DOI: 10.53469/jrve.2024.06(09).14

An Eco-Friendly Alternative to Orange Peel, Sustainable Fashion Hair Accessories

Aman Kumar

Swami Vivekananda English High School, Chembur, Mumbai 400071 India
kumar4000@gmail.com

Abstract: ***The fashion industry contributes around 10% of global greenhouse gas emissions and 35% of plastic micro-fibers released in oceans [4][5]. This impact is amplified by the increasing demand for hair accessories, which are often made from plastic or metal and contain harmful chemicals. The global market for hair accessories is estimated to be worth Rs. 1,96,566 Crs. in 2023 and is forecasted to reach Rs. 3,50,201 Crs. by 2030 with a growth rate of 8.60%. To address the significant environmental impacts of hair fashion industry, there is a need to emphasize sustainable and eco-friendly fashion practices, including the use of organic waste. This action research project explores the use of bio-plastic made from Orange Peels, for creating sustainable and eco-friendly hair accessories. Due to high cellulose content in orange peel, bio-plastic produced using simple techniques have shown promising results, with excellent strength, flexibility, and biodegradability [1]. This research not only showcases the 'best from the waste' concept but also opens the door of additional income source to the orange farmers & consumers. A comprehensive online survey was conducted to get feedback from key stake holders toward promotion of eco-friendly fashion. The 'Sakhi Paryavarnachi' campaign has been initiated to promote the bio-plastic hair accessories amongst the end users. Overall the combined efforts of experimentation, observation, evaluation and survey based campaign have been explored herein to promote 'Orange peel eco-friendly alternative for sustainable fashion in hair accessories.'***

Keywords: Orange Peel, Bio-plastic, Hair Accessories, Fashion Footprint, 3D Printing, DHBBVC

1. Introduction

In recent years, the world has witnessed a growing concern for environmental sustainability and the need to reduce our fashion footprint. Fashion has an impact on the environment in terms of carbon emissions and is also responsible for 35% of the plastic micro-fibers released in oceans, and 20% of industrial water pollution [4]. This harmful environmental impact is multiplied by the increasingly high demand for the production of clothes and accessories, such as hair accessories [5]. To reduce the negative impact of hair accessories, it is essential to adopt eco-friendly and sustainable materials as an alternative. This action research project promotes the use of 'Orange Peel' for making eco-friendly and biodegradable hair accessories [1]. The process of making bio-plastic from orange peel is quite simple and requires materials which are readily available at home like cornstarch, vinegar, glycerin, baking soda, lemon juice, coconut oil etc. [8]. 3D printing technology is a futuristic solution for crafting hair accessories suggested here but hand crafting hair accessories from bio-plastic is the real creativity and pleasant approach. 'Sakhi Paryavarnachi' an ambitious program is explored herein to encourage active participation from women in promoting bio-plastic accessories. By participating in this, women can contribute to a greener future and reduce their personal fashion footprint. In addition to additional income source to orange farmers, processors, and consumers the 'best from waste concept' is the main key take away from this research. In short, this action research project explores eco-friendly alternatives for the fashion industry and helps to tackle the environmental impact of fashion trends and fashion habits. The results of online survey not only highlight the huge demand for eco-friendly and sustainable hair accessories but also prompted individuals and industries to seek eco-friendly alternatives for various products, including fashion accessories.

2. Conception of Orange Peel to Bio-plastic

There are two basic scenarios which prompted towards conceptualization of making bio-plastic from orange peel;

2.1. Scenario-1: Hair Fashion

Everyone especially women always keen on keeping their hair neatly tied and looking beautiful. For that they explore different colored hair clips, bows, rubbers, barrettes etc. Most common examples are school / collage girls. While looking into this, it is observed that most of the hair accessories used as fashion are made of plastic and the plastic used in these accessories is not eco-friendly and also non-biodegradable. Some of the plastics found are bio-degradable but they require decades to degrade, which is also harmful to the landfill. Therefore, finding alternative source for making plastic used in hair accessories to tackle the environmental impact is need of the hour.

2.2. Scenario-2: Orange Village

Meanwhile, widely known 'Orange Village' under Maharashtra State i.e. Mungala under Washim District came in picture for its huge orange farming. The economy of Mungala village is mostly based on orange production. Every second farmer in the village has been growing oranges in their field. During the season orange consumption of village itself is huge. The peels of orange during this period generate lot of agriculture food waste. Few observations about that orange peel waste are the bio-waste generated from orange peel is not recycled for any application and thrown away directly by neglecting its bio-plastic properties. Further, bio-waste generated does not provide any additional source of income to the farmers / villagers.

2.3. Conception

Considering above two Scenarios, it is conceptualized that to explore Orange Peels for production of bio-plastic material and further utilizing for making hair accessories. Accordingly, the project plan, objectives and research proceed.

Figure 1: Conception of Orange Peel to Bio-Plastic

3. Statement of Necessity

We are in dire need of developing bio plastic derived from orange peels for hair accessories. This innovative approach will not only reduce food waste and fashion footprint but also promote sustainability and scientific development in the fashion industry. By utilizing orange peels, a readily available and often discarded byproduct, we can create fashion accessories that will replace the plastic material made up from harmful chemical in future. This initiative is 'need of the hour' to reduce environmental harm, meet consumer demands for sustainable products, and address food waste challenges.

4. Objectives, Hypothesis and Research Plan

4.1. Objectives

1) Investigate the current environmental impact of hair accessories production and disposal.
2) Identify eco-friendly materials and manufacturing processes for hair accessories.
3) Develop and evaluate prototypes of eco-friendly hair accessories from bio-waste like orange peels to bio-plastic.
4) Assess consumer attitudes and preferences towards sustainable hair accessories and fashion preferences thereof.
5) Propose strategies and campaign for promoting eco-friendly and sustainable fashion in hair accessories in the market.

4.2. Hypothesis

1) Producing bio plastic from orange peels for hair accessories for eco-friendly alternative will significantly reduce the environmental impact of hair accessory production and consumption.
2) This bio plastic will helpful for resource conservation, lower fashion footprint, increased consumer acceptance, and food waste reduction.
3) It is anticipated that this innovative approach will promote sustainable and responsible fashion industry.
4) Campaign suggested in this action research i.e. 'Sakhi Paryavarnachi' will become a mass program in future.

4.3. Research Plan

A comprehensive plan of 28 days is prepared for conducting this action research project which includes Literature Review & Visits, Environmental Impact Assessment, Material & Process Exploration, Prototype Development, Prototype Development, Evaluation & Development and Promotion & Publicity etc.

5. Overview of Hair Accessories

5.1. History

Hair accessories have a rich history in Indian culture, reflecting the country's heritage and diverse traditions. One of the earliest examples dates back to the Indus Valley Civilization around 2200-2600 BC [14]. They were used for fashion, function, and symbolic purposes, carrying religious, social, and cultural significance. Over the time, they evolved with changing styles and tastes, incorporating European influences while maintaining their unique identity. Today, hair accessories remain essential in traditional attire and modern fashion, representing beauty, culture, and identity in India.

5.2. Availability & User

Hair Accessories available in various forms, such as metal or plastic clip, bands, ribbons, bows, hairpins, combs, barrettes, beads, and more. They are worn by people of all ages and genders, signifying different meanings based on their design and materials.

Figure 2: Various types of Hair Accessories

5.3. Environment Concerns

Many hair accessories contain chemicals that can harm the environment, and some are produced unsustainably. Plastic hair clip, ties, hairpins, combs, barrettes, elastics are non-biodegradable and can take decades to decompose. These accessories participated in generating carbon footprints at

each stage of their life cycle i.e. manufacturing, marketing, consumption, and disposal.

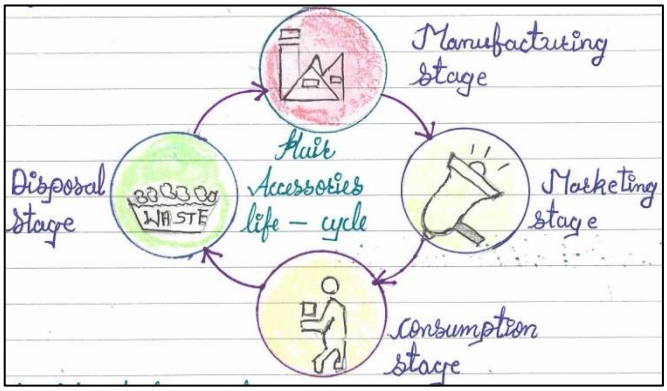

Figure 3: Life Cycle of Hair Accessories

5.4. Observations and Way Forward

The study of hair accessories reveals the potential for pollution at every stage of its lifecycle. However, by adopting sustainable manufacturing practices, reducing packaging, promoting conscious consumption, encouraging proper disposal and by adopting eco-friendly material we can mitigate the environmental impact of hair accessories [7]. While reviewing literature of sustainable and eco-friendly bio-plastic material for hair accessories a one thought comes to made it from bio-waste which will not only address the utilization of waste but also provide alternative for the fashion industry. Further it will also enable the additional source of income to the farmers & consumers. The research begins and option of 'Orange peel' explored herein.

6. Orange and Bio-plastic

6.1. Orange - At a Glance

Oranges are a nutritional powerhouse, packed with vitamins and minerals. The most noteworthy of these is vitamin-C, a water-soluble antioxidant that prevents cell damage. Mandarin orange (Citrus reticulata) is most common among citrus fruits grown in India. It occupies nearly 40% of the total area under citrus cultivation in India. The most important commercial citrus species in India are the mandarin (Citrus reticulata), sweet orange (Citrus sinensis) and acid lime (Citrus aurantifolia) sharing 41, 23 and 23 % respectively of all citrus fruits produced in the country. Nagpur is the hub of Oranges and knows as Orange city of the country.

Table 1: Orange Producing States in India (2022-23)

States	Tones / Annum	%
Maharashtra	692000	57.72
Madhya Pradesh	237000	19.77
Assam	83000	6.92
Other States	186891	15.59
All India	**1198891**	

6.2. Properties of Orange peels

1) Orange peels are food wastes that are highly challenging as waste.
2) The peels have high starch content and hence find potential use for the production of bio-plastic.
3) It also contains pectin, an essential source in providing bio-plastic strength.
4) The orange peel consists of hemicelluloses, starch, cellulose, lignin, pectin, soluble sugars, fat, ash, protein, and flavonoids.
5) Orange has a huge quantity of cellulosic content, disposed of in landfills.
6) As the orange peels decompose to produce methane gas and contribute 20% of methane gas leads to global warming. Hence, the utilization of solid wastes of orange peels into a useful and beneficial product is vital.

6.3. Bio-Plastic:

1) Bio-plastic is a Biodegradable plastic that is made or derived from biological materials or renewable sources.
2) Bio-plastics can be bio based (made from a renewable resource), biodegradable (able to break down naturally) or both.
3) Biodegradable bio-plastics can be just as durable as other types of plastic, as they only break down in specific conditions.
4) Bio-plastic has less/zero harm to the nature likely meager cost of production and availability as alternate materials upon the conventional and banned plastic based for the changing requirements of the modern society.

6.4. Advantages of bio-plastics

1) Reduce carbon footprint
2) Provide energy savings in production
3) Do not consume non-renewable raw materials
4) Reduces non-biodegradable waste that contaminates the environment
5) Do not contain additives that are harmful to health or skin.
6) Do not change the flavor or scent of the food contained or packed in it.
7) Provide additional source of income to farmers, consumers and processors.

7. Procedure: Orange Peel to Hair Accessories

There are different methods of making bio-plastic from Orange peels. For the ease of understanding and experimentation a pure bio-based and homemade process is adopted herein [8].

7.1. Ingredients and Quantity

For the ease of making Bio-plastic [13] [14], collect all the following ingredients in the specified quantities as below:

Table 2 : Ingredients and Quantity

SN	Ingredients	Quantity	Approximately
1	Orange peel (finely Chopped)	100 gm	1 Cup
2	Cornstarch	25 gm	2 tbsp
3	Vinegar	15 ml	1 tbsp
5	Glycerin	10 ml	1 tsp
4	Baking Soda	10 gm	1 tsp

	(Sodium Bicarbonate)		
6	Lemon Juice (Citric Acid)	10 ml	1 tsp
7	Coconut Oil	10 ml	1 tsp
8	Water	200 ml	1 Cup

Apart from above ingredients the equipments like mixing bowl, saucepan grinder, mixer or food processor, heat source, oven, different mold, shaping tool, tablespoon & teaspoon, gloves etc. are required for making bio-plastic.

7.2. Functions of Ingredients

The functions of the ingredients are given below [8].

1) **Orange Peels:** Fresh orange peels have a higher moisture content that results in a more flexible and pliable bio-plastic.
2) **Cornstarch:** Cornstarch is a thickening agent that will improve the stability of bio-plastic product. It also contributes to the overall texture and consistency of the bio-plastic.
3) **Vinegar:** Vinegar improves bio-plastic's overall stability and strength, due to its acidifying properties.
4) **Glycerin:** Glycerin makes a more flexible and durable bio-plastic by enhancing the elasticity of orange peel bio-plastic. Thus, it is not prone to brittleness, ensuring material strain and strength over time.
5) **Baking Soda:** It is one of the preservative and plasticizer additives. It strengthens bi-plastic and make it more durable.
6) **Lemon Juice:** Citric acid is used as an organic cross linking agent and a plasticizer for starch films. It forms hydrogen bonds with starch to enhance its thermal and water stability.
7) **Coconut oil:** It helps to make bio-plastic more stretchable and support to increase transparency.
8) **Water:** Water serves as a solvent for natural oils and cellulose extraction. It facilitates the workable and moldable bio-plastic mixture, ensuring to get a desirable consistency.

7.3. Steps in Making Bio-plastic Hair Accessories

1) Boil the finely chopped orange peel in water for about 30 minutes to soften it and extract the necessary components for making bio-plastic.
2) Strain the boiled orange peel and let it cool down. After cooling convert the peel into fine pulp using grinder.
3) In a separate bowl, mix 2 tablespoons of cornstarch with 1 cup of water to create cornstarch slurry.
4) In a saucepan, combine the cornstarch slurry, 1 tablespoon of vinegar, 1 teaspoon of sodium bicarbonate, 1 teaspoon of glycerin, and 1 teaspoon of lemon juice.
5) Heat the mixture over low heat, stirring constantly until it thickens and forms a gel-like consistency.
6) Add the orange peel pulp to the mixture and continue stirring until well combined.
7) Remove the mixture or formulation from heat source and let it cool slightly.
8) Using molds or shaping tools, Craft the bio-plastic mixture or formulation into hair accessories like hair clips, pins, or combs.
9) Allow the bio-plastic hair accessories to dry and harden for at least 24 hours or heat them using oven till it become achieve desired toughness.

Figure 4 : Process flow of Orange Peel Making Bio-plastic

10) Once dried, carefully remove the hair accessories from the molds or shaping tools.
11) To look beautiful, color the hair accessories using different colors as per requirement.
12) Some successfully made sustainable and eco-friendly bio-plastic hair accessories from orange peel are shown below.

Figure 5: Some Hair Accessories

Figure 6: Final Product Application

8. Awareness Survey and Outcomes

The survey of Hair Accessories was conducted through offline as well as online mode. The objectives of the survey were to gather the information of hair accessories being utilized by the consumer and awareness about environmental consequences and 'Sakhi Paryavaranachi' Movement.

8.1. Questions and responses

Table 3: Survey Questions & Responses

SN	Questions	Yes %	No %
1.	Are you using hair accessories?	77.13	22.87
2.	Do you have any plastic hair accessories like hair clip, claw, pin, Head Bands etc.at Home?	79.37	20.63
3.	Do you think plastic hair accessories are harmful to the environment?	87.00	13.00
4.	Do you know any alternate source of plastic for making hair accessories like bio-plastic or natural plastic?	43.05	56.95
5.	Are you using any bio-plastic / Natural hair accessories which are bio-degradable and eco-friendly also?	37.22	62.78
6.	Can you use hair accessories if made up from bio-plastic using waste material like orange peels, which is bio-degradable and eco-friendly?	82.51	17.49
7.	Do you like to reduce or limit your hair accessories fashion or share your unused accessories to your friend, relatives, needy one just like cloths and shoes?	84.75	15.25
8.	Do you like to be part of the mission 'Sakhi Paryavaranachi' for promoting natural plastic for hair accessories	84.30	15.70
9.	Would you like to do the promise to the mother earth to adopt eco-friendly sustainable fashion in hair accessories?	91.48	8.52
10.	Would you like to speak about your promise to your family, friends and aware them also?	91.48	8.52

8.2. Observations from survey results

1) Positive feedback on the eco-friendly aspect of the orange peel product, with respondents appreciating the use of sustainable materials.
2) Concerns about the durability and longevity of the bio-plastic compared to traditional plastic hair accessories.
3) Interest in learning more about the process of making bio-plastic and its environmental benefits.
4) Suggestions for expanding the product line to include more variety in designs and colors to cater to different preferences.

In short, the survey outcomes could indicate a promising market for hair accessories made from bio-plastic derived from orange peel, with a focus on sustainability and eco-conscious consumers.

9. Futuristic Move

9.1. Direct-Ink-Writing 3D Printing Technology

Apart from mold based or hand crafted shapes it is observed that these peel based prepared formulation can be utilized for 3D printing also [2]. Using Direct-Ink-Writing (DIW) 3D printing technology, we can successfully craft orange peel hair accessories. 3D printing is a manufacturing technique which uses layer-by-layer deposition to create items.

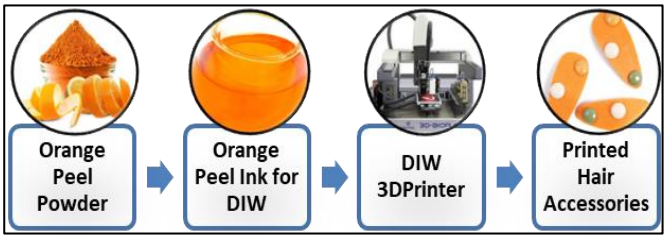

Figure 7: 3D Printing Process Flow

The detailed literature review was conducted based on available material and it is suggested that orange peel ink formulation and 3D printing process works well and will be a futuristic solution for eco-friendly and sustainable fashion in hair accessories.

9.2. 'Sakhi Paryavarnachi' Campaign

The manufacturing of bio-based hair accessories does not completely solve the purpose of making fashion world sustainable and eco-friendly. It requires promoting these accessories in society through women groups, social workers and amongst the end users. To achieve this, a revolutionary campaign 'Sakhi Paryavarnachi' is explored in this action research project. It promotes the use of bio-plastic materials and eco-friendly hair accessories amongst the end user from the user itself. By participating in choosing bio-plastic over traditional plastic, women can reduce their fashion footprint and protect the environment. With 'Sakhi Paryavarnachi' they can make a positive impact on the society while looking fabulous. Everyone can join the movement towards a greener future with 'Sakhi Paryavarnachi' and be a part of the change.

10. Observations

1) The process of making bio-plastic from orange peel is relatively simple and requires minimal ingredients and equipment.
2) The resulting bio-plastic has a natural orange scent, which adds a pleasant aroma to the material.
3) The texture of the bio-plastic may vary depending on the exact process used, but it generally has a smooth and flexible feel.
4) The color of the bio-plastic can range from a pale yellow to a deep orange hue, depending on the concentration of orange peel used in the process.
5) The bio plastic made from orange peel is biodegradable and eco-friendly, making it a sustainable alternative.
6) Hair accessories can be hand crafted but in future it can be explored through "3D Printing" technology.
7) Awareness campaigns are required for increasing use of bio-plastic hair accessories.
8) While promoting best from the waste concept, this research explore additional income source for stake holders.
9) In general, making of bio-plastic from orange peel is a creative and innovative way to reduce waste and create eco-friendly materials for various applications.

11. Analysis

1) After the analysis it is clear that a biodegradable raw

material from orange peels can be used for various applications such as hair accessories, disposable cutlery, and even the same can be utilized for 3D printing.
2) This bio-plastic is not only eco-friendly but also helps in reducing the reliance on traditional plastic derived from chemical materials.
3) It's a great example of turning waste into a valuable resource for a more sustainable future of fashion industry.
4) Creating awareness about bio-plastic and eco-friendly accessories is needed for which promotion program has tremendous scope to explore.
5) Overall, this research is the "fresh start moment" for hair fashion industry to think beyond the limitation.

12. Conclusion

Creating bio-plastic from orange peels to produce hair accessories is a sustainable and innovative way to reduce waste and promote eco-friendly fashion. By harnessing the natural properties of orange peels, we can transform them into stylish and beautiful hair accessories that not only look great but also contribute to a greener planet. This action research project showcases the "best from the waste" concept of making accessories either by hand crafting or futuristic 3D printing technology. Apart from this, it opens the door of additional income source to the orange farmers & consumers. 'Sakhi Paryavarnachi' social program enriched from this action research project which may become a movement in future to preserve the 'Mother Earth'. So, let's embrace the creativity, sustainability, and style with bio-plastic hair accessories made from orange peels!

References

[1] Jayachandra S. Yaradoddi, Nagaraj R. Banapurmath & others, "Bio-based material from fruit waste of orange peel for industrial applications", Journal of Materials Research and Technology, Volume 17, March–April 2022, Pages 3186-3197
[2] Jian Da Tan,1,† Cheng Pau Lee & Others 3D printability and biochemical analysis of revalorized orange peel waste, PMC, PubMed Centralm, Jun 2023; Pg. 776
[3] Sanjeev Singh a, Amar K. Mohanty, Renewable resource based bio-composites from natural fiber and polyhydroxybutyrate-co-valerate (PHBV) bioplastic Composites" Part A: Applied Science and Manufacturing Volume 39, Issue 5, May 2008, Pages 875-886.
[4] https://www.sustainyourstyle.org/en/whats-wrong-with-the-fashion-industry
[5] https://climateseed.com/blog/the-environmental-impact-of-fashion
[6] https://www.theenvironment.in/2023/10/04/the-future-of-indias-sustainable-fashion-a-glimpse-into-2024-and-beyond-opinion
[7] https://climateseed.com/blog/the-environmental-impact-of-fashion
[8] https://ecomaniac.org/how-to-make-bioplastic-from-orange-peels
[9] https://earth.org/statistics-about-fast-fashion-waste
[10] https://earth.org/fast-fashions-detrimental-effect-on-the-environment
[11] https://www.zerowaste.com/blog/zero-waste-electronics-is-it-possible
[12] https://www.wikihow.com/Make-Bioplastic
[13] https://boundedbybuns.com/weight-conversion
[14] https://www.deepagurnani.com/blogs/journal/a-brief-headband-history

Author Profile

Arjit Amol More is the student of swami Vivekanad English High School, Chembur, Mumbai studying in standard VI. Arjit is the keen physicist of his age, who explores the knowledge of science and technology. He has own YouTube channel (Littlentist) for promotion of science and technology. He is very well known for his innovative 'Umbrella that shines the lives' project i.e. 'Illumbrella' for which he received science exhibition award. He has won several medals for Olympiad exams. His aim is to build a scientific and innovative world for the ease of society.