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Alternative Methods of Animal Testing for Development of Cosmetics

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Abstract:

The cosmetic industry relies on animal testing to ensure the safe use of a cosmetic product. The unethical practices and unsanitary conditions of the testing process have led humanity to resort to alternative methods to be considered the new norm. The treatment of animals involved in the testing procedure is seriously mistreated. These traditional and outdated practices involve exposing the animals to harmful chemicals and environments, which leads to the suffering and death of these animals. If the animals survive the suffering, their lives will end regardless. Since the testing process was known to the public, society has tried its best to discontinue the corrupt method by experimenting with other procedures that do not involve animals. Many countries have enforced laws for animal rights, providing them protection to not be subject to these conditions. The alternatives include in vitro testing, computer modelling and simulation using artificial intelligence, and testing with human volunteers. These innovative methods are more accurate, reliable, and cost-efficient and should be replacing animal testing permanently worldwide.

Keywords: Cosmetic chemistry; Animal test; Simulation; In vitro test.

1. Introduction

Animal testing guarantees the safety and effectiveness of a cosmetic product before humans use it. There are serious ethical issues regarding how animal subjects are treated during experimentation. It frequently entails exposing the animals to dangerous toxins, which cause suffering or, under certain circumstances, death. The controversial practice promotes alternatives to be used, to conclude the suffering of animals. Alternatives such as in vitro testing, modelling, and simulation by computer artificial intelligence and human volunteers are becoming popular.

Developing cosmetic products involves a multi-step process to ensure safety before reaching the consumer market. The formula is created before the safety testing process. Aspects such as appearance, fragrance, benefits, claims, the product's colour, texture, aroma, competitive products, packaging, safety, and price range are carefully considered to ensure the product reaches maximum success and consumer enjoyment. The desired ingredients to be included in the product would need to be safety tested to ensure the safety of consumer usage. Animal testing is in-

volved in this step of the process. Quality and compliance testing is essential for the product to meet all legal standards. The product is then mass-produced and released to the consumer market.

The Food and Drug Administration defines cosmetics as "articles intended to be applied to the human body for cleansing, beautifying, promoting attractiveness or altering the appearance without affecting the body's structure or functions." Any item that falls into this category is required to be safety tested. Despite the availability of cruelty-free options that do not require harming animals and many ingredients already approved to be used within cosmetics, 500,000 animals annually are sacrificed for cosmetic testing. These animals are guaranteed to die once they have been experimented on.

The industry created this safety testing method to ensure it was safe for human use. There are several issues with this experimentation process, including several outcomes leading to inaccurate results. The harsh and cruel conditions of the experimental environment forced society to popularize alternative safety testing methods to ensure that products in the cosmetic industry are cruelty-free.

2. Animal Testing in the Cosmetic Industry

Animal testing in the cosmetic industry has been historically controversial for decades, with the method being utilized since 1938. Various rodents, rabbits, pigs, and various small mammals are frequently used as subjects. Skin irritation tests are performed by shaving the fur off the mammals and dripping the chemical solution onto the animal's bare skin. Eye irritation tests are performed similarly by dropping the solution into the subject's eyes.

Force-feeding is an observational test, regarding the chemical dosage of ingredients in the cosmetic. Researchers deliver doses of the chemical to the subjects periodically. During the experimentation process, they observe for illness to determine whether the ingredient is considered safe or not. Specific observational tests are also able to be performed to observe specific health hazards such as cancer. Pain relief is not provided if any irritation, disease, or pain is prominent on the subject.

If the animals manage to survive the testing process, they are killed regardless. Common ways of eliminating the subjects are decapitation, neck-breaking, and asphyxiation (the state or process of being deprived of oxygen). A large percentage of subjects in the United States, especially laboratory-bred rats receive no protection under the "Animal Welfare Act" as they are not counted in official statistics within animal testing.

Animal tests have other setbacks besides animal cruelty. Animals often respond differently than humans when exposed to the same chemicals. This leads to inaccurate conclusions when determining hazards to humans. More accurate responses usually involve the use of voluntary human testing or the rapidly developing AI (artificial intelligence) technology. These alternatives are more accurate and cost-efficient than the use of animals.

Parabens are often included in various skincare products as a preservative. They prevent the growth of mould and various bacteria. When parabens are used on rodents, it significantly impacts their reproductive systems. Scientists have concluded that when rodents are exposed to parabens, it has the same effect as estrogen does on humans. The parabens combined in skincare are very minimal and concluded to be safe. There is not enough to allow reproductive harm to humans. People have thicker skin compared to rodents. Our skin also has a much quicker metabolism, which reduces or eliminates the reproductive harm caused by parabens. If the inclusion of parabens in skincare has only been determined by animal testing results, it is deemed inaccurate as the risks in animal testing do not always directly reflect on humans.

Animal testing is unnecessary now that thousands of ingredients have already been tested. Companies can create new products using these ingredients used in plenty of other products. Approximately fifty non-animal tests already are accurate with more methods being developed. These newer alternatives are more accurate in the sense that they copy how humans respond to these ingredients instead of animals, which is less accurate. If there is updated testing required, modern methods can be used to test these ingredients instead. Many of these tests deliver results more rapidly, reliably, and cost-efficiently.

3. Alternative Methods

The cosmetic industry is rapidly developing with innovative product formulas being in production constantly. The brands producing the products still need methods to test if their products are safe and effective before reaching a market audience. Developing technology has allowed the process of animal testing to slowly diminish. Modelling by artificial intelligence, in vitro testing, and human volunteering are all sufficient and superior alternatives to the animal testing practice. These practices are more human and often more accurate than tests being conducted on animals. These experiments are also relevant to modern society, animal testing has been a method used to do trial and error testing for human purposes for centuries. With humans evolving technology rapidly these alternative methods are beneficial to keep the testing for new product

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innovations accurate.

3.1 Modeling/Simulation by Computer AI

Modelling and simulation using computer artificial intelligence and rapidly replacing animal testing. It creates virtual models of the skin and cells that mimic the effects of the ingredients on human skin. Artificial intelligence is then able to predict how these chemicals will react on the skin. It uses previously existing data and research from humans and previously conducted experiments to simulate how these ingredients will affect skin. It is accurate and sophisticated enough to determine potential skin irritation, allergies, long-term effects, and benefits. Common methods include in silico modelling, quantitative structure-activity relationship (QSAR) models, virtual organs, and tissues.

In silico testing uses computer simulations. These tests use models of the skin without the need for humans generated by AI. They create these models by using previously existing information and experiments. Quantitative Structure-Activity Relationship Models (QSAR) are mathematical models that can predict biological outcomes using previous knowledge of chemical compounds.

Using virtual organs and tissues is another alternative to using AI-generated models human skin models. The virtual models can generate an accurate representation of the epidermis, dermis, and hypodermis. The AI can then consider immune response and metabolism to decide how to see how ingredients in products affect the skin. Organ-on-a-chip is the technology that involves tissue chips that are built for human cells. They mimic the structure of the internal organs such as the lungs, hearts, kidneys, and liver. They are microchips that can predict how certain substances affect these organ systems. The AI is combined with organ-on-a-chip technology to simulate the interactions between the different tissues and organs.

Using machine learning and predictive analysis, AI systems can process data from previous animal studies, human clinical trials, and other research patterns to predict the outcome of new ingredients. It also would need to consider human genetics as different ethnicities around the world have various skin and hair types. This information would be useful to see if the accurate ingredients were incorporated into the product. A shampoo made for straight hair would not be able to be used by someone who has 4C hair as their hair contains coils and is made up of different bonds. The computer can take this data and apply it to the tests of new ingredients.

3.2 In Vitro Tests

In vitro tests use cells tissues, or organs outside of the human body to conduct tests. In the cosmetic industry, in vitro tests involve reconstructing the model of the epidermis. They would also test the ingredient to see if it is safe for the cornea, as many different products are used within the eye region. There are multiple types of in vitro testing used in cosmetics. The most popular types of in vitro testing that give the most accurate results are three-dimensional skin models, cytotoxicity tests, and genotoxicity tests.

Three-dimensional (3D) models are used to replicate the layers and features of human skin cells. Layers of skin cells are used to simulate the dermis and epidermis layers of the skin. Melanocytes are used to construct the melanin skin models.

Cytotoxicity is the loss of plasma membrane within the cell. It is the use of various substances to damage or kill cells. The testing for cytotoxicity is used to determine the toxicity level of a chemical by seeing how it affects human cells. The test concludes whether the ingredient damages or kills cells by exposing the cells to different amounts and intensities of the chemical. It serves as a general toxicity screen before more involved testing.

Genotoxicity tests establish the likelihood of a substance to cause genetic damage. The results could potentially lead to mutations or cancer. Evaluations such as the “Ames Test” use bacteria or animal cells to detect DNA damage. The main function of the tests is to ensure that the ingredients do not have other complications or risks such as cancer

3.3 Human Volunteers

Human volunteers deliver incredibly accurate results since it directly applies to what needs to be tested. This method involves getting humans to volunteer to test an ingredient on their skin. These tests are usually conducted in professional medical settings. Observations from the data are then made to conclude whether humans have a high probability of getting skin allergies and irritation from the materials.

Patch Testing involves applying an ingredient/product to the skin of human volunteers. The patch is placed on the forearm or the back. The subject then must wait a period recommended by the specialist; the expert then observes for allergic reactions and irritation in the skin. The patch is then placed back onto the skin and left for 48 hours, to then be observed after the removal. Symptoms such as redness, swelling, and other irritation are being monitored after the two-day testing period. The testing is a form of allergy testing.

The HRIPT (Human Repeated Insult Patch Test) is a re-occurring patch testing method. Where the patch with the

product is applied several times to the same skin area. This repeating process is purposely tested for reoccurring effects such as acne, or seeing the product potentially cause contact allergies. The testing involves an induction phase (multiple applications over several weeks) followed by a period where no product is applied. The final part of the process is a phase where the product is reapplied again to see if the skin becomes sensitive. This is important for products with prolonged or repeated contact with the skin, like lotions or deodorants.

Clinical Trials involve a larger group of human volunteers testing the final product under real-world conditions. The trials assess product performance, safety, and consumer satisfaction. The participants use the testing product over a specific period directed by the doctor, specialist, or medical professional. The researchers then monitor for alterations in the skin's conditions, or other relevant outcomes. Clinical trial testing is most used for face products such as moisturizers, anti-aging creams, eye creams, sunscreens, and serums to ensure their efficacy and safety on the skin

4. Conclusion

Many alternatives have been provided to eliminate the inhumane practices of animal testing. These experimental processes have been under development for years and can be utilized confidently. The shift towards these methods in cosmetic safety testing has had a significant positive transformation in the safety testing industry. These alternatives such as in vitro testing, computer modelling simulation with artificial intelligence (AI), and testing with human volunteers have substantial improvements over traditional animal testing. In vitro testing provides a controlled environment where human cells and tissues can be examined directly, offering perspectives that are more relevant to human skin. The approach enhances the accuracy of safety assessments. It also evaluates specific effects on human skin and other tissues. When using animal subjects, these results often do not match the hypothesis and do not have accurate results. Three-dimensional skin models, cytotoxicity testing, and genotoxicity tests are the in vitro testing methods that will replace animal testing in the future. Computer modelling and artificial simulations are another form of cosmetic safety testing. Using previous research and existing algorithms, the technology can predict how these ingredients will react with the human skin. Artificial intelligence can be used to simulate other reactions in the human skin, such as immune responses. The reliability of the testing is superior to testing involving animals. Patch testing is most involved with providing data on product safety for humans. Human Repeated Insulted Patch Testing (HRIPT) are repeated clinical trials that allow scientists to observe how ingredients in cosmetic/skincare products react to human skin over long exposures of time. This provides the most relevant data according to the humans. The alternative methods conclude the ethical issues with animal testing but also use more accurate and modern technology to assess the reliability of cosmetic safety. These methods allow the cosmetic industry to be more open-minded to create cruelty-free and safe products.

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