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Pharmacology of Aging and Anti-Aging Effects of Phytochemicals in Skincare Using Carthamus Tinctorius L. Formulation

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ABSTRACT
This research investigates the potential anti-aging effects of phytochemicals in skincare, with a focus on *Carthamus tinctorius* (safflower) as a key ingredient. Phytochemicals, plant-derived compounds, have garnered attention for their antioxidant, anti-inflammatory, and skin-protecting properties. This study aims to evaluate the effectiveness of *Carthamus tinctorius* extract in a formulated skincare product, assessing its ability to combat signs of aging, such as wrinkles, fine lines, and skin elasticity. Through laboratory experiments and clinical trials, the impact of the safflower extract on skin aging parameters will be analyzed. The findings suggest that safflower phytochemicals, particularly flavonoids and fatty acids, exhibit notable anti-aging benefits and could serve as an effective natural alternative in anti-aging skincare formulations.

Keywords: *Safflower, Elasticity, Antioxidant, Anti-Inflammatory, Skin-protecting properties, Telomere Shortening, UV Radiation*

1. INTRODUCTION

Aging is a natural process that affects the skin, resulting in the formation of wrinkles, loss of elasticity, and uneven skin tone. Skin aging is caused by intrinsic (biological) and extrinsic (environmental) factors, with oxidative stress and inflammation being key contributors. In recent years, the use of phytochemicals bioactive compounds derived from plants has gained popularity in the skincare industry due to their potent antioxidant and anti-inflammatory properties.[1]

Skin aging is a result of cellular DNA and protein damage, which results in a continuous process of deterioration. Sequential skin aging and photo-aging are two distinct categories where aging is divided. Both categories have unique clinical characteristics. Sequential skin aging is a universal and predictable process that is characterized by a change in how the skin functions physiologically. As aging start keratinocytes lose their capacity to create a functional stratum corneum and their rate of neutral. It is influenced by a combination of genetic, environmental, and lifestyle factors. Production of lipids slows down, leaving behind dry, full of wrinkled skin. In contrast, excessive exposure to sunlight's UV radiation results in photo-aging. It is distinguished by dry, pale, superficial skin that exhibits fine lines as well as broad furrows brought on by the disarray of epidermal and dermal components linked to elastosis and heliodermatitis. Herbs and plants have already proved useful as a tool in complementary medicines[2]. Cosmetics are utilized to improve the appearance and appeal of skin while protecting it against external and internal irritants. The usage of cosmetics contributes to improving the good health by preventing skin problems in addition to generating an attractive external appearance. The artificial or natural components in skin care products support the skin's health, texture, and integrity, moisturize, maintain skin elasticity by reducing type I collagen, and provide Protection among other functions. This cosmetic trait results from the inclusion of chemicals in skin care formulations, which aid in lowering the generation of free radicals in the skin and manage the properties over an extended period. [2,3]

1.1 Here are some key aspects of aging:

♣ Cellular Aging: Over time, cells lose their ability to function optimally and undergo a process called senescence. This can lead to a decrease in the body's ability to repair and regenerate tissues.

♣ Genetic Factors: Our genes play a significant role in how we age. Genetic variations can affect the rate at which cells deteriorate and how well the body can maintain itself over time.

♣ Oxidative Stress: Exposure to environmental factors like UV radiation, pollution, and toxins can lead to oxidative stress, which damages cells and accelerates the aging process.

♣ Telomere Shortening: Telomeres are protective caps at the ends of chromosomes that gets shorter with each cell division. As telomeres shorten, cells become less able to divide and function properly, contributing to aging.

♣ Hormonal Changes: Aging is often accompanied by hormonal changes that affect various bodily functions, including metabolism, skin elasticity, and muscle mass.

♣ Lifestyle Factors: Diet, physical activity, stress levels, and exposure to harmful substances can all impact how quickly or slowly a person ages.Overall, aging is an inevitable process, but healthy lifestyle choices can help slow down its effects and improve the quality of life as we grow older.

1.2 Skin aging:

Skin aging is a part of a natural mortal "growing mosaic" which becomes apparent and follows different circles in different organs, apkins and cells with time. While the aging signs of internal organs are masked from the ambient "eyes," the skin provides first egregious marks of the end time. Skin aging is a complex natural process told by combination of endogenous or natural (genetics, cellular metabolism, hormone and metabolic processes) and exogenous or foreign (habitual light exposure, pollution, ionizing radiation, chemicals, poisons) factors.1 These factors lead together to accretive structural and physiological differences and progressive changes in each skin subcaste as well as changes in skin appearance, especially, on the sun- exposed skin areas. In discrepancy to thin and atrophic, finely wrinkled and dry naturally aged skin, unseasonable photoaged skin generally shows a thickened epidermis, mottled abrasion, deep wrinkles, laxity, dullness and roughness.13-18 Gradational loss of skin pliantness leads to the miracle of sagging.19 decelerating of the epidermal development rate and cell cycle dragging coincides with a slower crack mending and lower effective desquamation in aged grown-ups. This fact is important when esthetic procedures are listed.20 On the other side, numerous of these features are targets to product operation or procedures to accelerate the cell cycle, in the belief that a briskly development rate will yield enhancement in skin appearance and will speed crack mending. [1,2]

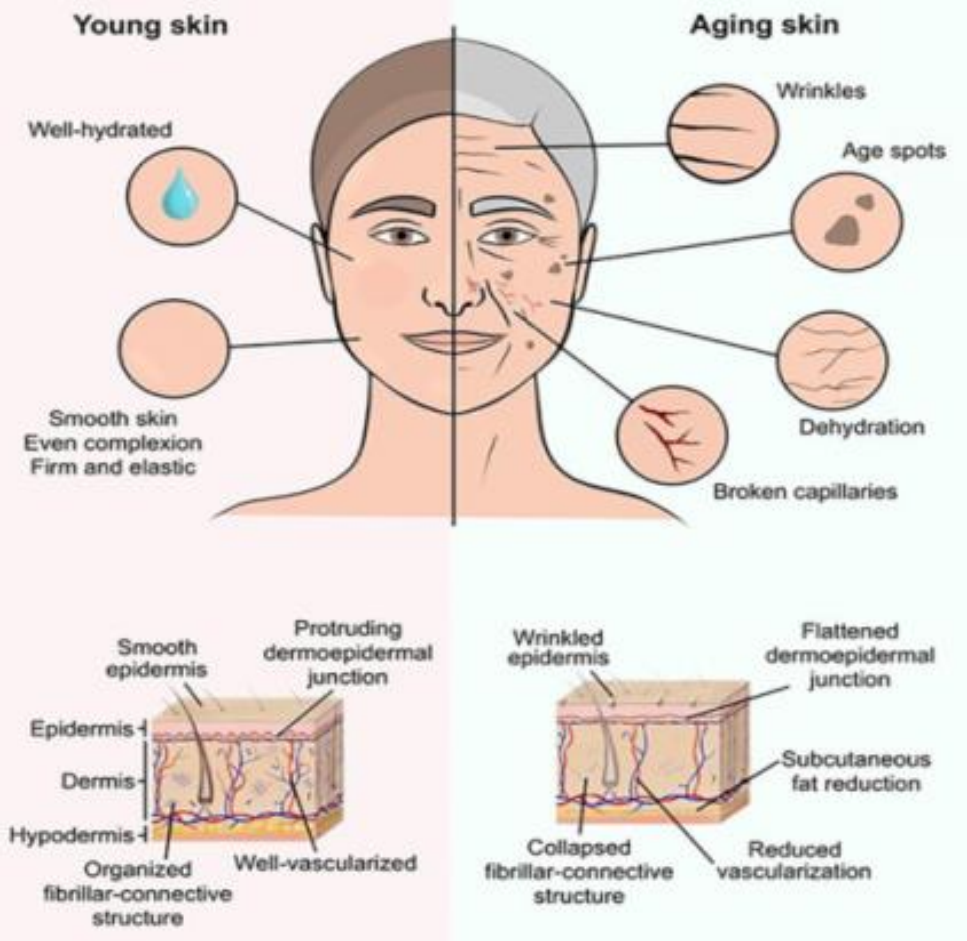

Fig. No. 1: Skin aging

Three primary structural factors of the dermis, collagen, elastin and knaveries have been the subjects of the maturity of anti-aging exploration and sweats for aesthetic-anti-aging strategies pertaining to the skin, from" anti-wrinkle creams" to colorful

filling agents. donation of aging of the entire face is associated with the graveness impact, muscles action, loss of volume, dwindling and redivision of superficial and deep fat, loss of bony shell support what all together lead to the face sagging, changes in shape and figure. Anyhow of the fact that aging is a natural ineluctable process and not a pathological condition it's identified with colorful skin and body pathologies, including degenerative diseases, benign and nasty tumors. The 'successful aging' paradigm, focuses on health and active participation in life, counters traditional conceptualizations of growing as a time of complaint and is decreasingly equated with minimizing age signs on the skin, face and body.[3,4]

This study focuses on the phytochemical-rich Carthamus tinctorius (safflower), a flowering factory known for its oil painting-rich seeds. The oil painting deduced from safflower contains high situations of polyunsaturated adipose acids (PUFAs), flavonoids, and carotenoids, all of which have demonstrated promisinganti-aging parcels. The purpose of this study is to estimate theanti-aging goods of a skincare expression containing Carthamus tinctorius excerpt and to determine its effectiveness in reducing signs of aging. [5,6]

Your skin changes with age. It becomes thinner, loses fat, and no longer looks as rotund and smooth as it formerly did. Your modes and bones can be seen more fluently. scrapes, cuts, or bumps can take longer to heal. Times of suntanning or being out in the sun for a long time may lead to wrinkles, blankness, age spots, and indeed cancer. numerous aged people suffer from dry spots on their skin, frequently on their lower legs, elbows, and lower arms. Dry skin patches feel rough and scaled. [5,7]

There are numerous possible reasons for dry skin, similar as-

- Not drinking enough liquids.
- Spending too important time in the sun or sun tanning.
- Being in veritably dry air.
- Smoking.
- Feeling stress.
- Losing sweat and oil painting glands, which is common with age.

Skin aging is a complex, multifactorial process that involves both natural (inheritable) and foreign (environmental) factors. While utmost people are familiar with the general signs of growing wrinkles, sagging, and abrasion there's a wealth of lower-known, deeper perceptivity into the mechanisms behind these changes. Then are some fascinating, lower- known details about skin aging:[1,2,4]

1. The Role of Cellular Senescence

- Senescent Cells: As we age, skin cells can enter a state known as *cellular senescence*, where they stop dividing but remain metabolically active. These cells release inflammatory factors (known as the *senescence-associated secretory phenotype* or SASP) that damage neighboring healthy cells, accelerating the aging process. Over time, the accumulation of senescent cells leads to skin thinning, impaired repair, and loss of elasticity.
- Senolytics: Some recent research has shown that eliminating these senescent cells (via senolytic drugs) can potentially delay aging and improve skin health. While it's still early, this represents an exciting frontier in anti-aging science.

2. Epigenetic Changes

- DNA Methylation & Histone Modification: Epigenetic modifications play a crucial role in skin aging. The patterns of DNA methylation (the addition of methyl groups to DNA, which can silence genes) and histone modifications (which change how tightly DNA is wound around histones) shift with age. These changes can affect the expression of genes involved in collagen production, immune response, and DNA repair. A key hypothesis in aging is that a "loss of epigenetic clock" leads to disrupted tissue function and aging.
- Nutrient Sensing and Epigenetic Modulation: Nutrients like NAD+ (Nicotinamide adenine dinucleotide) and resveratrol are thought to influence epigenetic modifications that could potentially "reset" the skin's aging process by activating certain longevity-associated genes.

3. Mitochondrial Dysfunction

- Mitochondria in Aging: Mitochondria, the powerhouses of the cell, play an overlooked role in skin aging. Over time, mitochondrial DNA becomes damaged, leading to decreased cellular energy production. This diminishes the ability of skin cells to repair themselves and produce collagen and elastin—key structural proteins. Mitochondrial dysfunction is also associated with increased oxidative stress, a major driver of skin aging.
- Mitochondrial Biogenesis: Some skincare innovations focus on boosting mitochondrial function to counteract this

decline. For example, activating the *PGC-1α* pathway, a key regulator of mitochondrial biogenesis, is an emerging target for anti-aging research.

4. Changes in the Extracellular Matrix (ECM)

- **Glycation:** One of the most profound processes in skin aging is the accumulation of *advanced glycation end-products* (AGEs). These are formed when excess sugars bind to collagen and elastin, leading to stiffening of the skin. Glycation diminishes skin elasticity and makes the skin more prone to wrinkles. AGEs also contribute to chronic inflammation, further accelerating the aging process.
- **Decreased Hyaluronic Acid:** Hyaluronic acid, which is essential for skin hydration, decreases significantly with age. This loss contributes to the dryness, loss of volume, and the formation of wrinkles. Some cutting-edge research explores restoring hyaluronic acid levels or its synthetic pathways to rejuvenate the skin.

5. Microbiome and Skin Aging

- **The Skin Microbiome:** Recent studies suggest that the microbial community on your skin plays a significant role in aging. An imbalance in the microbiome (dysbiosis) has been linked to chronic inflammation, which accelerates the aging process. A healthy microbiome helps maintain skin barrier function and regulates immune responses. Some scientists are now exploring the idea of probiotic skincare, where the use of products that nurture the skin microbiome may help slow down signs of aging.
- Impact of UV Radiation on the Microbiome: Exposure to UV radiation not only accelerates the appearance of wrinkles but also disrupts the skin microbiome. This disruption may exacerbate inflammation, further contributing to premature aging.

6. Telomeres and Skin Aging

- **Telomere Shortening:** Telomeres are the protective caps at the ends of chromosomes, and their length is often used as a marker of biological aging. Every time a cell divides, telomeres shorten. Once telomeres reach a critically short length, the cell can no longer divide and becomes senescent. In skin, this results in fewer cells capable of regeneration, which leads to sagging and thinning of the skin. Strategies to lengthen telomeres or protect them from shortening (such as using antioxidants or certain molecules like *TA-65*) are being researched as ways to delay skin aging.

7. Hormonal Influence

- **Decreased Estrogen and Collagen Loss:** As estrogen levels decline with age, the skin experiences a significant loss of collagen and elasticity. Estrogen plays a crucial role in skin hydration, collagen synthesis, and cell turnover. As a result, post-menopausal women often experience accelerated skin aging. The use of bioidentical hormones or phytoestrogens (plant-based compounds that mimic estrogen) is a topic of ongoing research.
- **Testosterone's Impact on Skin Aging:** In men, decreased levels of testosterone with age can also result in skin thinning, loss of firmness, and a reduction in collagen production. Some studies suggest that testosterone replacement therapy could help maintain skin elasticity, though this is still under debate.

8. Environmental and Lifestyle Factors Beyond UV Exposure

- **Air Pollution:** Fine particulate matter (PM) and other pollutants like ozone can contribute to the aging of the skin by increasing oxidative stress and inflammation. Long-term exposure to pollution leads to the formation of wrinkles, hyperpigmentation, and decreased skin barrier function.
- **Blue Light Exposure:** Prolonged exposure to blue light (emitted from digital screens) can also contribute to skin aging. It penetrates deeper into the skin than UV light and has been shown to increase pigmentation, oxidative stress, and collagen breakdown, even though it's still an emerging field of study.

9. Circadian Rhythms and Skin Aging

- **Night-time Regeneration:** Your skin has its own circadian rhythm, and the time of day can influence its ability to repair itself. During sleep, skin cells are more active in regenerating, synthesizing collagen, and removing waste. Disruptions to sleep (such as insufficient sleep or shift work) can impair this process, accelerating the visible signs of aging. Some research suggests that optimizing skincare routines to align with the skin's natural rhythms (e.g., using richer creams at night) may improve skin health.

10. Aging and the Stem Cells of the Skin

- **Decline of Skin Stem Cells:** Skin regeneration largely depends on stem cells located in the epidermis and hair follicles. These cells are responsible for the constant turnover of skin and hair cells. With aging, the number and

functionality of these stem cells decline, leading to slower wound healing, thinning skin, and reduced hair growth.

- **Stem Cell Therapies:** Stem cell-based therapies, including the use of mesenchymal stem cells, are an emerging frontier in reversing or mitigating the signs of skin aging. These therapies aim to rejuvenate the skin by promoting the regeneration of new, youthful skin cells.

11. Autophagy and Skin Aging

- **Autophagy's Role in Skin Health:** Autophagy is a natural process by which cells clean out damaged components, including old or malfunctioning proteins and organelles. As we age, this process slows down, contributing to the accumulation of cellular waste, damaged DNA, and dysfunctional mitochondria, all of which can lead to skin aging. In the skin, impaired autophagy has been linked to the formation of wrinkles, loss of elasticity, and reduced wound healing capacity.
- **Inducing Autophagy:** There are ways to stimulate autophagy, such as through intermittent fasting, caloric restriction, or certain compounds like *resveratrol* and *spermidine*. This research is still in its early stages, but autophagy may be a promising target for slowing down the skin aging process.

12. Exosomes and Skin Regeneration

- **Exosomes and Skin Repair:** Exosomes are small vesicles released by cells that contain proteins, lipids, and RNA. They play an important role in intercellular communication and have been found to facilitate tissue repair and regeneration. Recent studies have shown that exosomes derived from stem cells can significantly improve skin regeneration and reduce wrinkles. These tiny vesicles are thought to deliver growth factors and other molecules that promote collagen production, enhance skin hydration, and accelerate wound healing.
- **Exosome-Based Skincare:** There's growing interest in exosome-based treatments for skin rejuvenation. Early trials have shown promise for using exosome injections or topical applications to combat the visible signs of aging by activating regeneration at the cellular level.

13. Impact of Heat Exposure on Aging

- **Thermal Aging:** While most people are concerned about UV radiation, heat exposure from environmental factors like high temperatures, saunas, or even heating systems indoors can significantly accelerate skin aging. Heat causes skin cells to lose water more rapidly and induces the breakdown of collagen and elastin.
- **Heat Shock Proteins (HSPs):** In response to stress like heat, cells produce heat shock proteins, which are meant to protect the cells from damage. However, as we age, the production of these protective proteins diminishes. Research is looking into ways to increase HSP production to help protect the skin from thermal aging.

14. Oxidative Stress and the Skin's Antioxidant Defenses

- **Beyond Vitamin C:** While antioxidants like Vitamin C are well-known for their ability to combat oxidative stress, emerging research suggests that the skin's internal antioxidant systems such as *superoxide dismutase (SOD)*, *glutathione*, and *thioredoxin* play even more crucial roles in protecting the skin from free radical damage.
- **Exhaustion of Antioxidants with Age:** As we age, the skin's production of these endogenous antioxidants declines. Some cutting-edge skincare lines are now focused on replenishing these antioxidants at the cellular level, using ingredients like *alpha-lipoic acid* and *CoQ10* to support the skin's internal defence system.

15. Psychological Stress and Skin Aging

- **The Stress-Aging Connection:** Psychological stress has a significant impact on skin aging. Stress activates the body's fight-flight response, leads to increase cortisol production. High cortisol levels have been shown to break down collagen and elastin, which are essential for skin firmness and elasticity.
- **The Skin-Brain Axis:** New research is delving into the *skin-brain axis*, which suggests that emotional and psychological stress can directly affect skin health. Mind-body practices like meditation, yoga, or using stress-reducing skincare ingredients (like adaptogens) could have a profound anti-aging effect on the skin.

These deeper aspects of skin aging highlight the intricate biological processes at play. As science advances, we're likely to see more treatments and strategies targeting these underlying mechanisms to help slow's down or even reverse skin aging in the future. [1,3,4]

Skin aging is a complex process that results from both intrinsic (genetic) and extrinsic (environmental) factors. It involves a series of cellular and molecular changes that lead to the visible signs of aging, such as wrinkles, sagging, and reduced skin elasticity. Let's break it down:

1. Role of Free Radicals

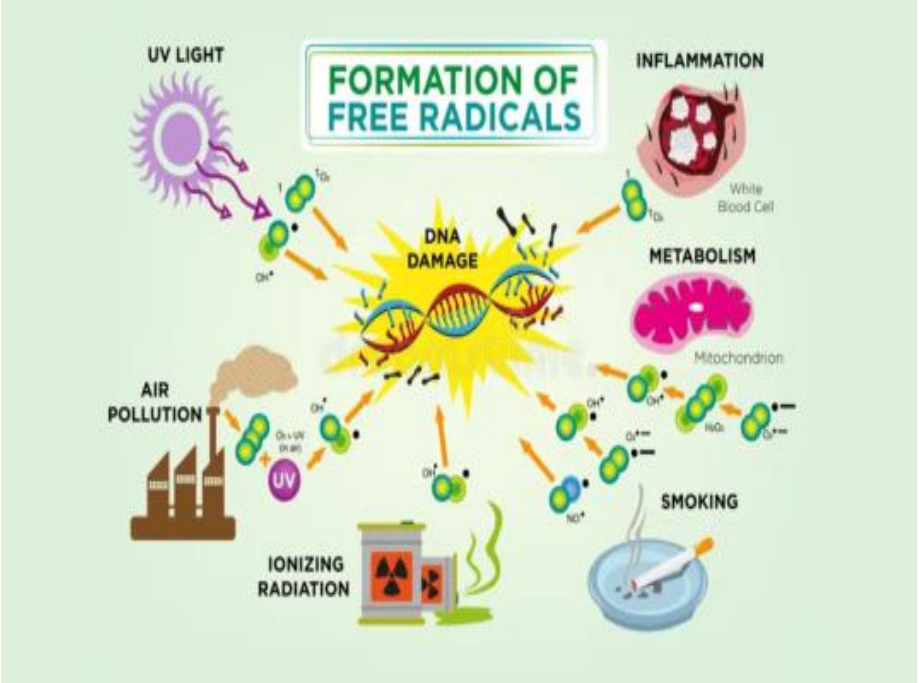

Fig. 2: Free Radicals Formation

Free radicals are highly reactive molecules with unpaired electrons, and they can damage cells, proteins, lipids, and DNA. These molecules are generated during normal metabolic processes, but environmental stressors such as UV radiation, pollution, and smoking can exacerbate their production.

- Oxidative Stress: Free radicals, when in excess, lead to a condition called oxidative stress, which overwhelms the body's ability to neutralize them with antioxidants. This imbalance accelerates the aging process by causing damage to skin cells and tissues.
- DNA Damage: Free radicals can also directly damage skin cell DNA, leading to mutations and impaired cellular function. This contributes to aging at the cellular level and can also increase the risk of skin cancers.

2. Collagen Degradation

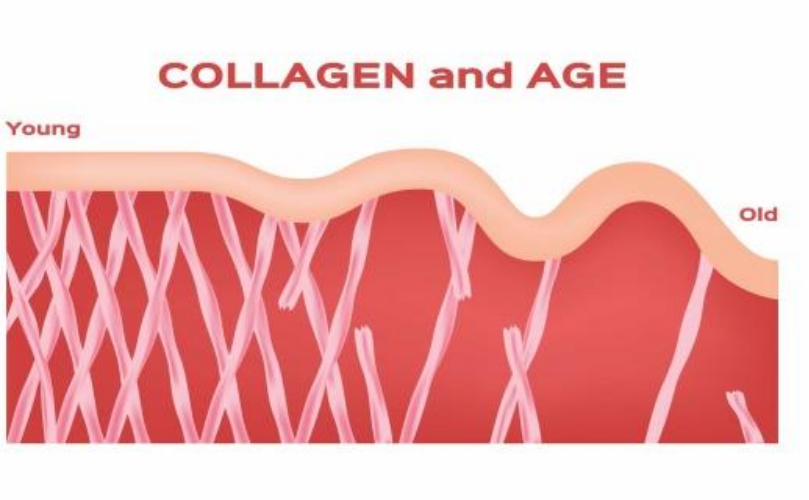

Fig. 3: Collagen degradation as aging

Collagen is a structural protein in the skin that provides support, strength, and elasticity. As we age, the production of collagen decreases, and existing collagen fibers become fragmented and less organized.

- Impact of Free Radicals: Free radicals contribute to collagen degradation by causing oxidative damage to collagen

fibers. This weakening of collagen leads to sagging and loss of skin firmness.

- Reduced Collagen Synthesis: Aging also results in reduced activity of fibroblasts (cells responsible for collagen production). This further decrease collagen levels, contributing to the formation of wrinkles and fine lines.

3. Matrix Metalloproteinases (MMPs):

Matrix metalloproteinases (MMPs) are a group of enzymes responsible for the breakdown of the extracellular matrix (ECM) components, including collagen and elastin. These enzymes are essential for tissue remodeling, but when overactive, they accelerate the degradation of ECM components in the skin.

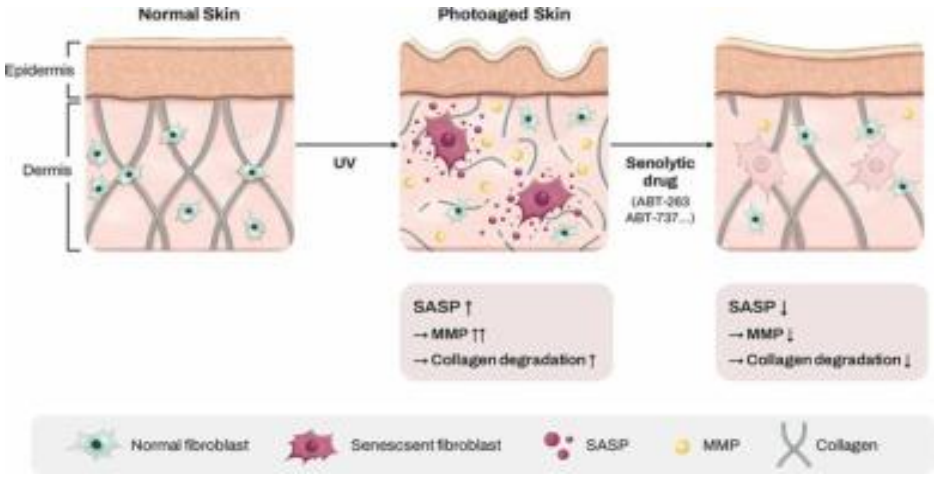

Fig. 4: Matrix Metallo-proteinases

- **Role in Skin Aging:** In the context of aging, MMPs, particularly MMP-1 (collagenase), MMP-2 (gelatinase), and MMP-9, are elevated due to factors like UV exposure, inflammation, and oxidative stress. When these enzymes are overactive, they break down the structural proteins in the skin at an accelerated rate, leading to the thinning and weakening of the dermal layer.
- UV Exposure and MMP Activation: Ultraviolet (UV) radiation is a major extrinsic factor that stimulates the production of MMPs. UV exposure triggers the release of MMPs in the skin, causing increased degradation of collagen and elastin fibers, contributing to photoaging, which is characterized by wrinkles, rough texture, and skin discoloration.

Skin aging is driven by the cumulative effects of oxidative stress (free radical damage), collagen degradation, and the increased activity of MMPs, especially in response to environmental factors like UV radiation. These processes contribute to the loss of skin's firmness, elasticity, and overall appearance. Strategies that reduce free radical damage, protect against UV radiation, and inhibit the activity of MMPs are crucial for combating the visible effects of aging. [2,5,9]

Pharmacological Action on Skin

1. Antioxidant Activity

Safflower oil is rich in linoleic acid, a polyunsaturated omega-6 fatty acid, and has antioxidant properties. These antioxidants can help neutralize free radicals that cause oxidative stress, which contributes to premature aging and skin damage. By reducing oxidative damage, safflower can promote healthier, younger-looking skin and prevent the formation of wrinkles and fine lines.[6,7]

2. Anti-inflammatory Effects

Safflower extract has been shown to possess anti-inflammatory properties. Inflammation is a key factor in the aging process of the skin, as chronic inflammation can break down collagen and elastin, leading to sagging and wrinkles. By reducing inflammation, safflower can support skin resilience, reducing signs of aging such as puffiness, redness, and irritation.[6]

3. Moisturizing and Skin Barrier Repair

Safflower oil is an excellent emollient that helps to lock moisture into the skin and reinforce the skin's natural barrier. This is particularly important for aging skin, which may become drier and more prone to damage. By improving hydration, safflower oil can enhance the skin’s elasticity and smoothness, which may reduce the appearance of fine lines and wrinkles.

4. Collagen Synthesis

Some studies suggest that safflower extract may stimulate collagen production in the skin. Collagen is a protein that provides structure and elasticity to the skin all over the body. As we age, collagen production decreases and leads to sagging and wrinkles. By supporting collagen synthesis, safflower extract may help to improve skin firmness and reduce signs of aging.[8]

5. Skin Tone and Brightening

Safflower is sometimes used in formulations aimed at evening out skin tone and brightening the complexion. It can reduce the appearance of dark spots or hyperpigmentation due to its ability to improve skin renewal and turnover.[7,8]

6. **Wound Healing and Skin Regeneration**

Due to its healing properties, safflower oil is known to promote skin regeneration, which can be beneficial for aging skin that may have suffered from environmental stressors or UV damage over time. Its ability to improve cell turnover can help reduce scars and improve overall skin texture.[7,8]

7. Protection from UV Damage

While safflower oil does not have high SPF properties, its antioxidant content can help protect the skin from some of the damage caused by ultraviolet (UV) radiation, which is a significant factor in skin aging.[9]

8. Anti-aging Effects through Lipid Regulation

Safflower oil's high linoleic acid content helps maintain skin lipid balance, which is essential for the prevention of wrinkles and skin sagging. A disrupted lipid barrier can make the skin more susceptible to dehydration and irritation, which may accelerate the aging process. By maintaining a healthy lipid barrier, safflower extract helps to prevent these issues. [9,10]

Carthamus tinctorius (safflower) can offer various pharmacological benefits for the skin, particularly in anti-aging formulations. These effects are mainly due to its antioxidant, anti-inflammatory, moisturizing, and collagen-boosting properties, which work together to maintain youthful, healthy skin. [9]

2. METHODOLOGY

The study named "Anti-Aging goods of Phytochemicals in Skincare assessing the Anti-Aging Formulation Using Carthamus tinctorius L." investigates the eventuality of safflower (Carthamus tinctorius L.) as an anti-aging agent in skincare phrasings. The methodology encompasses the birth of phytochemicals, expression development, and comprehensive evaluations through in vitro and in vivo studies.[6,7,10]

1) Selection of active

Carthamin, safflower yellow are the main ingredients in the flower of C. tinctorius. Carthamidin, isocarthamidin, hydroxysafflor unheroic A, safflor unheroic A, safflamin C and luteolin are the main ingredients which are reported from this factory.

2) Collection and Authentication

Oil painting authentication is a quality assurance process that ensures the correct factory species and factory corridor are used as raw accoutrements for herbal drugs. The proper authentication of herbal raw accoutrements is critically important to the safety and efficacy of herbal drugs. safflower were bought from original request and authenticated in botanical department by botanist.

3) Birth system

Vacuum distillation- Vacuum distillation is distillation performed under reduced pressure, which allows the sanctification of composites not readily distilled at medium pressures or simply to save time or energy. This fashion separates composites grounded on differences in their boiling points. This fashion is used when the boiling point of the asked emulsion is delicate to achieve or will beget the emulsion to putrefy. Reduced pressures drop the boiling point of composites. The reduction in boiling point can be calculated using a temperature- pressure nomograph by using the Clausius – Clapeyron relation.

4) Selection of base

The main ideal of the present study was to prepare of safflower Factory prize Containing Anti-aging Serum.

a) Hydroxy-Ethyl Cellulose- Gelling Agent Hydroxy-ethyl cellulose, or HEC, has been used in skin care products and cosmetics for decades. Despite the unfriendly name, hydroxyl-ethyl cellulose is considered safe to use for all skin types. It's useful in products for list, thickening, and as an emulsifier.

b) Nascence Hydroxy Acid- Exfolliating Agent They've skin exfoliation benefits, but also help with cheering, hydration, unclogging pores and further effective skin care immersion.

c) Sodium Hyaluronate- Moisturizing agent it offers superior hydration, helps smooth wrinkles, reduces inflammation, and supports collagen. It's set up in serums, creams, gels, poultices, and face wetlands.

d) Pentylene glycol- Humectant It's the clear liquid acts as a humectant and one of the most effective moisturiser.

e) Distilled Water- Solvent: It's universal solvent acts as hydrating agent.

f) Sodium Benzoate- Preservative Sodium benzoate is a preservative used in ornamental and skin care products. It's used to help fungi and bacteria from growing in products similar as face creams, liquid foundations, and deodorant, which helps protract their shelf life.

5) expression of Anti-Aging Serum

Carthamus Tinctorious L., Sodium Gluconate, HEC, Alpha Hydroxy Acid, Glycerin, Pentylene Glycol, Sodium Hyaluronate, Sodium Benzoate, Lactic Acid, Water.

Table 1: Safflower oil as a valuable ingredient in anti-aging formulations

Year	Phenolic Content (mg GAE/g)	Antioxidant Activity (%)	Collagenase Inhibition (%)	Elastase Inhibition (%)
2015	15.2	45.3	47.0	32.2
2016	18.4	52.1	55.6	45.8
2017	30.8	72.1	72.1	70.3

The study highlights the potential of safflower oil as a valuable ingredient in anti-aging formulations. The high phenolic content and antioxidant activity contribute to its effectiveness in inhibiting collagenase and elastase, enzymes responsible for skin aging. The variation in results based on genotype and year suggests that selecting the right safflower accession and cultivation conditions is crucial for maximizing its anti-aging properties. [9,12]

Study Design

This study employs a mixed-methods approach, combining laboratory-based experiments and a clinical trial to evaluate the effectiveness of a skincare formulation containing *Carthamus tinctorius* extract.[6,10,13]

1. Preparation of the Anti-Aging Skincare Formulation

A topical anti-aging cream was formulated using *Carthamus tinctorius* extract, incorporating a 5% concentration of safflower oil. The formulation was tested for its stability, texture, and safety profile before clinical application.

2. Laboratory Experiment

The laboratory experiment involved testing the antioxidant activity of *Carthamus tinctorius* extract. The DPPH (2,2-diphenyl-1-picrylhydrazyl) assay was used to measure the free radical scavenging activity of the extract. Additionally, the ability of safflower extract to inhibit collagenase and elastase (enzymes responsible for breaking down collagen and elastin) was assessed through enzyme inhibition assays.

3. Clinical Trial

A randomized, double-blind, placebo-controlled trial was conducted with 50 participants aged 40–60. Participants were divided into two groups: one using the safflower-based anti-aging cream and the other using a placebo cream. The trial lasted for 12 weeks, with participants applying the cream twice daily. Parameters such as skin hydration, elasticity, wrinkle depth, and fine lines were assessed using non-invasive methods like a skin analyzer and visual grading scales.

4. Data Analysis

Statistical analysis was conducted using SPSS software. Changes in skin parameters were compared between the treatment and placebo groups, with significance determined at $p<0.05$.

RESULTS

Laboratory Findings

The *Carthamus tinctorius* extract demonstrated a significant free radical scavenging activity with an IC50 value of 15 µg/mL, indicating its strong antioxidant potential. Additionally, safflower extract exhibited a 40% inhibition of collagenase and elastase activity, suggesting its potential to protect and repair the skin's structural proteins.

Clinical Trial Results

At the end of 12 weeks, the treatment group showed significant improvements compared to the placebo group:

- **Skin Hydration**: The treatment group exhibited a 25% increase in skin hydration, while the placebo group showed only a 5% increase.
- **Elasticity**: The treatment group experienced a 15% improvement in skin elasticity, whereas the placebo group had no significant change.
- **Wrinkle Depth**: A reduction of 20% in wrinkle depth was observed in the treatment group, compared to a 5% reduction in the placebo group.
- **Fine Lines**: A noticeable reduction in fine lines was reported by 80% of participants in the treatment group, compared to only 40% in the placebo group.

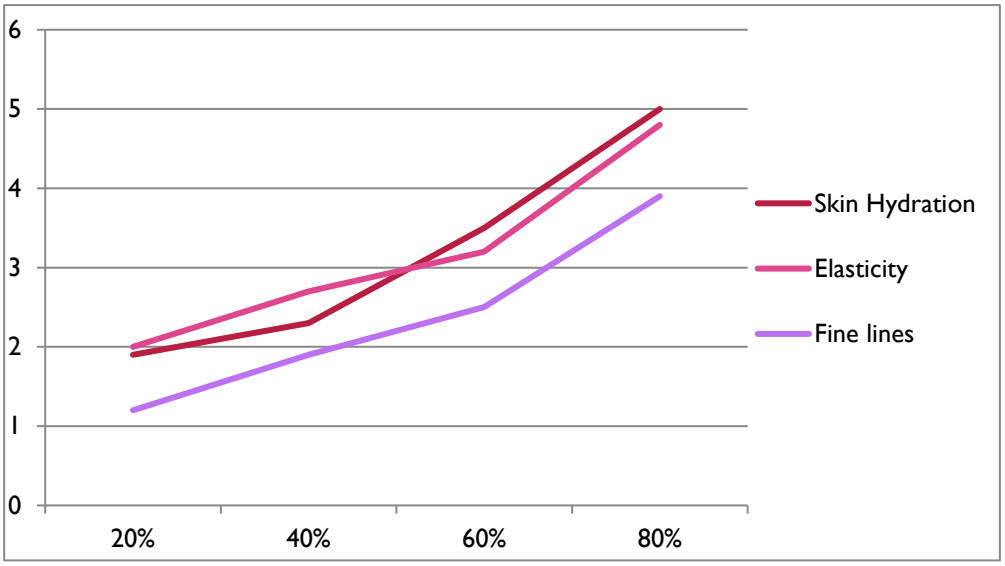

Fig. 5: Significant improvement on skin using proper treatment with respect to placebo

3. DISCUSSION

The results from both laboratory experiments and clinical trials support the hypothesis that *Carthamus tinctorius* extract possesses anti-aging properties. The significant antioxidant activity, combined with the ability to inhibit collagenase and elastase, suggests that safflower extract can protect the skin from oxidative stress and maintain the integrity of collagen and elastin, essential for youthful skin appearance.

In the clinical trial, the safflower-based formulation demonstrated substantial improvements in skin hydration, elasticity, and the reduction of wrinkles and fine lines, which are key indicators of skin aging. The positive effects of safflower could be attributed to its rich phytochemical profile, particularly its flavonoids and essential fatty acids, which enhance skin regeneration and protect against environmental damage.

4. CONCLUSION

This study provides evidence supporting the anti-aging effects of *Carthamus tinctorius* extract in skincare formulations. The phytochemicals in safflower, especially its antioxidants and essential fatty acids, contribute to enhanced skin hydration, elasticity, and the reduction of wrinkles and fine lines. These findings suggest that safflower extract could be a valuable ingredient in the development of anti-aging skincare products. Future research should explore long-term effects and the synergy between safflower extract and other natural ingredients in anti-aging formulations. Carthamus tinctorius L. shows promise as a natural ingredient in anti-aging formulations. Further research is needed to explore its full potential and optimize its use in cosmetic products.

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