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FORMULATION AND EVALUATION OF HARBAL PATCH MORINGA OLEIFERA AND PASIDIUM GUAJAVA FOR DIABETIC FOOT ULCER.

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ABSTRACT :-

Diabetic ulcers are a complication in patient with uncontrolled diabetic , especially on the feet with amputation rates reaching 30% . Wound management with dry gauze can damage new cells because the gauze sticks to the wound and cause pain. The patch innovation has the advantage of protecting the wound from external factors, providing moisture ,and being sterile without causing pain. The combination of moringa leaf and guava leaf can help diabetic wound heal. Guava leaves *(psidium guajava L.)* Contain saponins, tannins, and flavonoids that effectively inhibit bacterial growth and are antioxidants.

Moringa Oleifera, also known as the Moringa ,tree of life or miracle tree, is classified as an importance herbal plant due to its immense medicinal and non-medicinal benefits. Traditionally, the plant is used to cure wound , pain, ulcers, liver disease, heart disease, cancer, and inflammation. It is a single family shrub and tree that is cultivated in a whole tropical belt. It belongs to the family Moringaceae. Multiple bio-active compounds such as phenolic acid, flavonoids, alkaloids, natural sugars, vitamin, minerals, and various organic acids are analyzed. Many pharmacological studies has shown the ability of plant as it posses many analgesic, anti-inflammatory, immune-modulatory and many more properties. Formulation it in a transdermal patch will increase its absorption into the systemic circulation as the human skin is readily accessible surface of drug delivery system. There is considerable interest in the as a site of drug application in both systemic and local affect. Thus the review article explores the overall study on the extraction of Moringa oleifera and its formulation in transdermal patch.

INTRODUCTION :-

Diabetes and its complications are increasingly prevalent worldwide with a serious burden on patients and health care systems. [1] Diabetic foot ulcers have a substantial impact on disability, morbidity, and mortality. The Mechanism of diabetic wound chronicity has not been well understood. It is currently believed that oxidative stress plays a vital role in the occurrence and development of diabetic wound [2, 3]. Oxidative stress is caused by over production of reactive oxygen species and insufficient antioxidant systems. However, the process of oxidative stress in wound development and healing remains unclear. This review will further develop the discussion on how oxidative stress may affect diabetic wound healing in terms of skin injury, neuropathy, arterial disease and infection, the plausible role of antioxidants including plant bioactive compounds in promoting wound healing will be addressed in order to explore novel approaches and strategies for promotion of diabetic wound healing.

From the World Health Organization (WHO), it is reported that the number of people with diabetes is surging from all over the world, especially in middle-income countries [4]. Diabetic foot ulcer (DFU) is a rather common comorbidity of diabetes [5]. The lifetime risk of developing DFU for diabetics is up to 25% [6]. Among old adults, more presence of senescent cells has been hypothesized to contribute to pathophysiological conditions, which is the main factor for higher DFU morbidity [7]. With a growing and aging population in the world, the status of diabetic wounds will be more challenging for the healthcare system [8].

Wound healing is a sophisticated and highly coordinated process including four overlapping phases: hemostasis phase (0-several hours after injury), inflammatory phase (1–3 days), proliferation phase (4–21 days), and remodeling phase (21days-1year) [9,10].

However, diabetic wounds are difficult to heal due to pronounced immune imbalance, resulting in stagnating in the inflammatory phase (pro-inflammatory state) rather than entering the subsequent proliferation phase (pro-regenerative state) [11]. The physiological conditions in diabetic wound healing have dynamic spatial inflammation patterns, which make a distinction between early injuries to long-term non-healing wounds. The early-wound pattern shows an absence of inflammatory storm while the long-term non-healing wound pattern displays excessive and persistent inflammation owing to the M1 macrophage overflow. In the early-wound pattern, both impaired peripheral neuropathy and un stabilization of mast cells blunt the ability to develop an Acute pro-inflammatory response [12].

Fig.No.1 Diabetic Food Ulcer

Moringa :-

Moringa oleifera (M. oleifera), the “miracle tree”, thrives globally in almost all tropicaland subtropical regions, but it is believed to be native to Afghanistan, Bangladesh, India,and Pakistan [13]. The Moringa family comprises 13 species (M. oleifera, M. arborea, M. rivae,M. ruspoliana, M. drouhardii, M. hildebrandtii, M. concanensis, M. borziana, M. longituba,M. pygmaea, M. ovalifolia, M. peregrina, M. stenopetala), of which M. oleifera has become wellknown for its use in nutrition, biogas production, fertilizer, etc., [14,15] Moringa has theunique property of tolerating drought [16]. Studies have shown that M. oleifera is among the cheapest and most reliable alternatives for good nutrition [17]. Nearly all parts of

the tree are used for their essential nutrients. M. oleifera leaves have a high content of beta-carotene,minerals, calcium, and potassium [18]. Dried leaves have an oleic acid content of about 70%,which makes them suitable for making moisturizers [18]. The powdered leaves are used to make many beverages, of which "Zija" is the most popular in India [19].

Fig.no2. Moringa

Guava :-

Guava leaves (from the Psidium guajava plant) have been traditionally used in various cultures for their medicinal properties, including their potential anti-inflammatory effects. These leaves are rich in bioactive compounds such as flavonoids, tannins, and essential oils, which contribute to their therapeutic benefits. Scientific research has shown that guava leaves possess anti-inflammatory, antioxidant, and antimicrobial properties, making them a promising natural remedy for inflammation related conditions. [20]

Fig.no3. Guava

LITERATURE SURVEY :-

T.A.Kadam *et al* (2025) Nowadays, various products are available for the treatment of oral ulcers. However, they cannot remain in stable contact with the ulcer meanwhile, mucoadhesive patches remain stable on the ulcer and also provides a physical barrier to particles that come into contact with it. The aim of the research is to formulate a product that provides protective and healing properties to ulcer using guava leaves extract. Mucoadhesive drug delivery system has different advantage as compare to conventional dosage forms such as gels, capsules, tablets, lozenges,[21]

Ahmad Ainurofiq *et al* (2025) The hydrocolloid patch innovation has the advantage of protecting the wound from external factors, providing moisture, and being sterile without causing pain. The combination of guava leaf and aloe vera can help diabetic wounds heal. the results of the study, guava leaf extract and aloe vera can be formulated as a hydrocolloid patch and proven to help heal diabetic ulcers characterized by the percentage of wound closure every day for two weeks.[22]

Shaikh Muskan S *et al* (2025) Herbal transdermal patches are an emerging promising niche for the controlled release of bioactive phytochemicals in an unconventional, patient-centric transdermal method that avoids bioavailability restrictions in oral delivery by promoting transdermal permeability.[23]

Titin Sulastri *et al* (2025) The aim of this study was to prepare and formulate a transdermal patch of Moringa oleifera Lam. leaf extract with hydroxypropyl methylcellulose (HPMC) and polyvinyl pyrrolidone (PVP) as the polymers. The study was aimed at investigating the effect of various concentrations of the extract (20%, 40%, and 80%) on the physical properties of the patch, including organoleptic properties,[24]

Vaibhav Jain *et al* (2024) Formulating it in a transdermal patch will increase its absorption into the systemic circulation as the human skin is readily accessible surface of drug delivery system. There is considerable interest in the as a site of drug application in both systemic and local affect. Thus the review article explores the overall study on the extraction of Moringa oleifera and its formulation in transdermal patch. [25]

Dian Eka Ermawati *et al* (2024) Moringa leaf extract contains flavonoids confirmed as anti-inflammatory at 200 mg/Kg BW. For topical anti-inflammatory drug delivery system, the patch matrix was chosen. Patch is continuous for an extended treatment period compared with cream, lotion and gel. Previous research has developed a patch matrix formula using a combination of polyvinyl alcohol (PVA) and alpha-cellulose (1: 2) that produced a patch required for good patch preparation.[26]

Magfirah *et al* (2022) Lantana camara Linn is one of the plants that can help the wound healing process because it contains phenolic, flavonoids, and alkaloids that have antibacterial abilities against Staphylococcus epidermidis. but its use is still very simple, therefore it is necessary to develop traditional medicinal preparations in the transdermal patches with a combination of EC (Ethyl Cellulose) and PVP (Poly Vinyl Pyrolidone) polymers. This study aims to see the effect of using ethyl cellulose and polyvinyl pyrrolidone based on the physical characteristics of the Formulation.[27]

D E Ermawati *et al* (2022) Moringa oleifera oleifera Lam leave contains quercetin which has anti-inflammatory activity, with the mechanism of action reducing mast cell activity through the NF-kB pathway. The topical patch of Moringa oleifera leave ethanolic extract was develop as an alternative to oral anti-inflammatory side effects, including first-pass metabolism and gastric irritation. Polymer is the main component of a patch matrix system because it functions to control drug release.[28]

AIMS AND OBJECTIVE :-

AIM :- To formulate ,optimize, and evaluate a herbal transdermal patch containing extracts of Moringa oleifera and Psidium guajava for effective management of diabetic wounds, focusing on enhanced wound healing, antimicrobial activity ,and sustained drug release. Diabetic wound are difficult to heal due to poor blood circulation, infection risk, and delayed tissue regeneration. Herbal patches use to provides controlled and prolonged release of active constituents. Maintains a moist wound environment, promoting faster healing. Reduces risk of infection due to antimicrobial properties of herbs.

OBJECTIVE :-

1. Herbal patches use to provides controlled and prolonged release of active constituents.
2. Maintains a moist wound environment , promoting faster healing.
3. Reduces risk of infection due to antimicrobial properties of herbs.

4. Provides anti-inflammatory action to reduce pain , swelling , and redness.
5. Increases patient comfort due to easy and non-invasive application.
6. Prevents wound dryness and maintains proper hydration at the wound site.
7. Enhances antibacterial and antioxidant activity for diabetic wound care.
8. Develops a safe , cost-effective , and eco-friendly herbal wound dressing system.

MATERIAL AND METHOD :-

1.Plant Profile:-

Moringa :-

Inflammation is the body's response to injury, infection, antigen, or cell damage so that it is a sign of something wrong and harm the body or the occurrence of disease [29]. The inflammatory responses are characterized by conditions in the form of rubor (redness), heat (heat), dolor (pain), tumor (swelling), and impaired function. Inflammation can be local and systemic. It can also occur acutely or chronic that causes pathological abnormalities. Anti-inflammatory agent derived from natural ingredients have been developed because it has mild side effects. The plant that has the potential as an anti-inflammatory agent is Moringa oleifera (Moringa oleifera oleifera Lam). The results of the phytochemical analysis showed that the ethanolic extract of Moringa oleifera leaves contained flavonoid and polyphenolic compounds. They are known to have anti-inflammatory activity because flavonoids can inhibit cyclooxygenase or lipoxygenase. They also inhibit leukocyte accumulation in the inflammatory area, so they can be called an anti-inflammatory agent. Quercetin is one of the flavonoid groups that are the identity of the Moringa oleifera plant[30]

Fig.No.4 Moringa leaves

Moringa leaves :-

Botanical Name :- Moringa oleifera Lam.
Synonyms :- drumstick tree
Family :- Moringaceae
Biological sources :-The primary biological source of moringa is Moringa oleifera Lam., a rapidly growing, drought-resistant tree belonging to the family Moringaceae.
Chemical constituent :- Leaves contain high amounts of phenols, flavonoids , saponins, and tannins, while seeds are rich in oleic acid and amino acids

Moringa uses :- Anti microbial, Wound healing, Antioxidant ,Diabetic ulcer treat, Anti-inflammatory, Reduce inflammation, Manage blood sugar levels, Lower cholesterol, Boost immunity, and improve digestive health

2.Guava : -

Results of phytochemical screening and identification of guava leaf extract compounds show that the extract contains flavonoids, tannins, and saponins. This screening obtained positive results for flavonoid compounds with red, next compound obtained was tannin by obtaining blue-back, dan saponin compoundwith stable foam.

In addition, identification of flavonoid compounds in the thick extract of guava leaves was also carried out using the Thin Layer Chromatography (TLC) method with a standard comparison compound quercetin. The use of quercetin standards because in guava leaf extract, quercetin is one of the secondary metabolite compounds of the flavonoid group as an agent that acts to facilitate rapid healing in chronic diseases such as diabetic ulcers with low side effects as has been shown in previous preclinical and clinical studies. Quercetin has been shown to have anti-bacterial, antioxidant, anti-inflammatory, and anti-fibrotic activities. A study reported quercetin to have a modulating effect on all four phases of the wound healing process [31].

Fig.No.5 Guava leaves

Guava leaves :-

Botanical name :- Psidium guajava L
Synonyms:- Jamphal ,Amarood
Family :- Myrtaceae
Biological source :- Guava leaf biological source is Psidium guajava Linn, belonging to the family Myrtaceae.
Chemical constituent :- Guava leaves (Psidium guajava L.) are rich in bioactive compounds, primarily flavonoids (quercetin, avicularin, guaijaverin), phenolic acids (gallic acid, ellagic acid), tannins, and essential oils (1,8-cineole-caryophyllene). These constituents contribute to their strong antioxidant, antibacterial, and anti-diabetic properties.
Guava leaf uses :- Manage blood sugar, Treat diarrhea, and Improve digestive health, Anti-microbial, Anti-inflammatory Treat diabetic ulcer used in wound healing.

2. Collection of plant:-

Collection of Moringa leaf and Guava leaf :- Moringa leaf and Guava leaf collected from herbal garden of Nandurbar .

3.Extraction Process:-

1)Drying the plant leaf to remove moisture and preserve active constituents.

Fig.No.6 Dried Plant Leaf

2)Grinding is the process of reducing dried plant leaves into smaller particles or powder

Fig.No.7 Grind Leaf Powder

3)Maceration is a process in which coarsely powdered plant material is soaked into Ethanol for a specific time (2-3days) to extract active constituents.

Fig.No.8 Maceration Process

4)Filtration is the process of separating solid particles from a liquid using a filter medium

Fig.No.9 Filtration Process

5)Applying heat to the filtrate (liquid extract) to evaporate excess solvent and obtain a concentrated extract.

Fig.No.10 Boiling Process

6) The final extract is the concentrated product obtained after maceration, filtration, and evaporation of solvent. It contains the active constituents of the plant leaves.

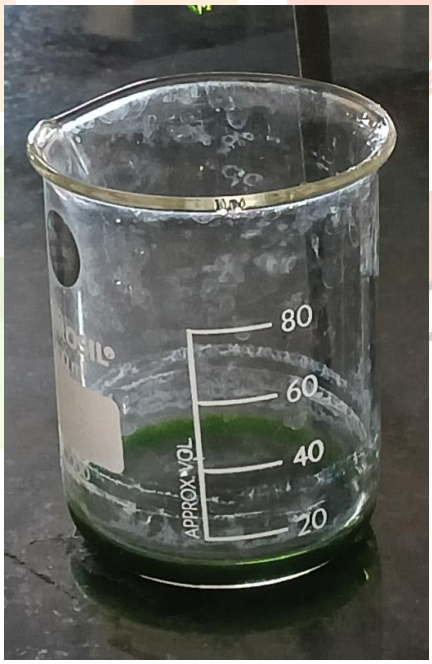


Fig.No.11 Extraction Solvent

4.Chemical Requirement :-

Tab.No.1. Observation table

Chemical	Quantity	Use
Gelatin	1.6 gm	Polymer (film forming agent)
Corbopol	0.4 gm	Thickening Agent
Glycerine	1.94 gm	Plasticizer (provide flexibility)
Eucalyptus Oil	0.18 ml	Anti-Microbial agent
Guava Leaves	1 gm	Antibacterial agent / active ingredient
Moringa Leaves	2 gm	Antibacterial / healing ingredient
Ethanol	0.25 gm	Preservatives / solvent solvent
Agar	2 gm	Gelling agent / film support
Distilled Water	33.4 ml	solvent /Vehicle

5.Various Uses Of Chemical :-

1) Gelatin :-

Gelatin is a natural polymer which is made of hydrolytic degra-dation of protein from collagen and its distinctive structure ofamino acids gives it several medical benefits [32]. Generally, gelatinis in the form of tablets, granules or powders and sometimes it can
be dissolved in water before use [33]

Source: As a source of protein-matrixof gelatin, collagen is the most naturally found protein in humansand animals. Collagen has been contained anywhere else in thebody, but the skin, bones, tendons, and ligaments are the mostabundant [34]

2) Carbapol :-

Polymers of cross-linked acrylic acid with polyalkenyl ethers or divinyl glycol, commercially known as Car- bopol polymer, are the major components of drug deliv- ery systems for ocular, nasal, rectal, vaginal, buccal , and transdermic applications. Depending on the molecular weight and manufacturing conditions , various grade of Carbopol® polymer are available and demonstrate different rheological properties and viscosity values, related to the particle size, molecular weight between cross-links, dis- tribution of molecular cross-links and the fraction of the free chain ends [35]

3) Glycerol :-

Glycerol is the main component of triglycerides, found inanimal fat, vegetable oil, or crude oil. Glycerol is derived fromsoap or from biodiesel production [36,37].

4) Eucalyptus Oil :-

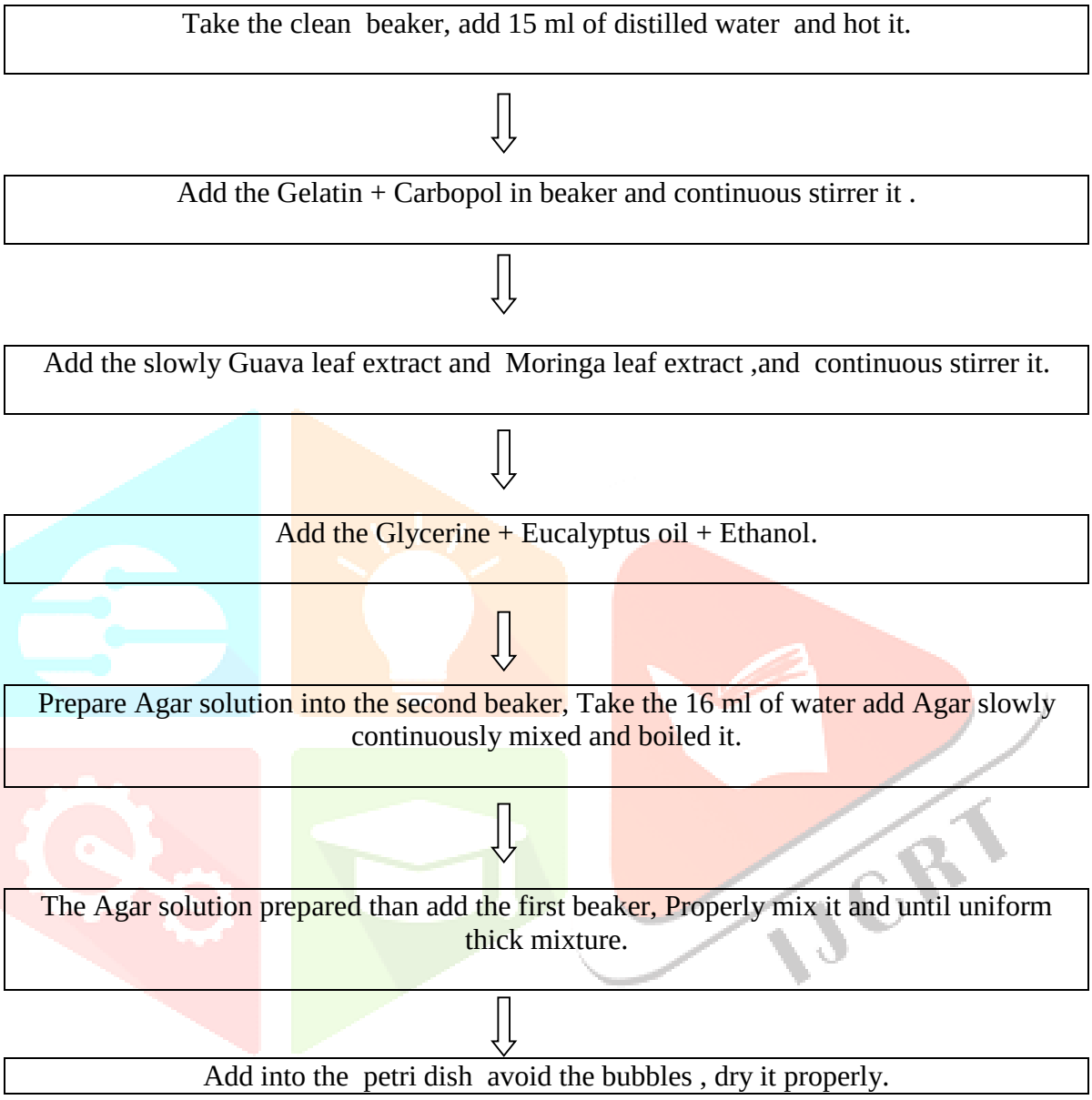
Eucalyptus is a kind of ever green trees, which is indigenous to Australia, Indonesia and Philippines which, is grown to provide paper pulp, wood, gum and oil used in medicines (campinhos, 1999). Eucalyptus has 945 species sub species or verities among which, 100 species or subspecies or verities which, are economically important (Fris, 1995) use as antimicrobial[38]

5) Agar Use :-

Agar is a biopolymer derived from red seaweed, two main species of which are Gelidium and Gracilaria. Agar derived from Gelidium species are preferred due to their higher gelling strength. Similar to starch, cellulose, and chitin, agar is also a polysaccharide. In chemical terms, unlike the former three substances, agar is a sulfated polysaccharide and falls into the group of linear polymers called galactans [39,40].The majority of agar (~90%) is used for its gel forming ability in the food industry and the rest is used for biotechnological, bacteriological, and pharmaceutical applications. Agar is also used in Asian kitchens as a

gelling agent and as a substitute for animal-based gelatine for vegetarian meals. Agar-based thermo reversible gels have a higher melting point (60-97°C) compared to animal-based gelatine (~37°C) [41,42].

6.Evaluation Of Patch:-



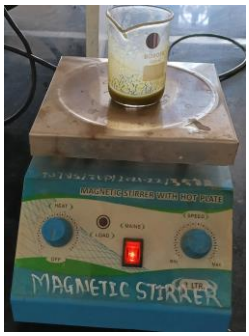


Fig.no.12
Prepare polymer Solution

Fig.no.13
Add Moringa extract

Fig.no.14
Add Guava extract

Fig.no.15
Extract solution dissolve properly

Fig.no.16
Add Agar solution

Fig.no17
Patch

7. Observation table :-

Table.no2 :- Identification of patch

Sr.no	Parameter	Observation
1	Composition	Moringa leaf extract + Guave leaf extract
2	Colour	Light brown to yellowish
3	Shape	Circular (as per petri dish mold)
4	Surface texture	Smooth, slightly glossy
5	Appearance	Uniform, semi-solid gel
6	Clarity	Slightly opaquse
7	Consistency	Flexible and soft
8	Odour	Mild herbal smell

RESULT AND TEST OF PATCH :-

1) Anti-Bacterial Activity Test :-

The diameter of the inhibition zone or clear zone can be observed from the area on the nutrient agar media around the disc paper if the test material is liquid or if using the pitting method with solid test material can be observed around the test preparation in the nutrient agar media. This can be an indication of the sensitivity of bacteria to the antibacterial material used as a test material. The inhibition zone formed around the disk is measured by the vertical diameter and horizontal diameter with in units using a vernier caliper, [43]

Fig.No.11 Anti-Bacterial Activity Test

2) Adhesion Test :-

Adhesion test is used to determine the ability of a patch to stick to the skin surface for a required period without falling off.

Fig.No.12 Adhesion Test

3) Patch Of Weight :-

The patch weights in the 7 formulas are in the range of 1.1166-1.6040 with a small standard deviation (SD) value indicating the uniformity of the weight of the patch made. The same formula weights indicate that the patch formulations have the same number of components or do not differ much. If the number of components weighed in the same formula is expected in one formula to have a uniform weight, this indicates the Weight of the active substance content (44,45,46,47-49) .

4) Patch Thickness :-

Thickness has a role in the physical properties of the patch, a thin patch will be more easily accepted in its use. Patch thickness test results, obtained in 7 formulas in the range of patch thickness are 6.86-13.7 mm. Thickness measurement provides a guarantee of uniform thickness of the patch made by the solvent evaporation method. Aesthetically thin patches are more attractive and easy to accept. A thickness test was carried out to determine the thickness of the patch at three different points. The ideal patch has a thin thickness but does not tear quickly, so it is comfortable to use. Patch thickness is influenced by the technique of pouring the patch solution into the mold and is also influenced by the amount of patch weight formed from each formula. The greater the weight of the patch, the greater the thickness of the patch (44,45,46,47-49) .

5) Patch Folding :-

Folding endurance is done by folding the patch repeatedly in the same place. If the number of folds is greater than 300, then the patch is considered to have good folding endurance. Increased folding resistance of a patch indicates that the patch has a good film consistency so that it is not easily broken or torn during storage (44,45,46,47-49) .

6) Loss Of Drying :-

Loss Of Drying is a method to determine the moisture content in the patch. A good patch should not be too moist. After all, it will tear easily but also should not be too dry because it can break easily. There is no absolute value for the required amount of drying shrinkage, however, based on previous research, it was stated that a good patch drying shrinkage value was <9.29% ,the high value of drying loss is due to the

difficulty of adjusting the moisture content with the solvent evaporation method in making patches. This is because the temperature used during drying is room temperature (44,45,46,47-49) .

7) Moisture Uptake : -

Moisture uptake is a response parameter to determine the ability of the patch to absorb moisture. A low percentage value of absorption will produce a patch that is relatively stable and protected from microbial contamination. In general, the percent moisture absorption capacity of the film will increase if the hydrophilicity of the polymer or plasticizer, or enhancer used also increases. Based on previous research, it was stated that the percent value of moisture absorption ranged from 2-10% (44,45,46,47-49) .

8) Surface pH :-

For measuring the surface PH Agar plate is prepared by using IPS (Isotonic phosphate buffer solution) Then patch is kept on it for swelling for 2hrs. After this the surface PH was measured by means of ph paper placed on the surface of swollen patch. [50]

CONCLUSION :-

Based on the results of the study, guava leaf extract and Moringa leaf extract can be formulated as patches. All formulas that have been physically characterized have met the standard parameters. patches with a combination of guava leaf extract and Moringa leaf extract are proven to help heal diabetic ulcers characterized by the percentage of wound closure every day for two weeks. The patch also proved to be more effective in healing wounds compared to guava leaf extract and Moringa leaf extract which were not incorporated into the patch. There is a combination of Quercetin compounds from guava leaves and Flavonoids compounds Moringa leaf extract to treat diabetic ulcers formulated in the form of patches. The novelty of this research can be proven by the absence of previous studies that discuss the combination of guava leaf extract and Moringa leaf extract formulated in the form of patches as an innovation in healing diabetic wounds. This research is useful for the community, especially people with diabetic ulcers as an alternative in healing diabetic wounds. In addition, this research can be a means of knowledge regarding the utilization of a combination of natural ingredients that have the potential to heal diabetic ulcers. This research can also be useful for industry, especially in the health sector as a basis for mass production innovation with the advantage of being easy to find main ingredients sourced from natural and affordable plants [50]

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