Keerat Dhilon: Logbook Science Fair 2024-2025

On November 1, I started to think about my project. After watching an article on science buddies about artificial skin, I wanted to do that topic.

On November 5, I decided to have four parts to my experiment testing sweat, UV exposure, WVTR, and retaining ability. This would add depth to my project.

By November 7, I had decided my final topic, which was:

When testing for the UV exposure, sweating, retaining ability, and the water vapor transmission rate (WVTR) of aloe vera gel, coconut oil, petroleum jelly, and shea butter using gelatin-based artificial skin, then which moisturizer is best for the skin?

By November 14, I had finished my hypothesis, key words, and most of my background research.

Hypothesis:

If we test for UV exposure, retaining ability, sweating, and water vapor transmission rate of aloe vera, coconut oil, petroleum jelly, and shea butter using gelatin-based artificial skin, then petroleum jelly will show the best results for retaining moisture. Based on my background research, petroleum jelly has high occlusivity, which means it can prevent water loss. Petroleum jelly is made from oils that create a protective barrier on the skin. Shea butter will show the best results when the skin is placed under UV exposure because it contains vitamins A and C, which protect against UV rays damaging your skin. Shea butter will also perform best with sweating due to its vitamin C content. Petroleum jelly will excel with WVTR because of its high occlusivity levels.

Key Words:

Skin: Skin is the main organ in the body, which is composed of water, proteins, minerals, and fats. Its primary function is to protect the inner body.

WVTR: WVTR stands for water vapor transmission rate, which refers to the amount of water vapor passing through an object.

Artificial Skin: The term artificial refers to something made or produced by humans instead of occurring in nature. Similarly, artificial skin is a type of skin created by humans that mimics the functions and structures of natural skin.

Hydration: Hydration is the process by which something absorbs water.

Moisturizer: A moisturizer is a lotion or cream used to alleviate dry skin.

<u>Background Research 1:</u>

Aloe vera gel comes from a plant that grows in tropical climates. This is a medicinal plant that provides the aloe vera gel. There are at least 75 ingredients in the plant, including enzymes, amino acids, vitamins, and minerals. An enzyme is a biological catalyst and is almost always a protein. A catalyst is a chemical that speeds up a chemical reaction. Amino acids are the substances needed for the body to create proteins. These acids are obtained through the foods that are consumed. When amino acids are combined, they form different types of proteins. Vitamins and minerals are crucial for the body as they enhance the immune system and assist the cells and organs in performing their functions. Aloe vera can be used by applying it, drinking it as juice or gel, swallowing tablets, and consuming aloe latex. Aloe vera can help with various skin conditions, including acne, cuts and scrapes, insect bites, and burns. When you take the tablets, they help lower cholesterol and blood sugar levels, and they also assist with heartburn.

<u>Background Research 2:</u>

Coconut oil is an oil extracted from raw coconuts. It is a saturated substance. The main reason coconut oil works as a moisturizer is that 65% of the oil consists of fatty acids. Through various tests, dermatologists have identified two fatty acids: lauric acid and linoleic acid. Fatty acids are what make up the fat in the skin, along with the food we consume. They are good for the skin as they provide hydration, adjust the skin's oil, prevent acne, and reduce the signs of wrinkles. Because of these two acids, coconut helps with dry skin, helping with small cuts and scrapes, and more. The coconut oil is very hydrating, especially for the areas of the body where skin is dryer, such as elbows, hands, and feet. The best type of coconut oil is unrefined coconut oil.

<u>Background Research 3:</u>

Petroleum jelly is a semisolid. It consists of various mineral oils and waxes. The most common brand is Vaseline. It is mixed with many different oils. Petroleum is used to create a protective layer on the skin against water. Due to this protective layer, it aids in healing the skin and maintaining moisture. Petroleum jelly also keeps the skin soft, hydrated, and prevents water loss. The waxes in Vaseline are the paraffin wax and the microcrystalline. The paraffin wax is the film formed that is waterproof. Paraffin is a name usually used to describe a group of alkaline hydrocarbons. Microcrystalline is used for skin care products because it protects the skin from the wind and cold and is the main reason for keeping the skin hydrating and soft.

Background Research 4:

Shea butter is a seed fat produced from shea trees. The grain is removed from the seed and boiled in powdered form. The butter then rises to the top. The most common reasons to apply shea butter are that it helps with skin, acne, burns, dandruff, dry skin, eczema, and swelling. Shea butter works for all skin types. There will be no signs of clogged pores. This product is also helpful to those who have collagen deficiency. Shea butter helps brighten the skin without any toner. Due to vitamins A and C, applying shea butter can prevent UV rays from damaging your skin. It also helps if you sweat a lot.

Background Research 5:

Skin is the main part of the body made up of fats, proteins, and minerals. The skin is a protective layer against water loss, bacteria, germs, injuries, and more. It also helps the immune system fight bacteria, balances body temperature and water, absorbs vitamin D when exposed to sunlight, and senses touch, heat, cold, and pain. The skin requires collagen, a supplement that reduces wrinkles and improves elasticity and hydration. Keratin is a protein in the skin that aids in wound healing and keeps nails and hair healthy. There are three layers of skin: the epidermis, dermis, and hypodermis. The hypodermis is the bottommost layer. Since the hypodermis is composed of fat, it protects bones and muscles, preventing extreme heat or cold. It is also known as subcutaneous fat. Next is the dermis layer, which comprises 90% of skin thickness. This layer contains collagen and elastin, grows hair follicles, senses touch, produces oil and sweat, and supplies blood. The oil is needed to prevent an overflow of water in the skin. A hair follicle is a tube-like structure that surrounds the root and strand of the hair. There are over 5 million of the hair follicles that you are born with. The epidermis layer is the very top layer of the skin. This layer creates a protective barrier from all the germs, bacteria, rain, sun, and other components. This layer makes new skin cells about every 30 days. Hydration refers to the water in the skin. In order for the skin to look and feel healthy, it needs to have strength and needs to be elastic.

Background Research 6:

Sweat glands are groups of cells that are produced or released in the body. They help the body stay cool after an exercise. The sweat is made from salt. Their main function is to regulate the body's temperature and to discard waste by producing water There are two types of sweat glands. Eccrine glands and apocrine glands. Eccrine glands are mostly found on the palms, soles, and head. They produce a watery kind of sweat that helps the body cool down itself. Apocrine glands produce a sweat that can be found on the hair follicles They play an important role in cooling down the body. It is important to sweat as it helps regulate body temperature, protects the skin, and may help eliminate some chemicals from the body.

Background Research 7:

Artificial skin is a replica of human skin; it can be used for damaged or lost skin. It can be made from synthetic materials, biological materials, and dermo-epidermal components. Synthetic artificial skin is made from materials such as silicone and polyurethane. Silicone helps keep the skin hydrated. Polyurethane can cause irritation and does not dissolve in the skin. These skins imitate the properties of human skin. Biological skin can be further divided into two parts: acellular and cellular skin. Acellular skin is made from the extracellular matrix, including collagen and elastin.The extracellular matrix is a network of proteins and molecules that provide support, surround, and make up the structure of the cells in the body. Cellular skin uses living cells in a scaffold. Lastly, there is dermo-epidermal. They use both the layer of skin synthetic and biological. They are considered to be the greatest level of artificial skin.

Background Research 8:

WVTR stands for Water Vapor Transmission Rate. It measures how much water vapor passes through an object over a set period of time. It is often measured in grams per square meter per day (g/m2/day). Grams per square meter is the weight of a specific fabric, like paper. Moisturizers with high emollients and occlusivity levels are better for the skin as they lock in moisture. Moisturizers with a lower water vapor transmission rate are better for the skin.

Background Research 9:

Occlusivity comes from the word "occlusive," which refers to the ingredients in skincare products that help retain water in the skin. The most common example is petroleum jelly, as its barrier prevents water loss from the skin. Occlusivity aids help retain moisture, protect the skin, speed up the healing process of wounds, and reduce itchiness. Moisturizers with higher occlusivity (e.g., petroleum jelly) will show lower WVTR, indicating better moisture retention. A humectant is a water-absorbing substance used to keep things moist. An example includes glycerin. Humectants provide hydration and skin elasticity, help combat dry skin, strengthen the skin barrier, and assist in wound healing. Humectants (e.g., glycerin) will show higher initial moisture absorption but greater moisture loss rates due to increased permeability. Permeability measures how much fluid or other substances can pass through a material. Emollients are moisturizing treatments that help smooth and hydrate the skin. They are applied directly to the skin. Emollients cover the skin with a protective film that helps trap moisture.

Background Research 10:

UV stands for ultraviolet. UV originates from our main light source, which is the sun. There is a process known as a nuclear reaction. This process causes a significant amount of radiation. Radiation is energy that comes from a source and travels through

space, potentially breaking into different materials. As the reaction occurs, energy is released. This energy is known as the electromagnetic spectrum, which includes radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays. Due to the wavelengths of the radiation, visible radiation allows us to see colors; ultraviolet rays impact our health. Ultraviolet rays can be measured in nanometers. Nanometers are one billionth of a meter. UV light can be divided into three types: UVA, UVB, and UVC. UVA is considered to range between 320 and 400 nanometers. This UV light can reach the middle layer of the skin (dermis). It can lead to immediate tanning and skin cancer. UVB has a shorter wavelength, ranging from 280 to 320 nanometers. It can cause delayed tanning and skin burns, primarily penetrating the top layer of the skin. UVC can be considered the most dangerous ultraviolet light. Its wavelengths can range from 100 to 280 nanometers. It can be very energetic. This UV light stays in the ozone layer of the earth. The rest position in the wavelength is the line through the center of the wave. Crest is the highest part of the wave, and the lowest is known as the trough. The distance between the resting position and the crest or trough is the amplitude. The wavelength is the distance between two similar points. Like crest to crest or trough to trough.

By November 20, I had finished my materials, variables, and procedures.

Materials needed for the skin:

- ***40 grams of unflavoured gelatin***
- ***2 tablespoons of cornstarch***
- ***60 ml of glycerine***
- ***200 ml of warm water***
- ***10 ml of olive oil***
- ***1 heat-resistant bowl***
- ***1 tablespoon or measuring spoon***
- ***1 shallow dish***

Materials

- ***12 ml of vaseline***
- ***12 ml of coconut oil***
- ***12 ml of aloe vera gel***
- ***12 ml of shea butter***
- ***1 digital scale***
- ***1 UV lamp***
- ***1 spray bottle***
- ***4 plastic containers***
- ***12 desiccant packets (can be substituted with uncooked rice)***
- ***1 ruler***
- ***Timer***

- ***Cotton Swabs***
- ***Plastic wrap***
- ***1 knife***
- ***1 marker***

<u>Variables: Retaining Moisturizer</u>

Controlled Variables: My controlled variables are the amount of moisturizer used, the type and amount of gelatin, glycerine, cornstarch, and olive oil being used each time, the accuracy and type of scale, the type of plastic wrap, and the time when the plastic wrap is put.

Uncontrolled Variabl: My uncontrolled variable is the type of skin (dry, oily, and more).

Manipulated Variable: My manipulated variable is the type of moisturizer being used each time (aloe vera gel, coconut oil, shea butter, and vaseline).

The responding variable is: Which moisturizer sample has the lowest decrease?

<u>Variables: WVTR</u>

Controlled Variables: My controlled variables are the amount of moisturizer used, the type and amount of gelatin, glycerin, cornstarch, and olive oil being used each time, the accuracy and type of scale, the amount of desiccant packets, and the time and temperature when desiccant packets are put.

Uncontrolled Variable: The uncontrolled variable is the temperature at which the sample was put in the container.

Manipulated Variable: My manipulated variable is the type of moisturizer being used each time (aloe vera gel, coconut oil, shea butter, and vaseline).

The responding variable is: Which moisturizer has the lowest water vapor transmission rate?

<u>Variables: UV Exposure</u>

Controlled Variables: My controlled variables are the amount of moisturizer used, type and amount of gelatin, glycerin, cornstarch, and olive oil being used each time, the accuracy and type of scale, and time when the samples are under the UV lamp

Manipulated Variable: My manipulated variable is the type of moisturizer being used each time (aloe vera gel, coconut oil, shea butter, and vaseline).

Uncontrolled Variable: The uncontrolled variable was where the UV light hit the sample.

The responding variable is: Which moisturizer shows the lowest decrease in weight under UV exposure?

<u>Variables: Sweating</u>

Controlled Variables: My controlled variables are the amount of moisturizer used, the type and amount of gelatin, glycerin, cornstarch, and olive oil being used each time, the accuracy and type of scale, and the number of times the sample gets sprayed.

Manipulated Variable: My manipulated variable is the type of moisturizer being used each time (aloe vera gel, coconut oil, shea butter, and vaseline).

Uncontrolled Variable: The uncontrolled variable is the amount of water sprayed (sometimes the amount of water sprayed on the sample was more or less).

The responding variable is: Which moisturizer shows the lowest decrease in weight when being tested with sweat?

<u>Procedure for Gelatin-Based Skin</u>

1. ***First, gather all the materials.***
2. ***Second, pour 20 grams of unflavored gelatin into a heat-resistant bowl.***
3. ***Third, pour 30 ml of glycerine.***
4. ***Fourth, pour 100 ml of warm water.***
5. ***Next, pour 5 ml of olive oil.***
6. ***Then, add one tablespoon of cornstarch.***
7. ***Stir the mixture until the gelatin is dissolved with all the other ingredients.***
8. ***Then, heat up the mixture in the microwave for 30-45 seconds.***
9. ***Once the mixture has turned into liquid, put it in the shallow dish.***
10. ***Then, let the mixture set in the refrigerator for 30 minutes.***
11. ***Now, take out the skin and cut it into 5x5 cm pieces.***
12. ***Finally, repeat the procedure again.***

<u>Procedure for Retaining Moisturizers</u>

1. ***To start off, gather a sample of gelatin-based artificial skin and apply 1 ml of aloe vera gel by a cotton swab.***
2. ***Then put plastic wrap on top of the skin.***
3. ***Weigh the sample.***
4. ***Make sure to label each sample so you do not forget which moisturizer was applied.***
5. ***After about 1 hour, take off the plastic wrap.***
6. ***Next, wipe the excessive moisturizer by tapping on it.***

7. ***Now reweigh the sample again and calculate the lowest decrease.***
8. ***Put the plastic wrap back on the sample and weigh it after 2 hours, 6 hours, and 12 hours.***
9. ***Don't forget to record the measurements.***
10. ***Repeat this process with coconut oil, petroleum jelly, and shea butter.***
11. ***Finally, do three trials per moisturizer.***

<u>Procedure for WVTR</u>

1. ***First, gather all the materials.***
2. ***Second, get one plastic container and put one desiccant packet at the bottom with uncooked rice surrounding it.***
3. ***Third, apply 1 ml of aloe vera gel to a skin sample.***
4. ***Weigh the skin and place it in the plastic container.***
5. ***Fourth, cover the container with a lid or plastic wrap.***
6. ***Write which sample has which moisturizer so you do not forget.***
7. ***Weigh the sample again after 4 hours, 6 hours, 8 hours, and 12 hours.***
8. ***Don't forget to record the measurements.***
9. ***Repeat the step with the other moisturizers.***
10. ***Finally, do three trials for all the moisturizers.***

<u>Procedure for UV exposure</u>

1. ***First, get a gelatin-based skin sample and apply 1 ml of aloe vera gel to it using a cotton swab.***
2. ***Second, weigh the sample.***
3. ***Write which moisturizer was put on what sample.***
4. ***Third, put the sample under the UV lamp.***
5. ***Weigh the sample after 4 hours, 6 hours, 8 hours, and 12 hours.***
6. ***Don't forget to record the measurements.***
7. ***Repeat the procedure for the other moisturizers.***
8. ***Finally, do three trials per moisturizer.***

<u>Procedure for Sweating</u>

1. ***First, apply 1 ml of aloe vera gel to a gelatin sample by using a cotton swab.***
2. ***Second, spray the sample twice with water.***
3. ***Dissolve the water as much as it can.***
4. ***Cover the sample with plastic wrap.***
5. ***Weigh the sample.***
6. ***Record the results after 1 hour, 2 hours, 4 hours, 6 hours, and 12 hours.***
7. ***Don't forget to write which sample was applied to which sample.***

8. ***Repeat the steps for coconut oil, shea butter, and vaseline.***
9. ***Finally, do 3 trials per moisturizer.***

<u>By December 21, I had finished drawing conclusions and finishing up the rest of my science fair.</u>

<u>Conclusion 1:</u>

The focus of this experiment was to see which moisturizer works best on the skin using a gelatin-based artificial skin model through various tests that can include retaining ability, water vapor transmission rate, UV exposure, and sweating. It was hypothesized that petroleum jelly will show the best results for retaining ability and water vapor transmission rate (WVTR), and shea butter will show the best results for UV exposure and sweating. The results of retaining moisturizer were proven correct because petroleum jelly did show the best results, and for water vapor transmission rate, aloe vera gel showed the best results. For sweating, my hypothesis was proven wrong because coconut oil worked better and not shea butter, and finally, for UV exposure, my hypothesis was proven correct because shea butter did work the best. The average results for the lowest decrease percentage for retaining moisturizers showed that aloe vera gel had an average weight of 31.9%, shea butter 32.4%, vaseline 26.7%, and coconut oil 33.9%. For WVTR, the average results showed that aloe vera gel weighed 35.2%, shea butter 38%, vaseline 36.7%, and coconut oil 35.7%.

<u>Conclusion 2:</u>

For UV, the average results explain that aloe vera gel weighed 26.4%, shea butter 26%, vaseline 29.5%, and coconut oil 27.2%. Finally, for sweating, the average results tell us that aloe vera gel weighed 44.7%, shea butter 27.1%, vaseline 28.7%, and coconut oil 25.6%. This experiment can be supported by the following research: Skin is the main organ in the body that is made from fats, proteins, and minerals.The skin requires collagen to stay healthy. There are three layers of skin: dermis, epidermis, and hypodermis. The hypodermis is the most bottom layer of the skin and consists mostly of proteins, minerals, and fats. The epidermis layer is 90% of the skin thickness. It protects the inner body and maintains the collagen and more. Finally, the demis layer consists of hair follicles. It is important to stay hydrated. Aloe vera gel comes from a medical plant that produces amino acids. Amino acids help the skin to make proteins. There are many ways to use aloe vera gel. Aloe vera can help with acne, cuts, scrapes, insect bites, and more. Shea butter comes from a seed that is produced in shea trees. Then the grain is

removed from the seed and is boiled till the butter rises to the top.

<u>Conclusion 3:</u>

Shea butter has many benefits when applied, as it helps skin, acne, burns dandruff, dry skin, eczema, and many more. It works for dry skin and swelling. Shea butter consists of vitamin A and C, which prevent the UV rays from damaging your skin. Coconut oil comes from raw coconuts and is a saturated substance. Coconut oil consists of lauric and lenoliec acids, which hydrate, adjust the skin's oil, prevent acne, and reduce the signs of wrinkles. Because of these two acids, coconut helps with dry skin, helping with small cuts and scrapes, and more. The coconut oil is very hydrating, especially for the areas of the body where skin is dryer, such as elbows, hands, and feet. The best type of coconut oil is unrefined coconut oil. Sweat glands are groups of cells that are produced or released in the body after an exercise. It is important to sweat as it helps regulate body temperature, protects the skin, and may help eliminate some chemicals from the body. Petroleum jelly is semisolid and is made from minerals and waxes. The waxes help build the barrier between the skin. This traps the water and prevents water loss. Due to higher occlusivity levels, petroleum jelly worked best with retaining moisturizers. From this experiment, we can infer that shea butter works best with UV, aloe vera gel works best for water vapor transmission rate, coconut oil works best with sweating, and petroleum jelly works best with retaining ability of different moisturizers.

<u>Application:</u>

The results of this science fair experiment can help many people for a variety of reasons. First, it can tell people who exercise. When they sweat, the people want to know which moisturizer is best against the water. Second, it can help people who do summer activities in the sun. The people will then know which moisturizer harms the skin the least under UV. Another thing people will know is which moisturizer gets absorbed by the skin the most and how long the moisturizer lasts. The results of the water vapor transmission rate can help people who live in dry climates (e.g., Calgary). The time intervals can also help people to know which moisturizer would be best based on the time the person/people want to go out or do an activity.

<u>Sources of Error:</u>

My science fair could have had been improved because, as I applied the moisturizer by the cotton swabs, it was uneven, which was bad because the weight on the scale kept on changing. Another error in my experiment was that after the moisturizer was applied, the center was thicker, and as you went towards the side, it got thinner. Due to this, the weight was almost all just the gelatin skin, and the moisturizer kept falling off the edges. It was also that while I was applying the melted oils, some of the oil got absorbed with the cotton swab.

Next Experiment:

In order to further study the results of my experiment, my next experiment can be 'Does the temperature affect how different moisturizers work on gelatin-based skin?' It can also be, 'Does the brand of the moisturizer affect how the results of the WVTR change? I can also do, 'Does the time of day when each moisturizer (aloe vera gel, coconut oil, shea butter, and petroleum jelly) is applied affect the results?

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