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## “UPCYCLING INGREDIENTS IN COSMETIC INDUSTRY”

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### ABSTRACT:

Waste from different industry is increasing day by day; also the consumption of the resources from nature is higher than the rate at which earth could actually regenerate. The increasing world population and their demand for various goods calls out for solutions to use resources in such a manner that the current requirements are met without compromising with the availability of resources for future generation. People being conscious about the way they look and concerned to look beautiful have increased the demand for cosmeceutical products. Cosmetic industry need to find ways to reduce the use of virgin raw ingredient to maintain its socio-economic profile in a world where people are changing their attitude towards the nature and its exploitation. As a solution cosmetic industry has implemented the idea of upcycling and is currently using many upcycled ingredients in the production of cosmetics. This article discusses about some of the way in which cosmetic industry is upcycling waste from other industries. Single use plastic waste is upcycled into high quality liquid by selective hydrogenolysis, the poly (ethylene terephthalate) PET is upcycled into glycolic acid and vanillin by biological valorization and microbial synthesis respectively. The dried blackcurrant pomace after the juice extraction is upcycled to extract blackcurrant bio extract using mixture of ethanol and water. *Citrus reticula* peels are used to synthesize silver nano-particle by treating it with silver nitrate, the silver nano-particles are found to be safe for cosmetic use. Waste from the coffee industry is used to extract the lipid and silverskin from the byproduct after coffee usage both of which are beneficial for skin preparation. Such upcycling practices would help cosmetic industries to set up a circular economy and maintain a sustainable profile.

### INDEX TERMS:

Upcycling, sustainability, green cosmetics, biological valorization, vanillin, silver nano-particles.

### I. INTRODUCTION:

In recent years, the quantity of the waste derived from the industrial practices and processes have been increased significantly. Every industry produces different type of disposable by-products, which are considerably rich in valuable compounds. Their representation and enhancement can not only convert them into products of higher value and quality with application in the diverse biotechnology fields, such as pharmaceuticals or cosmetics, but will, also reduce the impact of waste on the environment and the related treatment cost. [1] Upcycling can be considered as a process of converting materials otherwise considered as waste into something different with a higher quality and value. Upcycling is a term used for giving waste materials a second life. It has been increasingly gaining popularity and being recognized as a promising mean to reduce the consumption of energy as well as raw material use.[2] It is a beautiful idea that completely transforms the circle of waste making into waste using in a clean and positive way.[3] Upcycling provides an environmental benefit by reducing or by delaying the addition of waste or trash that goes to the landfills and hence reduces the pollution. However no matter how eco conscious a brand owner is, they always have a right to be concerned about the uncontrolled use of their trademark on the product that have been upcycled. The law has fairly settled the concern by stating that once a trademark owner has done the initial sale they have no right on the resale of the product, no matter who sells it, in which form, where and at what price.[4] Since the industrial revolution humans are constantly using the environment as a mean of economic growth, an infinite source of raw materials or resources and an endless space to discard the waste. Products are now a part of the throw away culture, creating waste at every step of its lifecycle. This throw away culture has created mountains of waste that are poisoning the environment- the air, land and the waterways, endangering the existence of life on the planet.[5] To deal with this issue sustainability is the solution. The need to replace traditional fossil based raw ingredients with eco-friendly products is for the benefit of our environment and Upcycling on the other hand would aid this need.[6] Upcycling and recycling should be a part of the curriculum as educating students in this regard will promote public awareness on waste management and reusing resources, change the consumption pattern in the society and encourage people to produce less garbage.[7]

## II. SUSTAINABILITY IN COSMETIC INDUSTRY:

As defined by the current European regulation on cosmetics (European Commission 2015), cosmetics are any substances or mixtures that are intended to be placed in contact with the external parts of our bodies (epidermis, hair, nails, lips and external genital organs) or with the teeth and the mucous membranes of the oral cavity with the purpose of exclusively or mainly to clean them, perfume them, change their appearance, protect them, keep them in good condition or correct the body odors, plays an essential role in today's society.[8] Our world is changing; the global population is around 7 billion and is estimated to reach near about 9 billion by the year 2050. There is a mutual agreement on the matter that the planet's resources cannot cope up with such a hike in human population, especially with the existing consumption rates. Human are responsible and at the same time they have contributed in the climatic changes, loss of the biodiversity, destruction of the different habitats for different species and many such environmental damages.[9] Sustainability is presently seen as the principal factor in the cosmetic industries and the beauty sector. With the increase in the worldwide profitability and economic importance of the beauty business in the past decades, their social and ecological impacts have also grown significantly. Since the cosmetics are all about the human well-being and the desire for beauty and attractiveness, the social responsibility plays a key role in the cosmetic industry.[10] Cosmetic companies do face challenges in fully implementing sustainability as even the raw ingredients derived from nature cannot make a cosmetic formulation completely sustainable because the ingredient derived from the natural mineral will have a petrochemical origin, ingredients sourced from animals will lead to animal exploitation and the ingredients derived from the plants may lead to the possible deforestation .[8] According to the reports published by the Worldwide Fund for Nature (WWF), since late 80's human demand on earth's ecosystems goes way beyond the planet's bio capacity. People are wasting the natural resources at a higher rate than our earth can actually regenerate. The choices that are made today will define the chances for the future generations. It is necessary to develop the sustainability, so it can be ensured that there are sufficient resources for the next generation.[11] It is possible to incorporate the idea of sustainability in the business model when it is seen not only through the viewpoints of negative impacts but also as of the development of solutions that bring value to the company as well as the society and when a company line ups its strategic goals in the environmental and social extents to its transformation power and engages the direct and indirect suppliers, as well as develops new partners in its initiatives to find innovation in products and their processes.[12]

## III. GREENING UP OF COSMETIC INDUSTRY:

Green products are definitely the follow ups to a developing nation. The adaptation to become 'Green' is not only the urgency but also an opportunity for the consumers as well as the producers, the companies. The word green is now a popular synonym for 'organic', 'sustainable' or 'healthy'. Due to the threat of climatic changes, global warming and environmental issues the concept of going green is significantly moving faster. Even the consumers concern toward the environment has increased with time. Their pattern of buying cosmeceutical products is changing drastically. A healthy lifestyle and keeping environment clean is changing the mindset of the consumers. They prefer safe, clean, chemical free and healthy products. Environmental deterioration has made consumers understand the importance and necessity to buy green cosmetics.[13] Presently there are varieties of green-tech solutions available in the cosmetic industry using which environment friendly, natural cosmetics can be produced. There are abundant of research into the use of new environment friendly technological solution as well.[14] Going green is the solution to produce and consume eco friendly products however, the raw ingredient to formulate such good is still extracted from the nature only. There are fair chances of exploitation of the ecosystem; hence Upcycling can reduce the sourcing of material from nature. One industry's waste could be other industry's treasure. Organic and natural cosmetics shows qualitative similarities in a formulation, however they differ quantitatively.[11]

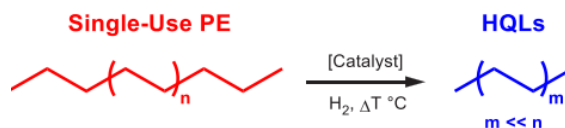
S.no.	Product type	Definition
1.	<b>Organics</b>	When 95% of the ingredients used excluding water, in the formulation are certified organic raw material, or raw material that has followed strict standards from its production to processing.
2.	<b>Made with organics</b>	These are the products that are made with 70-95% of certified organic raw materials excluding water.
3.	<b>100% organic</b>	Product seeking a 100% organic certification must be completely made with certified organic ingredients processed using only organic processing aids.
4.	<b>Natural</b>	When the formulation comprises of natural raw ingredients whether certified or not. The raw ingredients could be of animal, plant or mineral origin. Natural raw ingredients are not necessarily organic.

**Table 1:** - Different terminologies and their definition used for green products. [11]

## IV. UPCYCLING WASTE OF DIFFERENT INDUSTRY INTO RAW INGREDIENTS FOR COSMETIC INDUSTRY.

### 4.1 Upcycling single use polyethylene into high-quality liquid products:

Plastic pollution is a global issue that needs to be resolved as soon as possible. Due to the overuse of the single use plastic we are polluting our planet which in turn is harming the wildlife, their habitat and the earth's ecosystem. By reusing the plastic and upcycling it will help us to reduce the amount of plastic that ends up in the environment and also avoid people from purchasing new plastic product.[15] High molecular weight polyethylene can be transformed into high-quality liquid hydrocarbons with the help of the selective hydrogenolysis of the C-C bonds. The high-quality liquid hydrocarbon produced is of a narrow molecular weight distribution, such liquids with a molecular weight ranging from 200 to 1000 Dalton are perfectly linear or have advanced applications as lubrication oil or as an intermediate like waxes; these can be further processed to produce ingredients for everyday necessities such as detergent and cosmetics.[16]



**Figure 1:** - hydrogenolysis of single use polyethylene into high-quality liquid product with the help of a catalyst.[16]

#### 4.2 Upcycling Poly (ethylene terephthalate) (PET):

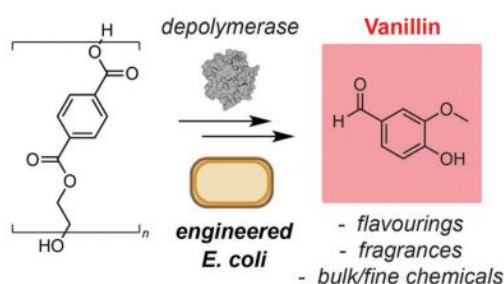
PET is semi-crystalline, thermoplastic polyester with great strength, transparency and safety. It is manufactured using pure terephthalic acid (TPA) and ethylene glycol (EG). When these two are heated together the first product they give is a monomer bis (2-hydroxyethyl) terephthalate (BHET) mixed with a low molecular weight polymer (oligomers). The mixture then reacts further, excess ethylene glycol is distilled out and the PET is thus formed. The PET at this stage is a molten viscous liquid which is then extruded and the water is drained out to form a glass like amorphous material. The mechanical properties of the PET like the stiffness, toughness, creep resistance and sufficient flexibility to resist bursting and breaking under pressure is due to its high molecular weight.[17] The annual global PET production was about 33 million metric tons in 2015, assuming on the basis it could be near about 70-80 million metric tons or more as of now (2022), making PET the most commonly produced polyester globally. PET does not decompose naturally neither does it decompose completely, unrecycled PET waste causes serious environmental damages like prevalence of micro plastic in the terrestrial ecosystem and plastic waste accumulation in the oceans .[18] Recycling and upcycling are the best ways to economically reduce the production and the consumption of the PET waste.[17]

##### 4.2.1 Biological valorization of PET:

Before the valorization of PET to its higher value products, values higher than the PET itself, it needs to be depolymerized into its monomers ethylene glycol (EG) and terephthalic acid (TPA). TPA can be biologically converted into various higher-value products than the value of PET, such as the Gallic acid (GA), Pyrogallol, Catechol, Muconic acid (MA), and vanillic acid (VA) via protocatechuic acid (PCA) using single or combined reactions of hydroxylation, oxidative ring cleavage, decarboxylation and methylation at a relatively high molar conversion yields ranging from 32.7-92.5% . The second monomer of PET; EG can be converted into Glycolic acid (GLA) by fermenting EG using "*Gluconobacter oxydans*". GLA is used as an Exfoliant in the cosmetic product whereas GA is currently used to produce an antibacterial agent; Trimethoprim, and an antioxidant; Propyl gallate.[18]

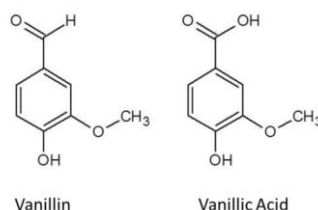
##### 4.2.2 Microbial synthesis of vanillin using waste PET:

The thermo-stable enzyme Leaf-branch compost cutinase (LCC) is a biocatalyst that has the capability to aid the hydrolysis of PET into Terephthalic acid (TA). LCC can release TA directly and does not require any additional enzyme to hydrolyze mono-2-hydroxyethyl terephthalate (MHET) for the release of TA unlike the PETase from "*Ideonella sakaiensis*". PET from post-consumer use are treated with LCC at a temperature around 70-75°C. The reaction is then cooled to ambient temperature after which freshly prepared "*Escherichia coli*" RARE *pVanX* and a biotransformation buffer concentrate are added. Vanillin can be detected after 24 hours in the presence of every pathway components.[19]



**Figure 2:** - Conversion of PET into vanillin, using engineered E.coli bacteria.[19]

\* Vanillin (4-hydroxy-3-methoxybenzaldehyde) is the major constituent of the vanilla bean and is produced naturally, however 90% of vanillin used for industrial processes is synthetically manufactured. It is widely used as a flavoring and aroma compound in food and fragrance industry.[20]



**Figure 3:** - Structure of Vanillin and Vanillic acid.[20]

#### 4.3 Upcycling dried blackcurrant berry pomace into blackcurrant bio extract:

Blackcurrant "*Ribes nigrum*" are small, dark purple colored fruits of a medium-sized woody shrub which grows in areas with colder climatic conditions such as Northern Asia, Northern Europe, Central Asia, with Poland having 80-90% of the total global export.[21] The bio-extract of the black currant acts as an anti-inflammatory, anti-microbial and antioxidant agent.[22]



Figure 4: - Blackcurrant berries.[22]

The dried black currant berry pomace is a co-product of the black currant berry juice production. The black currant berry pomace contains high valuable cosmetic ingredient anthocyanin and rutin. The black currant pomace is collected from the juice production companies and upcycled to manufacture the black currant bio extract to later incorporate in the cosmetic products. The drug is extracted with a circulating ethanol and water mixture. Later the ethanol is evaporated and the concentrated extract is obtained.[23] Anthocyanin from plants can prevent skin aging and UV-induced skin damage.[24] The anthocyanin of black currant extracts show phytoestrogen effects, which activate collagen and elastin production.[23] Rutin is a antioxidant from the group of flavonoids but its use in cosmetic dermal products is limited due to its poor water solubility. Rutin saturation solubility can be increased and the diffusion to the skin can be improved by producing rutin nanocrystals by the smartCrystal processes like bead milling followed by high pressure homogenization.[25]

#### 4.4 Upcycling mandarin peel for the synthesis of silver nano-particle:

"*Citrus reticula*" peels are the bio waste of the food industry. It can be upcycled and combined with the green biosynthesis to produce silver nano-particle (AgNP's). Adding the mandarin peel extract drop-wise with 1 millimolar solution of silver nitrate ( $\text{AgNO}_3$ ) in a 1:3 ratio and stirring the mixture for few hours under dark conditions will give a mixture with well dispersed AgNP's. Size of which can be studied using techniques like ultra violet visible spectroscopy, X-ray diffraction and scanning electron microscopy.[26] About 12% of the total nano-particles used in cosmetic products comprises of silver nano-particle. Silver nano-particles are safe to be used in cosmetic product however, smaller the size greater are the risk for its toxicity.[27]

#### 4.5 Upcycling coffee industry waste into cosmetic raw ingredient:

Coffee is a very popular drink all over the world because of its various functional and health properties. Coffee provides a great variety of bioactive by-products which can be further upcycled to formulate dermocosmetic products.[28]

##### 4.5.1 Upcycling spent coffee lipid extract:

Spent coffee ground is the residue of coffee and hot water or steam; it has a high content of lipids which can be used in cosmetic formulations. The barrier properties of the stratum corneum depend largely on the intactness of the lipid lamellae that surrounds the corneocytes. The human stratum corneum is made up of several layers of keratinized corneocytes embedded in a lipid matrix of systematically arranged lamellar structure. The systematical arrangement of the lipid layer in the stratum corneum plays an essential role in keeping an optimal skin barrier and regulating the skin hydration. The lipids from the used coffee grains can be extracted by supercritical carbon dioxide extraction process. These lipids are found to improve skin lipids and hydration skills. The coffee lipid extract can be incorporated in skin cream to increase the hydration property of cosmeceutical.[29]

##### 4.5.2 Upcycling roasted coffee by-product silverskin:

Coffee silverskin is a major coffee-roasting by-product which is a good source of bioactive compounds- chlorogenic acids (1–6%), caffeine (0.8–1.25%), and melanoidins (17–23%), among other antioxidants that can be extracted using various extraction techniques and further used by the cosmetic industry. It improves skin appearance, counteract with the aging of skin and related diseases such as anti-inflammatory, antimicrobial, anti-cellulite, and UV damage protection; all in an environment friendly way.[30]

## V. CONCLUSION:

This review highlights the contribution of cosmetic industry in sustainability and preservation of environment by upcycling various industry waste and sourcing raw ingredients from it. Upcycling is a beautiful idea in which the earlier circle of sourcing, producing, using and throwing out is changed into sourcing, producing, using and what is not used is taken again as a source to produce and use in other form. Upcycling is different from recycling as recycling requires to completely transform a product into a new one while upcycling provides another life to any material without compromising with its quality. Apart from sourcing cosmetic industry also looks into providing ingredients for other industry too so as to achieve the idea of zero waste. With the increasing population and demand for goods more and more ingredients should be sourced from what is considered as a waste to decrease the amount of trash going into our landfills. There should be adequate resources for the coming generations. Reducing the use of virgin raw material will reduce the pollution and greenhouse gas emission. It will also create an energy efficient route for product creation. Consumer interest in upcycled product is growing at a considerable rate which gives a great opportunity to the producers to manufacture ingredients using waste material which in turn would be cheaper for them. However the scaling up

of cosmetic production based on another industry's waste would depend on the success and production rate of that particular industry.

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