## Silk in personal care products & cosmetics

Proteins are the essential building blocks of life, carrying out distinct and specialized tasks, like in transporting and/or processing nutrients in a living being. However, some proteins also perform tasks outside the living body. One example is that of spider silk mainly consisting of silk proteins. Spiders use silk to spin their webs and catch their prey. In the same context, we all know of silk, a natural protein we obtain from silkworms that feed on mulberry leaves.

People from ancient times have been using silk as a material for making clothes, because of its high water-retaining function, ease of dyeing, its characteristic glossiness and fineness to feel on touching. Silk is a fibrous protein, produced by insects belonging to the Lepidoptera order, like the domesticated silkworm, Bombyx mori and spiders (Nephila clavipes and Araneus diadematus). We get silk when specialized silk glands present in a silkworm, secretes liquid silk. Sericin covers liquid silk that spurts out from the worm's mouth to become fibre with which it builds its cocoon. The silk producing insects generally biosynthesize these proteins in their epithelial cells, secrete



and store it in the lumen gland, prior to spinning it into silk fibres.

The quantity of cocoon fibre made by a silkworm is around 0.3-0.5 gram that can extend to a length of about 800-1,400 meter. Cocoon fibre consists of fibroin (70-80%) and sericin (20-30%). The fibre on processing with hot water or dilute alkali gives beautiful gloss that is characteristic of silk, due to the presence of sericin. Silk fibroin is mainly composed of glycine (40%), alanine (25%) and serine (13%). They are regularly ordered with glycine in every second position like -G - A - G - X - G - A - (G: glycine, A: alanine, X: other amino acid). Fibroin has a fine feel on touching and has very good water-retention and extension properties.

Ever since the discovery of silk, using it to make body make-up powder was common. In recent times, silk hydrolyte along with proteins like collagen, keratin, are popular for use in hair care products. Hydrolyzed silk protein is one luxury product to impart silkiness and a luxurious feel to personal body care products and cosmetics. The amazing characteristics of natural protein silk fibroin, its safety and stability to human skin, propels silk as one of the most sought out functional cosmetic raw materials in today's times.

#### Why people like silk

People around the world like to wear silk garments, for its opulence, its pliability and comfort. Silk's greatest appeal lies in its charming ele-



gance and its excellent sheen. We already know that the thread produced by the silkworms is composed of two major protein: fibroin and sericin. Fibroin is a crystalline fibrous protein and is present as a delicate twin thread linked by disulphide bonds. Layers of a sticky silk glue or sericin covers fibroin successively during cocoon formation. To obtain silk threads that are suitable for processing, we have to treat the cocoon with steam or hot water and use chemicals to loosen the thread, before taking several threads and winding them together.

Fibroins consist of a triangular section, similar to a prism. This reflects and absorbs light, creating a flawless lustre typical of silk. Among all natural fibres, silk is the finest. Silk threads are usually more than 1,500 meters in length. The long length makes it easy in weaving light, thin, soft yet sturdy cloth. Silk's marvellous attributes born out of a complex and precise natural mechanism is still an enigma of nature.

Human skin is made of proteins. Silk garments that are also proteins therefore, do not irritate people who wear it. Silk also has its disadvantages. Alkaline conditions easily affect silk fabrics. Moreover, they are difficult to wash. Silk discolours readily, creases easily and does not withstand much friction. However, silk is effective for atopic dermatitis [and other skin disorders], due to its inherent ability to absorb and release perspiration/moisture well. Silk also dries very quickly.

Silk protein by nature has antibacterial and anti-fungal properties. Silk allows the skin to breathe and is a natural moisture and heat regulator. It repels dust mites, mould and mildew. Silk is naturally hypoallergenic and provides relief in conditions like eczema, sensitive skin, allergic rash, shingles, psoriasis, etc. Silk is an environmentally sustainable, biodegradable and a natural fire retardant fibre. Undoubtedly for the apparel industry, silk [clothing] qualifies as "health-promoting clothing".

#### Silk in nature

Nature has more than 100 species of insects that spin cocoons. However, around 3000 B.C., it was apparently the Chinese, who were the first to discover how one could take out threads from wild silkworm cocoons. They realized that boiling the cocoons in water, can assist in reeling raw silk stands off the cocoons, spin it into a silk thread and finally convert it into silken clothes for use. Successful domestic breeding of silkworms, whose larvae do not escape from the nest and adult moths unable to fly off, are the result of innumerable attempts of ingenious selective breeding. The perfection of these techniques is, in reality, the history of silk.

Currently, selective breeding of silkworms, using biotechnology, is responsible for creating newer races. Crossbreeding parental silkworms or breeding from mutants for producing worms resistant to disease and with desirable characteristics, all aim for larger silkworm cocoons that also produce stronger and longer thread. Silkworm breeding techniques and practices that originally took root in China slowly spread to all other parts of the world.

Silk breeding has been in practice in India for centuries, but is essentially still a cottage industry. It is a side activity to the main farm activity, in spite of all post-rearing operations being cost-effective. India is the second largest producer of silk in the world and has a distinction of producing four different varieties of silk. This also includes producing waste silk, from the cocoons. Silk thread waste finds use as coarse yarn and spun silk, for incorporation in natural rubber to achieve superior physicochemical properties. One can extract fibroin and sericin even from silk wastes thus making commercial silk breeding or sericulture a viable agro industry.

Scientific efforts and biotechnological efforts that have taken place worldwide have resulted, in the creation of breeds with comparatively high productivity.



# Table 1Properties of silk proteins

Property	Value	Information		
Sericin				
Form	Gelatinous; Soluble gel	Easily dissolves in water at 50-60°C; returns to gel form on cooling. Gelation is rapid at 108°C and pH $\approx$ 6 to 7.		
	Powder; amorphous structure	Transforms into a $\beta$ -structure in presence of water.		
Molecular weight	10 to > 400 kDa	Depending on extraction methods, temperature, pH, and processing time.		
	35 to 150 kDa	Heat and acid extraction.		
	15 to 75 kDa	Alkaline solution extraction.		
	10 to > 225 kDa	Urea extraction.		
	< 20 kDa	Recovered during early stages of raw silk production.		
	> 20 kDa	Obtained from later stages of raw silk production.		
Solubility	Highly soluble in water	Decreases when molecules transform from random coil into the ß-sheet structure.		
Isoelectric point	$\approx 4.9$	Because there are more acidic than basic amino acids in sericin.		
Fibroin				
Form	Pale yellow mass			
Molecular weight	300 to 420 kDa			
Hydrolyzed fibroin				
Solubility	Soluble in concentrated alkalis, concentrated mineral acids, and in ammoniacal nickel oxide solution; Insoluble in water, alcohol, ether and dilute alkalis.			
Form	Yellow solution: Acid hydrolysis usually causes fibroin solution to turn yellow, due to chemical changes in amino acids such as tryptophan and tyrosine. Tryptophan and tyrosine become yellow upon hydrolysis, and the same is true for serine and glycine. Serine and threonine break down easily during hydrolysis and other amino acids in fibroin decompose in the following order: tyrosine, methionine, cysteine, phenylalanine and tryptophan.			

Silkworms usually just eat mulberry leaves, but we now have new polyphagous breeds that can eat feed that does not contain any mulberry. Some silkworms can even eat apples and carrots. The other newer breeds include silkworms that make large cocoons and produce thread more than 2,000 meters in length, and ones whose females produce yellow coloured cocoons and males produce white cocoons. The progress of silkworm technology continues.

#### **Chemistry of silk**

The silkworm, *Bombyx mori*, produces silk proteins during the final stage of larval development, and two silk proteins, fibroin and sericin, are the major components of silk cocoons.

#### Fibroin

The structure of Bombyx mori (B. mori) silk fibroin as a repeated type II  $\beta$ -turn structure. The conformation of one chain is a repeated  $\beta$ -turn type II, capable of forming intra-molecular hydrogen bonds. We have already seen that fibroin is a crystalline fibrous protein and is present as a delicate twin thread linked by disulphide bonds. Layers of a sticky silk glue or sericin cover fibroin successively during cocoon formation. It is a large molecule consisting of 3,700 amino acids. We can also describe fibroin as a glycoprotein that comprises of two equimolar protein subunits with a covalent linking of disulphide bonds.

Fibroin filaments have both amorphous domains with characteristic amino acids consisting of bulkier side chains and crystalline domains having a high percentage of alanine, glycine and serine.

#### Sericin

A circular dichroism spectrum and infrared absorption spectrum show that the molecular configuration of sericin is mainly a random crimp. The secondary structure of sericin varies depending on the way in which it is prepared. It can remain in a partially unfolded state, with 35%  $\beta$ -sheet,

							_	
Comparison of amino acid composition of various protein derivatives with human hair & skin								
Amino acid	Human hair	Human skin	Collagen	Keratin	Silk	Soy	Milk	
Glycine	5.8	32.4	33.7	8.0	45.9	6.7	3.2	
Alanine	4.4	11.4	11.5	5.5	31.3	5.3	4.5	
Valine	6.0	2.4	2.9	5.5	2.4	4.8	5.7	
Leucine	6.6	2.4	2.6	7.5	0.4	6.9	7.2	
Isoleucine	3.4	1.0	1.3	3.3	0.6	4.3	4.4	
Phenylalanine	1.7	1.2	1.2	2.8	0.6	3.9	3.0	
Proline	8.9	12.5	11.3	7.6	-	6.8	12.3	
Hydroxyproline	_	9.0	10.0	_	-	-	-	
Threonine	7.1	1.8	1.7	6.6	0.8	3.7	5.1	
Serine	10.9	3.6	3.1	10.9	10.2	5.9	7.7	
Tyrosine	1.9	0.3	0.1	2.3	1.9	2.5	3.3	
Methionine	0.4	0.7	0.2	0.0	-	1.0	2.4	
Cystine/2	14.3	_	-	9.2	-	-	0.4	
Cysteic Acid	0.3	-	-	0.5	-	-	-	
Arginine	6.7	4.9	3.4	6.9	0.5	5.9	2.8	
Histidine	0.8	0.5	0.3	0.5	0.9	2.2	2.8	
Lysine	2.5	2.6	2.5	3.0	0.6	5.5	7.3	
Hydroxylysine	_	0.5	0.1	_	-	-	-	
Aspartic Acid	5.7	4.7	5.8	6.4	1.5	11.4	7.3	
Glutamic Acid	12.6	7.7	7.0	12.5	1.0	21.0	20.6	

Table 2

Note: Hydrolyzed collagen is suitable for skin care products and hydrolyzed keratin is suitable for hair care products due to the similarity of amino acid composition to human skin and hair respectively. Silk protein that is largely composed of neutral amino acid, however is more stable in terms of total product quality.

63% random coil, and no  $\alpha\text{-helix}$  content.

Polarization microscopy shows that in silk sericin forms three lavers surrounding a fibroin fibre. Sericin is a globular protein that constitutes 25% to 30% of silk proteins. It contains 18 amino acids, most of which have strong polar side chains, such as hydroxyl, carboxyl and amino groups. The highly hydrophilic nature of sericin is due to the high content of serine and aspartic acid, approximately 33.4% and 16.7% respectively. The predominant amino acid groups comprising sericin are serine, glycine and glutamic acid. It consists of a polar side-chain made of hydroxyl, carboxyl, and amino groups that enable easy cross-linking, copolymerization and blending with other natural or synthetic polymers.

Sericin from a different source contains 37% serine, 17% glycine and 16% aspartate. Depending on the solubility, one can separate sericin into three fractions A, B and C. Sericin A, the outermost layer, is insoluble in hot water, and consists of nitrogen (17.2%) and amino acids. Sericin B, the middle layer, on acid hydrolysis, yields the same amino acids as sericin A and tryptophan and contains 16.8% nitrogen. Sericin C is the innermost layer that is adjacent to fibroin.

Insect silk glands secrete fibroin and sericin. Fibroin, in aqueous solution, converts into silk fibres by the spinning process. In another method. we manufacture lustrous silk from dried cocoons of silkworms, wherein we separate fibroin from sericin, by a degumming process, by discarding sericin in the wastewater. Several ways exist for removing sericin in the so-called degumming process of cocoons. Importantly and practically, all industrial removal methods involve extraction with soaps and detergents. Heat and acid extraction are other methods. However, the point to note is that sericin extracted by different methods can yield different amino acid compositions. In light of





the above industrial sericin generally contains alkali soaps and detergents as impurities.

#### Natural silk – The second skin

The structure and contents of amino acids in silk proteins are akin to the skin of the human body (Table 2). Most of us are aware of the ageold use of silk fibres, in the form of sutures, for intricate surgical and ophthalmological operations as it can completely integrate into the human body without triggering any adverse immune reactions. Silk is suitable for this purpose because of its fine soft fibres, its tensile strength, and importantly because it is easy to tie but difficult to untie. Its protein composition and edible nature make it very compatible with the human body.

Scientific studies claim that the protective effect of sericin is much evident in terms of significant reduction in tumour incidences and multiplicity. Sericin also possesses a photo-protective effect against UVB-induced acute damage and by reducing oxidative stress helps in controlling tumours. Sericin has a unique affinity with other proteins allowing it to bind very effectively to the skin and hair keratin to form a multi-functional protective anti-wrinkle film that is moisturizing, leaving the hair and skin with a smooth and silky feeling substantiating several appropriate cosmetic effects.

Scientific studies also make it clear that regeneration of the epidermis and dermis is faster when silk covers the wound beds, offering advantages over other dressings generally in use.

Recently regenerated silk solutions are also in use to form a variety of

biomaterials, such as gels, sponges and films, for medical applications. Commercial applications of silk include bandages; gauze pads, antihay fever masks and products for other dermatological disorders are already available in the market. The advance of technology in dissolving silk fibres to make a film of silk protein opens the way to for exploitation of silk's biocompatibility and permeability in preparing artificial skin, blood vessels, and tendons; contact lenses for eves: catheters for surgical procedures; anticoagulants, etc. Silk protein's versatility thus makes it a very valuable natural ingredient for use in a variety of cosmetic products.

#### Water retention of silk protein

A study test conducted shows the correlation between relative humidity and hygroscopic efficacy with silk amino acid, silk polypeptide, collagen polypeptide, keratin polypeptide and glycerine as samples to verify humectancy (Figure 1). All proteins have the hydrophilic group  $(-NH_2, -OH,$ -COOH) and show almost similar hygroscopic efficacy. Silk polypeptide is least affected by relative humidity, making it somewhat more suitable to create a non-tacky finished product.

# Antioxidant & antibacterial activity of silk

Silkworms feed on mulberry leaves that are super-rich in antioxidants. Scientific tests at the Massachusetts-based Brunswick Laboratories show mulberries can contain up to 79% more antioxidants (that aid cellular repair in the body), than antioxidants-rich fruits such as blueberries, blackberries and cranberries. Studies provide clear evidence for an antioxidant action of the silk protein sericin that suppresses *in-vitro* lipid peroxidation. Furthermore, studies also find sericin to inhibit tyrosinase activity, clearly suggesting it to be a valuable natural incredient for food and cosmetic industries. Using silk protein as a coating material for natural and artificial fibres. can also prevent abrasive skin injuries, the development of rashes and even improve anti-bacterial qualities for products such as diapers, diaper liners and wound dressings. Some studies also show it to be useful in the treatment of polluted air.

#### Bed hair & sleeping wrinkles

Silk fabrics do not absorb natural moisture from our face and hair unlike cotton. Cotton also causes too much friction, disrupting hair follicles as we move during our sleep cycle, eventually leading to hair breakage and loss. Silk pillowcases can help keep our hairstyle intact. Silk has the same pH as our skin. Scientific studies show that amino acids can counter the ill-effects of aging, especially of facial skin, and help in calming the nervous system. Silk also contains natural cellular albumen that helps in increasing the metabolism of skin cells and thereby helps to reduce signs of aging.

In 1987, Dr. Samuel J. Stegman described the theory of 'Sleep Creases'. James E. Fulton MD, PhD confirmed this theory. Farnaz Gaminchi, MD in 1999 re-confirmed the correlation

Hair after sleeping on Silk



between the location of the underlying, aberrant scar tissue and sleep lines, stating that sleep wrinkles actually accentuates with pillow contact. As silk is a smoother material in comparison to cotton and linen it minimizes night creases or 'Sleep Lines'. Swiss scientists have also published research papers showing that sericin can adhere to the keratin (protein) in skin and hair forming a significant homogeneous protective film, clearly proving that silk can form a barrier layer; help retain moisture and possibly have a plumping, anti-wrinkle effect.

#### A natural hypoallergenic – repels house dust mites and resist mould & mildew

House dust mites frequently cause allergic reactions. Mould and mildew are allergens often found in everyday households. Dust mites and/or their droppings are capable of causing allergic reactions to millions of people worldwide and may be responsible for triggering reactions in 50% to 80% of asthmatics. Dust mite faeces have about 15 proteins that act as allergens. Scientific research shows that silk repels dust mites and their faeces due to their small pore size and antiacrid properties of the silk proteins. Silk pillowcases reduce asthmatic reaction in individuals by repelling these allergens.

Cocoon silk has inherent natural anti-bacterial and anti-fungal properties in order to ensure the survival of the silk moths. Clinical studies also prove that silk can help ease conditions such as asthma, sensitive skin, allergic rash, shingles, psoriasis, eczema or atopic dermatitis, physiologiHair after sleeping on Cotton



cal skin flora and post-chemotherapy sensitive skin.

#### Natural heat & moisture regulator

The high hydroxy amino acid content of sericin (approximately 46%) is particularly important for the waterbinding capacity of silk and in regulating the skin's moisture content. Fibroin has many superior properties like absorbing and dissipating moisture and allowing air to pass freely. Silk has a unique lustre; it blocks UV rays, is water-resistant and neutralizes acids. Being a poor conductor of heat, silk can keep one cool in summer and warm during the winter.

#### Naturally, fire retardant material

Silk burns slowly is difficult to ignite, and possibly may self-extinguish. When it is on fire, silk does not fuse with skin unlike polyester, which makes it a brilliant choice as underwear, bedding and children's clothes.

#### Amino acids in silk

Silk is a natural fibre that is 97% protein containing 18 amino acids in totality (*not in the order of %*).

#### Glycocoll (Glycine)

It is a non-essential amino acid that we find primarily in gelatine and used therapeutically as a nutrient. It is a fast inhibitory neurotransmitter that helps trigger the release of oxygen to the energy requiring cell-making process, and is important in the manufacturing of hormones responsible for a strong immune system.

#### Leucine

An essential amino acid, it works along with the amino acids isoleucine and valine to repair muscles, regulate blood sugar and provide energy to the body. It also increases production of growth hormones and helps burn visceral fat.

#### Methionine

It is an essential amino acid and works in our body to process and eliminate fat. It contains sulphur, required for the production of the body's most abundant natural antioxidant, glutathione. The body also needs plenty of ethionines to produce two other sulphur-containing amino acids, cysteine and taurine, which help the body eliminate toxins, build strong, healthy tissues and promote cardiovascular health.

#### **Tyrosine**

It is a non-essential amino acid having a special role by virtue of its phenol functionality; especially occurs in proteins that are part of signal transduction processes. It functions as a receiver of phosphate groups that transfer by way of protein kinases (Receptor tyrosine kinases). Phosphorylation of the hydroxyl group changes the activity of the target protein.

#### Histidine

An essential amino acid, histidine plays a very important role in the growth and repair of tissues in the body and in preserving the integrity of the myelin sheaths that protect and insulate the nerve cells. At the same time, this amino acid is also required for the biosynthesis of red and white blood cells. Additional functions of histidine include protecting the body from damage caused by radiation. Histidine also aids the body in the detoxification process regarding the presence of heavy metals.

#### Threonine

An essential amino acid, it promotes normal growth so that the body maintains a proper protein balance. Threonine also supports cardiovascular, liver, central nervous, and

Special Article hpicindia

immune system function. Threonine is required to create glycine and serine, two amino acids that are necessary for the production of collagen, elastin and muscle tissue. Threonine also helps in keeping the connective tissues and muscles throughout the body strong and elastic, especially the heart, where it is in abundance. It also helps build strong bones and tooth enamel, and may speed wound healing or recovery from injury.

#### Alanine

We find alanine in many food protein sources. It is a non-essential amino acid that degrades in the liver to produce important bio-molecules such as pyruvate and glutamate. Its carbon skeleton also finds use as an energy source.

#### Isoleucine

An essential amino acid, it participates in haemoglobin synthesis, as well as in the regulation of blood sugar and energy levels. Isoleucine aids in preventing muscle wasting and promotes tissue repair after injury or surgery by increasing muscle protein content in human bodies suffering from muscle protein loss. Isoleucine finally converts to blood sugar in the liver, thereby helps in maintaining normal blood glucose levels.

#### Tryptophan

An essential amino acid, it is famous for its role in the production of nervous system messengers, especially those related to relaxation, restfulness, healthy sleep and a stable mood. It helps to make niacin and serotonin.

#### Cysteine

A non-essential amino acid, it is a key constituent of glutathione, supporting many vital physiological functions. Glutathione is a proven antioxidant, made from cysteine, glutamic acid and glycine, in all human body tissues. Cysteine is responsible for the antioxidant activity of glutathione.

#### Lysine

It is an essential amino acid. It plays a major role in calcium absorption, as well as in helping build muscle protein. In addition, lysine aids in recovering from surgery or traumas, helps our body produce hormones, enzymes, and antibodies and depress the central nervous system with its anti-seizure properties.

#### Aspartic acid

It is a non-essential amino acid widely distributed in proteins. It plays a major role in the body energy cycle. besides participating in the ornithine cycle, in transamination reactions, as well as in the formation of pyrimidines. purines, carnosine, and anserine. This amino acid is necessary for stamina, brain and neural health. Aspartic acid is also very important in the functioning of RNA and DNA, as well as in the production of immunoglobulin and antibody synthesis, helping our body promote a robust metabolism. Many times, it is useful to treat depression and fatigue. This amino acid plays a key role in the citric acid cycle (also known as Krebs cvcle).

#### Valine

It is an essential amino acid, key for smooth nervous system and cognitive functioning. Valine is important for everyday body functions and for maintaining muscles. Valine provides numerous benefits like improvement in insomnia and nervousness. It also alleviates muscle disorders, is an effective appetite suppressant and greatly improves the regulation of the immune system.

#### Phenylalanine

It is an essential amino acid, acting as a building block for proteins. Phenylalanine is a precursor of tyrosine, and in combination leads to the formation of adrenaline. Adrenaline, in turn, finally converts into noradrenalin responsible for promoting mental alertness and memory, and for the elevation of mood and for the suppression of appetite.

#### Proline

It is a non-essential amino acid. Proline is an essential component of collagen, so vital for proper functioning of joints and tendons. Besides, this amino acid helps maintain and strengthen heart muscles. It is essential for maintaining the appropriate pressure levels throughout the body, as well as for the long-distance transportation of blood around the circulatory system.

#### Serine

It is a non-essential amino acid, important for overall good physical and mental health. This amino acid is particularly essential for proper functioning of our brain and of our central nervous system. Serine assists in the production of immunoglobulins and antibodies for a healthy immune system, as well as in the absorption of creatine that helps build and maintain the muscles.

#### Glutamic acid

It is a non-essential amino acid. Glutamic acid is a major excitatory neurotransmitter in the human brain and in the spinal cord, transformed into glutamine or gamma-amino butyric acid. Being one of the few nutrients able to pass through the blood-brain barrier, glutamic acid is human brain's primary 'food' and its conversion into glutamine is the only way our brain employs in order to be detoxified. It has some essential antioxidant properties.

#### Arginine

It is a non-essential amino acid. It plays an important role in cell division and in immune functioning. It helps to heal wounds, release hormones and remove ammonia from our

body. This amino acid is a precursor of nitric oxide, which causes a blood vessel relaxation. Therefore, through nitric oxide (NO) it becomes a mediator in different biological systems. In addition, arginine is an intermediate in the urea cycle, cleaved into ornithine and urea.

#### **Cosmetic applications**

In view of the amazing characteristics and functional properties of natural proteins, fibroin and sericin, its safety and stability to human skin, silk is one of the most sought out functional cosmetic raw materials. To take advantage of silk proteins, formulators can incorporate silk cosmetic additives that are available in the following forms in cosmetics and personal care product applications.

#### Raw silk fibre

Dissolve raw silk fibre in determined amounts depending on the silkiness desired in the final soap product in the alkali prior to neutralization. It is advisable to experiment with different amounts of raw silk fibre and determine the preferred quantity as per requirement in the soap formulation.

#### Silk powder

Silk powder is a micronized powder of natural silk fibroin. Silk powder claims to give relief from sunburns, thanks to its crystalline structure capable of deflecting UV radiation and as a demulcent providing a protective buffer between human skin and the environment. It is also suitable for soap making. Silk powder with the finest micron dissolves/disperse in water while silk powder with a larger micron size is immiscible. Formulators can incorporate silk powder with lower microns along with the fragrance oil and silk that dispersible in water along with other liquid additives during soap manufacture.

Its silky touch, glossiness, moderate hydrophilicity, lipophilicity, good adhesion, makes usage of silk powder suitable for powder make-up products, such as pressed powder, eye shadow, etc. It can greatly improve the feel of the product. The fibre structure of silk fibroin can prevent the powder products from aggregating, hardening or caking. The products always remain soft and in powdery condition as its water-retaining function of silk will impart the moisturizing touch on skin. However, it finds limited usage as some formulations may affect the efficacy of fibroin.

#### Hydrolysed silk amino acids

Hydrolysed silk amino acids product is a combination of enzymes, acids and alkali with an average molecular weight is 400. It retains water, makes flexible film, imparts gentle touch, avoids any flaking phenomenon and is suitable for most personal care products and cosmetics.

#### Hydrolysed silk polypeptide

Silk amino acid, hydrolysed silk, because of good humectancy and film-making properties finds use as a good cosmetic additive to formulate hair care products. Polypeptides of silk with adjusted molecular weight are available for use in applications like shampoo, rinse, skin treatment liquids as well as skin lotion, skin cream, cleansing cream, soap, etc. Excellent film making function of silk makes it a suitable candidate in pretreatment liquid of permanent wave as hair pre-treated with fibroin film, is more resistant and protected against chemical reaction because fibroin peptide forms a stable crystal structure. Silk polypeptide is composed of strong elastic crystalline part and soft extensible non-crystalline part and surprisingly silk polypeptide film become soft as well as tough protecting hair against mechanical action of combing and brushing.

#### Hydrolysed silk ester

Hydrolyzed protein is soluble in

water but its solubility in ethanol is limited. Using hydrolyzed protein in alcoholic formulation is difficult. Ethyl ester of hydrolyzed silk polypeptide is completely soluble in alcohol and formulators can use them in hair spray, hair styling mousses, nail remover, nail enamel, hair tonic, hair treatment conditioners, etc., that have alcohol.

#### Quaternary silk protein

Quaternary silk polypeptide is a trimethyl quaternary ammonium derivative of silk polypeptide. Earlier quaternary ammonium salts like alkyltrimethyl ammonium chloride, dialkyldimethyl ammonium chloride, alkyldimethyl benzilchloride, etc., with long chain alkyl of 16-18C were in use in hair shampoos. They soften hair by adsorption. Products containing quaternary on excessive usage are capable of damaging hair, due to their strong surfactancy good enough to dissolve lipids and proteins. Quaternary derivative of silk polypeptide having good film making property and adsorbance to hair can protect hair, by forming a soft humectants film on it.

#### Conclusion

The history of silk as a textile goes hand-in-hand along with the evolution of the human race. Silk as a textile has its own advantages and disadvantages. The introduction of 'Hybrid silks' is one effort by industry to increase demand by minimizing the disadvantages of silk and maximizing its desirable properties. Combining silk threads with synthetics leads to the creation of hybrid silks offsetting the disadvantages and building on the advantages of the individual textiles components. Hybrid silks thus possess the smooth texture of pure silk along with the synthetic attributes of elasticity and durability, (e.g., women's stockings and tights).

Similarly, acrylic filament thread entwined with silk threads is in style

### Special Article hpicindia

to make socks and blouses. Other products include heavier satin and 'silky touch' knitted ones. They are easier to dye, have volume, are easily washable and yet retain the sheen and texture of silk. Technological progress along with user desire and satisfaction can only grow the likeability of silk as a textile product in years to come.

Apart from the apparel and cosmetic industry, silk also finds use in other fields because of its affinity to nature. Edible silk obtained by hydrolysing silk using enzyme and acid contains generous quantities of glycine and serine that reduce blood sugar levels. Alanine reduces liver stress, promoting alcohol metabolism. Tyrosine, part of a neurotransmitter in the brain, may help prevent dementia. Silk powder as part of the daily diet could help improve the health of people, suffering from surplus energy and lack of exercise.

In ancient times, people used to

wrap fruit and vegetables in silk for long keeping. Modern tests substantiate this ancient wisdom demonstrating how ethylene gas emitted by plants adheres to silk. Commercial development with a significant economic benefit is the manufacture of a nonwoven 'Silk Sheet', using a combination of silk and polyester that helps to keep fruit and vegetables fresh.

Non-conventional applications of silk are in membranes and filter material, to absorb or filter out specific substances (e.g., oxygen and carbon dioxide), in biosensors using silk enzyme fixing membranes that are capable of trapping enzymes. Environment friendly highly biodegradable, silk fishing lines can prevent fishing lines from polluting waterfowl habitats.

Mixing silk powder in a coating substance gives 'silk leather' for use in steering wheels of luxury cars, consumer electronics products like video players, watches, ballpoint pens and stationery. Products coated with silk leather range boast a soft, smooth texture and sheen that gives it a luxury feel. Research is on to make use silk to clean rivers polluted by household and industrial waste. Experiments to absorb and break down pollutants with bacteria cultured in gaps between scrap cocoons are in progress.

Silk cosmetics have been around for a long time with marketers primarily capitalizing its luxury image alone, but without seriously considering the health benefits. Silk treasured over the centuries as the mysterious thread of the East, may soon become an essential substance of daily use for humankind, thanks to its infinite appeal and immense potential.



#### **DR. SITARAM DIXIT**

Independent Consultant – F&F, Personal, Fabric, & Home Care Chemical Industry sitaramdixit.4t.com

Copen to: Annual Contract / Direct Billing from Manufacturer / Plant Audit)							
Kojic Acid Dipalmitate: Indigenous Sodium PCA: Moisturiser							
<ul> <li>BHT</li> <li>CCTG / MCT</li> <li>Camphor</li> <li>Cetearyl Ethylhexanoate</li> <li>Cetyl Palmitate</li> <li>Cetyl Triammonium Chloride 30% &amp; 50%</li> <li>Cetostearyl Alcohol</li> <li>Coco Glucoside</li> <li>Cocoa Butter</li> <li>Cocomonoethanolamide</li> <li>Dimethicone-silicone 350/1000 (50kg)</li> <li>Dimethyl Isosorbide</li> </ul>	<ul> <li>E. Wax (Ionic / Non-Ionic)</li> <li>Ethyl Hexyl Glycerine</li> <li>GMS (SE/NSE)</li> <li>Glycolic Acid 70%</li> <li>Hexylene Glycol</li> <li>Hydrogenated Castor Oil-RH</li> <li>Jojoba Oil</li> <li>Lactic Acid</li> <li>Lanoline Anhydrous</li> <li>Lauryl Glucoside</li> <li>Multani Mitti</li> <li>Octyl Methoxy Cinnamate</li> </ul>	<ul> <li>PEG 120 Distearate</li> <li>Phenoxy Ethanol</li> <li>Polyquaternium 7 &amp; 10</li> <li>Propylene Carbonate</li> <li>SLES Liquid</li> <li>SHEA BUTTER</li> <li>Sodium Hyaluronate</li> <li>Squalene (Veg)</li> <li>Stearic Acid</li> <li>Tetra Hydro Curcumionoids</li> <li>Triclosan</li> <li>ZPTO 50%</li> </ul>					
Inquiries Solicited for Small/Bulk quantity of any Branded Products-Active-or-Inactive Raw Materials							
Contact Person: Mr. Milan Shah Address: 111, Sterling Chambers, 56, Mogra Village, Andheri (East), Mumbai - 400069, Maharashtra Tel.: +91-22-28391197  Mobile: +91-9322240935 Email: tradewelcorp@gmail.com  Web: www.tradewel.com							