, Canada and few other European countries. A single hub of exporter from Chennai had exported 140, 00,000 kgs of human hair in a single month, then the whole amount of human hair available in India is abundant. (Jagannathan, 2010.)

Human hair has great potential if it is recycled and used as a material. Due to its variable strong characteristics it can be used a material in manufacturing different products. As Indian hair is very rich in its quality and texture, it can be further used to improve the economic value of the country. It can also create lot of employment opportunities. Human hair trade industry had done certainly good in the export business.

But, why stop at exports only?

1.2 Objectives

- To identify the sources of human hair and analyze its physical and chemical quality and quantity
- To understand the properties of human hair , and to analyze the scope for product development
- To study the amalgamation of hair with other chemicals in terms of form, strength and durability
- To develop a range of utilitarian products

1.3 Scope

- Establishing a design methodology for recycling waste human hair and developing a range of utilitarian products creating an impact on innovative edge to the product dictionary in sustainable living
- Productive usage of waste human hair can create a niche market and can thus create a lot of employment opportunities
- The project can initiate further advanced study for scaling up the manufacture or developing design and technological interventions and improve the global economic value

1.4 Significance

- The study comprises of analysing the sources of human hair and their economic value
- To study the physical and chemical properties of human hair and experiment with different chemicals to test its feasibility and design a range of products
- Developing an appropriate and feasible design methodology adopting simple and low cost invested manufacturing techniques

2. LITERATURE REVIEW

2.1 Human hair

2.1.1 Composition

Hair is primarily composed of proteins (88%). These proteins are of a hard fibrous type known as keratin. Keratin protein is comprised of "polypeptide chains." The word, polypeptide, comes from the Greek word "poly" meaning many and "peptos" meaning digested or broken down. If a protein is broken down, it gives individual amino acids. Many (poly) amino acids joined together form a "polypeptide chain". Two amino acids are joined together by a "peptide bond", and the correct number of amino acids placed in their correct order will form a specific protein; i.e. keratin, insulin, collagen and so on. The "alpha helix" is the descriptive term given to the polypeptide chain that forms the keratin protein found in human hair. Its structure is a coiled coil. The amino acids link together to form the coil and there are approximately 3.6 amino acids per turn of the helix (coil).

2.1.2 Structure

Its structure is a coiled coil. The amino acids link together to form the coil and there are approximately 3.6 amino acids per turn of the helix (coil). Each amino

3.2 Methodology

Phase	Activities	Duration	Deliverables
Phase 1	Desk Research:	3 Weeks (3)	Clearly defined problem statement/hypothesis for the research. Review of literature, Research Design
Phase 2	Field Study/Experiments/Design process and Data collection/Analysis 1)Ethnographic study: TTD (quantity of hair available, system of processing hair and its auction, reasons behind offering hair) 2)Collecting different samples of hair 3)Chemical analysis of hair, its feasibility, amalgamation of different chemicals 4) Experimentation with different binding agents 5) Making desired moulds	9 Weeks (3+9=12)	Primary Data, Various Experiments and results, Derived Design Methodology, product prototype models
Phase 3	Product Realization/Prototyping 6)Prototyping 7)Testing 8)Refining and final product formulation	4 Weeks (3+9+4=16)	Formation of final products and Prototypes

Table no.: 3.2 Research design

Secondary research (background study):

An intensive study on related area using different National and International books, journals, projects, research papers, reports, articles from different study centres, Libraries as well as from internet sources.

Statistics of TTD kalyanakatta during 2012 - 2013	
Average no. of pilgrimages visiting KKC per day	**20,000 – 25,000**
Tonsure centers	**17** in Tirumala **2** in Tirupati
Free tonsure centers	**6**
Paid tonsure centers	**13** (10/- Rs each per cutting / tonsure)
LPRT (ladies piece rate tonsurers)	**29** per batch, (2 batches working from 9a.m. – 3p.m. and 3 p.m. – 9 p.m.)
PRT (piece rate tonsurers)	**24** per batch (4 batches working round the clock, with a change in batch for every 6 hours)
Total LPRT	**986**
Total PRT	**1824**
Total tonsurers	**2810**
Average free service tonsures	**300 - 400**

Table no.: 4.1 Statistical data collected at TTD during March 2013

Tonsure:

Tonsurers make sure that the women's hair is braided properly before its cut. They shave the hair in same direction, in which the cuticles are faced. By having the hair cuticles facing same direction, the temple authorities are able to make big money, as this is the key point for the sale of hair locks to the wig makers.

Post – tonsure:

As soon as the hair is tonsured, the cleaning staffs (sulabh workers) collect the tonsured hair in bins which are called as "Hundis", at every tonsure centre. The administrative staff of Human hair godown of TTD, visits every tonsure centre and collects the tonsured hair from the hundis within 24 hours. Further, they are sealed in gunny bags and sent to the godown.

4.8.2.2 Method II

Sodium hydroxide (also known as lyse):

Sodium hydroxide (NaOH) is a white solid in pellets, flakes or granules, also available as 50% saturated solution. It is soluble in water, ethanol and methanol. Mainly, it is used in the manufacture of pulp and paper, soaps and detergents.

Sodium hydroxide pellets are dissolved in distilled water. The sodium hydroxide solution is heated with hair at 105 degree centigrade.

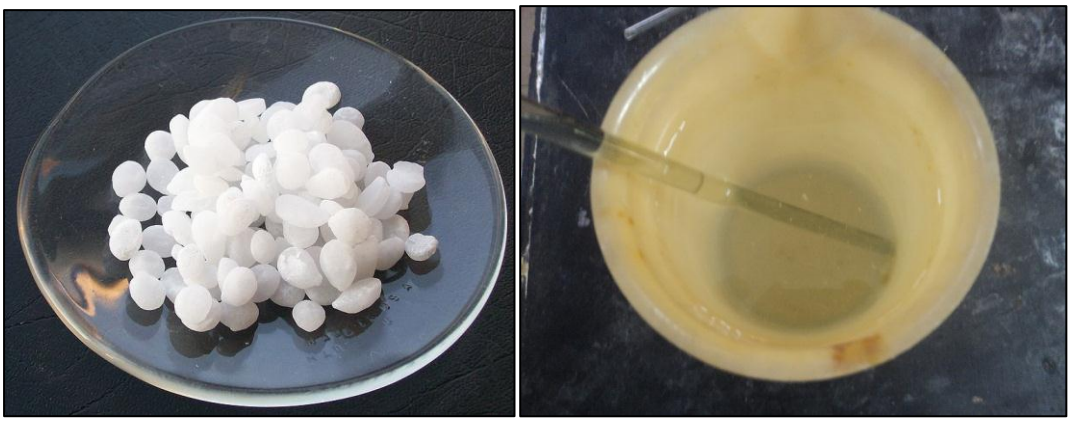

Image: 4.9 Sodium sulphate (pellets and solution)

Image: 4.10 Heating of hair with sodium hydroxide solution

4.8.3 Binding

4.8.3.1 Step I

The obtained hair solution should be mixed with resin in order to strengthen the solution and bind the mixture tightly.

6. Prototyping

After the hair and resin mixture are made ready, the necessary moulds are made according to the designs.

Features of the final deliverables:

- **User friendly**, **Comfortable and Safe**, easy to carry and handle as the raw material used would be soft.
  For example: The false eyelashes made of human hair are used at the most sensitive part of the body, as it causes no harm.
- **Strong, tuf and durable,** as the main quality of human hair is its high level strength which is comparable to bricks.
- **Enhancement of Strength and Reduction of breakage:** As the resin which is a binding agent, is added in the manufacturing process enhances the bond to increase the strength and to reduce the breakage.
- **Enhancement of durability and ease of the user:** The hardening and softening agents are added to enhance the durability and the ease of the usage.
- **Enhancement of Ergonomics:** Decrease of sharp ends and corners and increase of the rounded corners in the manufacturing process, to enhance the ease and comfort of the user. Different value added qualities would be incorporated in the design and manufacturing process to enhance the ergonomic value of the product.
- **Aesthetically pleasing and attractive:** To increase the market value of the products different contemporary designs with different range of colours would be incorporated in the process.

Product – I

Wall hanging with lights

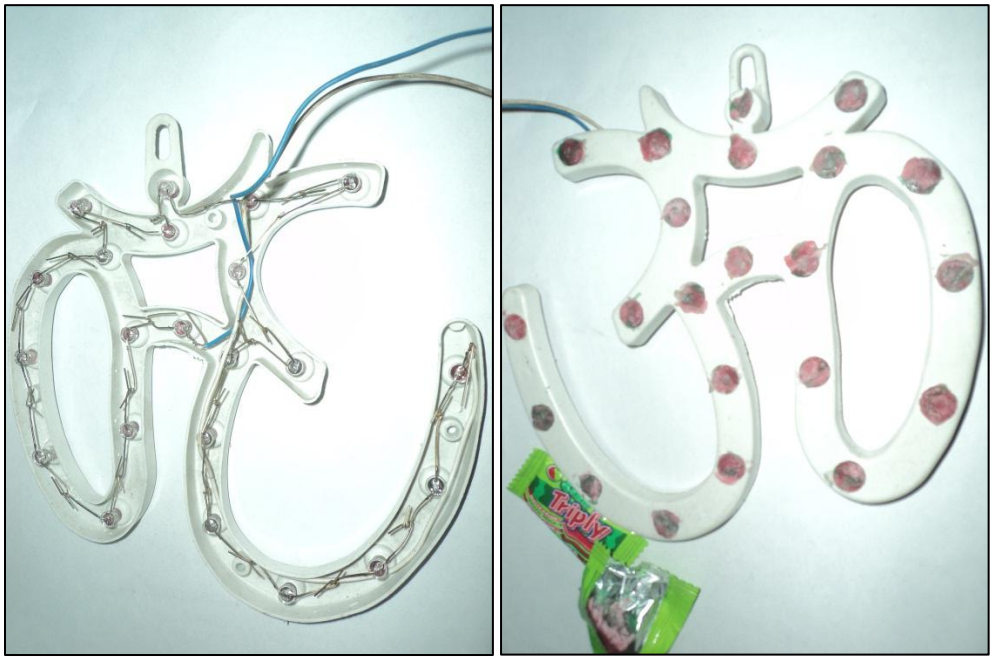

Image: 6.1 Preparation of Mould

Image: 6.2 Preparation of hair and resin mixture

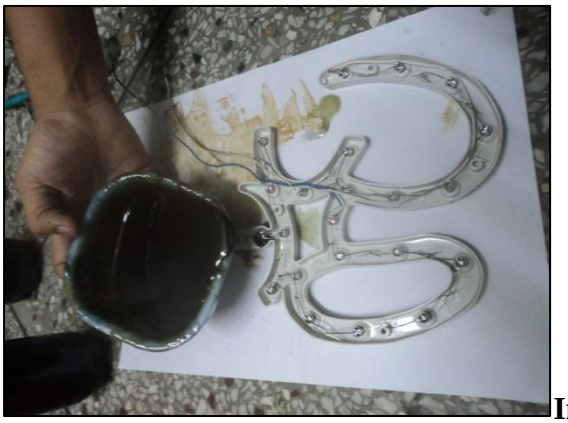

Image: 6.3 moulding

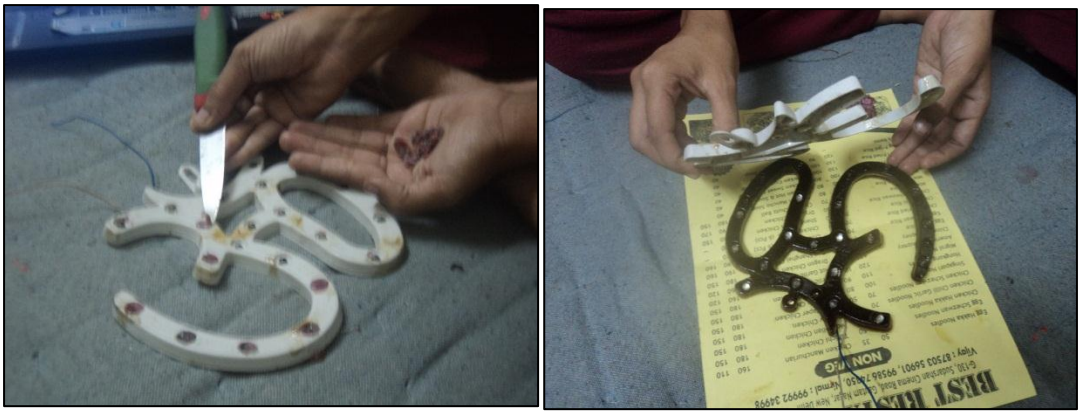

Image: 6.4 De moulding

Image: 6.5 Painting

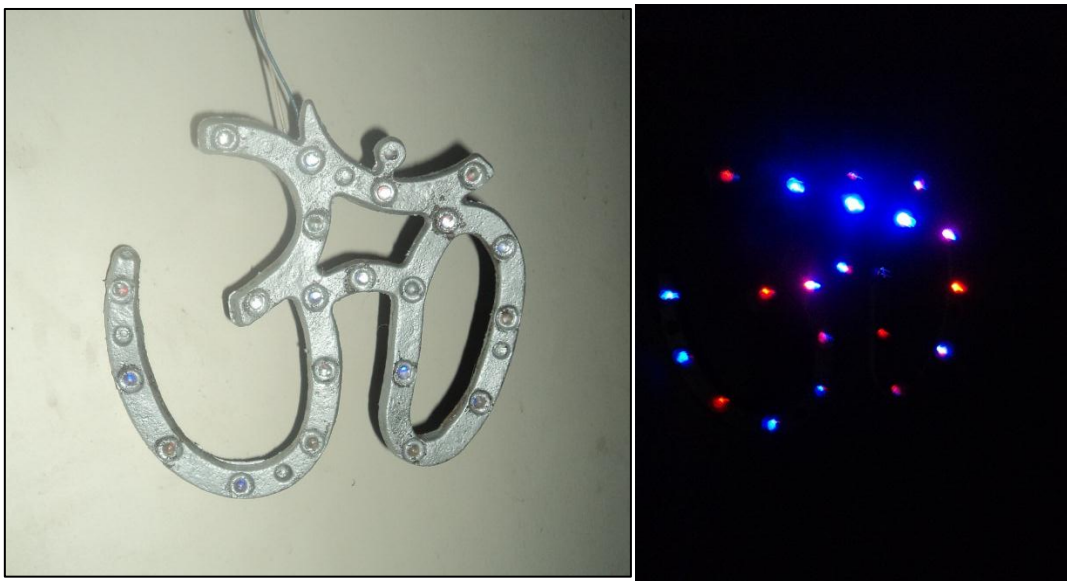

Image: 6.6 final product – wall hanging with lights

Image 6.9 Final product: Flower shaped wall fixtures

Image 6.9.1 Flower shaped ceiling fixtures

7. CONCLUSION

Human hair has great potential if it is recycled and used as a material. Due to its variable strong characteristics it can be used as a material in manufacturing different products. As Indian hair is very rich in its quality and texture, it can be further used to improve the economic value of the country. It can also create lot of employment opportunities. Culturally, Indians have been used to see hair as an excessive waste or a thing of no value. The truth is that the human hair is a best source of recycling and can used as a material in creating different products. Thus, there is a need to study the value of human hair and its varied uses as a material in bringing out different products such as fertilizers where India's largest economic sector is Agriculture. India's next business revolution lies in the remains of the barber shop's floor. It's time we see the Gold in it!!!