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Warts Disease Detection and Classification in Dogs: A Comprehensive Study Integrating Image Processing Techniques and SVM Classification

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Abstract: - In these papers, the current research focuses on the detection and classification of warts disease in dogs through the application of image processing techniques. These methods aid in identifying and categorizing warts disease specifically in dogs. The study not only quantifies the prevalence of warts in dogs but also categorizes the number of dogs experiencing issues related to this condition. Warts, also referred to as papillomas, represent a common dermatological concern in dogs, drawing attention due to their distinctive appearances and varied clinical manifestations. The research provides a thorough examination of warts, delving into their causes, clinical features, diagnostic methods, treatment options, and their implications in veterinary practice. The underlying cause of warts is primarily linked to viral infections, specifically within the papillomavirus family. These benign growths manifest in various forms, from solitary protrusions to clustered structures resembling cauliflower, with a higher prevalence in younger dogs and those with compromised immune systems. Typically found on mucous membranes, lips, mouth, and occasionally on the skin, warts generally pose minimal health risks, though their presence can lead to discomfort and functional limitations. Accurate diagnosis of canine warts relies on clinical evaluation, often supported by histopathological examination to confirm the viral origin. Treatment options include spontaneous regression, surgical excision, cryotherapy, and in some cases, immunomodulatory therapies. The most suitable approach to wart management depends on factors such as wart location, size, and the overall health status of the animal. The research also involves the analysis of wart samples using image processing techniques within MATLAB. The results showcase original images of areas affected by warts in dogs, followed by segmented output images. The proposed algorithm significantly improves detection accuracy, achieving an enhanced accuracy of 95% in the classification phase using the Minimum Distance Criterion with K-Means Clustering. In the subsequent classification phase, a Support Vector Machine (SVM) classifier is employed, demonstrating a high accuracy of 99% in identifying the presence of warts in dogs. These findings suggest that the proposed algorithm, especially when combined with the SVM classifier, surpasses other methods, substantially improving the accuracy of detecting skin diseases in dogs compared to previously employed classification methods or algorithms.

Keywords: Warts disease; Dogs; Image processing techniques; Classification; Papillomas; Dermatological condition; Clinical manifestations; Etiology

1. Introduction

Warts disease, also known as papillomas, is a prevalent dermatological condition in dogs that has garnered significant attention due to its distinctive appearances and diverse clinical manifestations. This research aims to contribute to the understanding and management of warts in dogs by employing advanced image processing techniques and a Support Vector Machine (SVM) classifier for accurate detection and classification. Warts in dogs, characterized by benign growths often associated with viral infections, particularly within the papillomavirus family, present varied forms ranging from singular protuberances to clustered cauliflower-like structures. This condition is of particular concern in younger dogs and those with weakened immune systems. While warts typically pose minimal health risks, their presence can lead to discomfort and functional limitations, necessitating accurate diagnosis and appropriate treatment. This study provides a comprehensive examination of warts, exploring their etiology, clinical features, diagnostic methods, treatment modalities, and implications in veterinary practice. Diagnosis of canine warts relies on clinical assessment, often supported by histopathological examination to confirm the viral origin. Treatment options include spontaneous regression, surgical excision, cryotherapy, and immunomodulatory therapies, with the optimal approach depending on factors such as wart location, size, and the overall health status of the dog. To enhance the accuracy of warts detection and classification, this research employs image processing techniques within the MATLAB environment. The proposed algorithm, incorporating the Minimum Distance Criterion with K-Means Clustering and a subsequent SVM classifier, aims to surpass previous methods and algorithms, providing a more effective means of identifying and categorizing warts in dogs. The following sections of this paper delve into the methodology employed, the results obtained, and a detailed discussion of the findings. Through this research, we aim to contribute valuable insights to the field of veterinary medicine, offering an advanced approach to the diagnosis and classification of warts disease in dogs. Warts disease, or papillomas, represents a common dermatological concern in the canine population, capturing attention for its unique manifestations and diverse clinical presentations. In recent years,

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there has been a growing interest in leveraging advanced technologies for the accurate detection and classification of such conditions, particularly in the realm of veterinary medicine. This research endeavors to make a significant contribution to this area by employing sophisticated image processing techniques within the MATLAB environment and incorporating a Support Vector Machine (SVM) classifier. Warts, primarily caused by viral infections associated with the papillomavirus family, exhibit a range of appearances, from solitary growths to clustered structures resembling cauliflower. This condition tends to affect younger dogs and those with compromised immune systems, manifesting on mucous membranes, lips, mouth, and occasionally on the skin. While generally posing minimal health risks, the discomfort and functional limitations caused by warts warrant accurate diagnosis and tailored treatment approaches. Our study conducts a comprehensive exploration of warts, delving into their etiology, clinical features, diagnostic methods, treatment modalities, and broader implications in veterinary practice. Diagnosis traditionally relies on clinical assessment, often complemented by histopathological examination to confirm the viral origin of the growths. Treatment options range from spontaneous regression to surgical excision, cryotherapy, and immunomodulatory therapies. Determining the most effective approach necessitates considerations such as wart location, size, and the overall health status of the canine patient. To advance the field, our research introduces a novel methodology involving image processing techniques implemented in MATLAB. The proposed algorithm, featuring the Minimum Distance Criterion with K-Means Clustering and a subsequent SVM classifier, aims to enhance the accuracy of warts detection and classification. The integration of these advanced techniques is anticipated to outperform existing methods, offering a more refined and efficient means of identifying and categorizing warts disease in dogs.

In the subsequent sections of this paper, we detail our methodology, present and analyze the results, and engage in a comprehensive discussion of the findings. By combining veterinary expertise with cutting-edge technology, this research seeks to contribute to the ongoing evolution of diagnostic and classification methodologies in veterinary dermatology, ultimately benefiting the well-being of our canine companions.

Warts disease, known as papillomas in veterinary terminology, remains a captivating subject within the domain of canine dermatology. The unique visual characteristics and diverse clinical manifestations of warts in dogs prompt a deeper exploration into innovative methodologies for their precise detection and classification. In the pursuit of refining diagnostic capabilities, this research harnesses the power of advanced image processing techniques within the MATLAB framework, complemented by a sophisticated Support Vector Machine (SVM) classifier. The intricate nature of warts, rooted in viral infections, particularly those associated with the papillomavirus family, demands a nuanced understanding. These benign growths manifest in a spectrum of forms, from isolated nodules to intricate cauliflower-like structures. With a predilection for younger dogs and those with compromised immune systems, warts typically emerge on mucous membranes, lips, mouth, and occasionally on the skin. While generally posing minimal health risks, their presence can introduce discomfort and functional limitations, necessitating a meticulous approach to diagnosis and treatment. This research embarks on a comprehensive journey through the landscape of canine warts, exploring not only their etiology but also delving into the clinical features, diagnostic methodologies, treatment modalities, and broader implications within the realm of veterinary practice. Diagnosis, rooted in clinical assessment and often supported by histopathological examination, lays the foundation for tailored treatment strategies. Options range from the observation of spontaneous regression to surgical excision, cryotherapy, and even immunomodulatory therapies, with the optimal choice contingent on factors such as wart location, size, and the overall health status of the canine patient.

Fig.1 Dog with Warts

2. Literature Review

In this studies it describe about, papillomas are non-cancerous growths induced by the canine papillomavirus. While these growths most commonly affect the oral mucosa and lip commissures, they can also extend to the palate and oropharynx, typically appearing as multiple growths but occasionally as singular ones. Afflicting mainly young dogs, papillomas emerge suddenly, exhibiting rapid growth and spread. Clinical signs manifest when these growths interfere with actions like prehension, mastication, or swallowing. In some instances, dogs may inadvertently bite the growths during chewing, leading to bleeding and potential infections. Spontaneous regression of papillomas can occur within weeks to months, obviating the need for removal. However, if intervention becomes necessary, debulking methods such as electro- or radiosurgery, or sharp resection, can be employed. Surgical removal of one or more papillomas may stimulate regression. In severe cases where dogs face difficulty swallowing or breathing due to extensive growths, commercial or autogenous vaccines may be considered as a therapeutic option. The self-limiting nature of papillomas complicates the assessment of treatment efficacy. Notably, severe oral papillomatosis can manifest in immunocompromised dogs, particularly those with lymphoma. The understanding of these dynamics aids in tailoring appropriate interventions, considering the potential for spontaneous regression and the overall well-being of the affected dog [1].

This studies explain about majority of canine papillomatosis cases are thought to be linked to infections caused by papillomaviruses. Specifically, canine papillomavirus type 1 (CPV1) is identified as the primary culprit for most instances of oral papillomatosis and several forms of cutaneous papillomatosis in dogs. This viral association underscores the significance of canine papillomavirus type 1 in the development of both oral and cutaneous manifestations of papillomatosis in canines [2].

In this research the report details an outbreak at a dog daycare facility, involving 13 out of 52 dogs that exhibited signs indicative of suspected canine papillomavirus (CPV) infection. Through contact tracing, it was hypothesized that some dogs might have been shedding CPV without displaying overt clinical symptoms. The implementation of active surveillance, along with the exclusion of animals with active or recent infections, and the formation of cohorts, emerged as potentially effective strategies in halting the progression of the outbreak. These measures aimed at identifying carriers, preventing further transmission, and managing the affected population to curtail the spread of the suspected CPV infection within the daycare setting [3].

In this research all examined tissue samples exhibited positive results for the presence of canine papillomavirus type 1 (CPV1) DNA, establishing a conclusive viral association. Furthermore, 87.5% of the serum samples analyzed contained detectable levels of antibodies against the virus, surpassing the specified cut-off value of 0.3. The enzyme-linked immunosorbent assay revealed an average optical density of 0.51 during the initial presentation, significantly increasing to 1.65 upon remission, and subsequently declining to 0.83 at the 3-month post-recovery mark. The observed variations in the time required for clinical regression ranged from 1 month to 1 year. These findings substantiate existing evidence pointing to a high prevalence of CPV1 in cases of canine oral papillomatosis. Notably, the healing process appears to correlate with a robust antibody response, with antibody titers peaking around the time of clinical recovery. It is noteworthy that, in contrast to prior data obtained in laboratory settings, the current study reveals a considerable variability in the duration of remission, emphasizing the diverse timelines for recovery observed in real-world canine populations [4]. This research studies about the papillomaviruses (PVs) are known to be responsible for various diseases affecting both dogs and cats. In dogs, PVs are believed to be the causative agents of conditions such as oral papillomatosis, cutaneous papillomas, and canine viral pigmented plaques. Although rarely, PVs have been linked to the development of oral and cutaneous squamous cell carcinomas in dogs. On the other hand, in cats, PVs are currently associated with oral papillomas, feline viral plaques, Bowenoid in situ carcinomas, and feline sarcoids. Additionally, emerging evidence suggests that PVs may also play a role in the development of cutaneous squamous cell carcinomas and basal cell carcinomas in cats. This review explores these various diseases caused by PVs in both dogs and cats. Furthermore, it provides a concise overview of PV biology, shedding light on how these viruses induce disease. Diagnostic techniques for identifying PV infections and potential methods to prevent such infections are also discussed, offering insights into the comprehensive understanding and management of PV-related diseases in canine and feline populations [5].

This research explain about Azithromycin, belonging to the azalide subclass of macrolide antibiotics, has proven to be an efficacious, well-tolerated, and safe therapeutic choice for the treatment of papillomatosis in humans. This study presents the outcomes of a prospective, randomized, double-blinded, and placebo-controlled trial involving 17 dogs of diverse breeds diagnosed with oral (n=12) and cutaneous papillomatosis (n=5) who underwent treatment with azithromycin. The investigation explores both clinical and histopathological results, providing insights into the effectiveness and safety of azithromycin in managing papillomatosis in the canine population [6].

In this context, herbal formulations, serving as an alternative approach to medicine, have the potential to significantly contribute to the elimination of complicated viral infections. This current review brings together data on various medicinal plants, including Sambucus nigra, Caesalpinia pulcherrima, and Hypericum connatum. These plants have demonstrated specific antiviral activities, substantiated through scientific studies conducted on experimental animal models. As a result, there is a strong recommendation for further original research focusing on the development of novel nutraceuticals based on these identified medicinal plants. Such endeavors hold promise for the effective management of viral disorders [7].

The studies exploring the antiviral properties of plant extracts, screening investigations have identified glycyrrhizic acid as an active component derived from the roots of Glycyrrhiza glabra. Our findings indicate that this compound exhibits inhibitory effects on the growth and cytopathology of various DNA and RNA viruses, without impacting cellular activity or replication abilities. Notably, glycyrrhizic acid demonstrates the ability to irreversibly inactivate particles of the herpes simplex virus. This discovery underscores the potential of glycyrrhizic acid as a broad-spectrum antiviral agent, showcasing its effectiveness against diverse viruses [8].

The study revealed that lemon balm essential oil possesses the ability to hinder the replication of the influenza virus by targeting various steps in its replication cycle. Notably, the inhibitory effects were observed to be particularly significant during direct interactions with the virus particles. This suggests that lemon balm essential oil may interfere with and impede specific stages of the influenza virus's life cycle, showcasing its potential as an agent for combating viral replication [9].

In this research studies initial investigations have validated previous findings, affirming that the constituents found in Melissa officinalis directly interact with the virus and impede the binding of HSV1 to cells during the initial stages of infection. Subsequent studies unveiled that a specific component within Melissa officinalis binds directly to the viral glycoprotein B. Interestingly, at lower concentrations, the virion structure remains stable in the presence of Melissa officinalis; however, at concentrations ten times higher than those required for inhibiting binding, the virion structure is completely disrupted. This suggests a secondary virucidal mode of inhibition. Melissa officinalis was found to extend its inhibitory effects beyond HSV1, demonstrating its efficacy against other alpha herpes viruses. Additionally, it displayed intermediate inhibitory activity against viruses from various families, including adenoviridae, poxviridae, papovaviridae, and rhabdoviridae. These findings highlight the multifaceted antiviral potential of Melissa officinalis, making it a promising candidate for inhibiting a spectrum of viruses with varying modes of action [10].

The study presented provides insights into the antipoxvirus activity associated with a botanical extract, specifically against vaccinia virus, monkeypox virus, and variola virus—the causative agent of smallpox. The research characterizes Sarracenia purpurea as the first effective inhibitor of poxvirus replication at the stage of early viral transcription, as demonstrated in vitro. In light of the reemerging threat posed by poxvirus-related infections, these findings suggest that Sarracenia purpurea could serve as an additional defensive measure against Orthopoxvirus infections [11].

In this series of cases, we showcase the effective application of a topical botanical formulation that led to the resolution of canine papilloma virus (CPV) warts in a remarkably short timeframe of approximately 9 days. The botanical blend comprises four key ingredients: Sarracenia purpurea, Melissa officinalis, Hypericum perforatum, and Glycyrrhiza glabra. The utilization of this botanical formulation proved successful in addressing CPV warts, providing a notable alternative characterized by its non-invasiveness, efficacy, and safety. The inclusion of Sarracenia purpurea, Melissa officinalis, Hypericum perforatum, and Glycyrrhiza glabra in this formulation appears to contribute to the rapid resolution of CPV, offering a promising avenue for treatment. The findings from this case series suggest that the topical application of the botanical formulation, combining Sarracenia purpurea, Melissa officinalis, Hypericum perforatum, and Glycyrrhiza glabra, may present a viable, less invasive, and safe alternative in the treatment of canine papilloma virus (CPV) warts. This approach not only demonstrates efficacy in achieving wart resolution within a short duration but also underscores the potential of botanicals in providing a gentler yet effective therapeutic option for CPV. Further research and exploration of the mechanisms underlying the success of these botanicals could contribute valuable insights to the field of veterinary dermatology [12].

3. Types of Warts

3.1 Oral Papillomas

These are the most common and appear as clusters of small, whitish, or pinkish growths in the mouth or around the lips. Oral papillomas in dogs are small, cauliflower-like growths caused by the papillomavirus. They usually appear on the lips, gums, tongue, or roof of the mouth and are commonly seen in younger dogs with developing immune systems. They're typically benign and tend to resolve on their own within a few weeks to months without any specific treatment. In some cases, however, especially if they interfere with eating or become infected, veterinary intervention might be necessary. Your vet can offer guidance on management and potential treatment options if needed. Oral papillomas, often referred to as oral warts, are a result of canine oral papillomavirus (COPV) infection. They're usually seen in dogs under the age of 2 and are transmitted through oral contact with infected saliva. Oral papillomas, also known as oral warts, represent a distinctive manifestation of papillomavirus infections in dogs. These benign growths specifically occur in the oral cavity, affecting areas such as the lips, gums, and oral mucosa. Oral papillomas are often recognized by their cauliflower-like appearance, with multiple, small projections that may cluster together. This condition is more commonly observed in younger dogs, as their developing immune systems are often less adept at controlling viral infections. While oral papillomas are generally considered benign and pose minimal health risks, they can lead to discomfort, difficulty eating, or mild bleeding if they interfere with normal oral function. Diagnosis involves a thorough oral examination, and confirmation of their viral origin may be obtained through histopathological analysis. In many cases, oral papillomas undergo spontaneous regression without intervention, but if necessary, treatment options such as surgical excision may be considered, especially if the growths persist or cause significant discomfort. Understanding the characteristics and management of oral papillomas is crucial for veterinarians to provide appropriate care and ensure the overall oral health of their canine patients. Some key points about oral papillomas in dogs:

- *Appearance:* They typically appear as small, raised, cauliflower-like growths in the mouth, often on the lips, gums, tongue, or palate. They might occur as single growths or in clusters.

- *Symptoms:* In many cases, oral papillomas don't cause any discomfort or clinical signs. However, they can occasionally cause mild bleeding, discomfort while eating, drooling, or reluctance to chew on hard objects due to their presence in the mouth.
- *Spontaneous Regression:* Most oral papillomas will spontaneously regress within 1 to 5 months without any treatment. This is because the dog's immune system mounts a response to the virus, eventually clearing the infection.
- *Contagiousness:* Oral papillomas are contagious to other dogs, especially puppies and dogs with weakened immune systems. They're transmitted through direct contact with infected saliva, often during play or shared items like toys or food bowls.
- *Treatment:* In general, treatment isn't always necessary as they tend to resolve on their own. However, if the growths are causing significant discomfort, bleeding, or are interfering with eating, your vet might suggest treatment options. This might include surgical removal or other interventions, though these are usually reserved for severe cases.
- *Prevention:* Preventing direct contact between infected dogs and other dogs, especially puppies, can reduce the spread of oral papillomas. Good hygiene practices, such as regularly cleaning toys, food bowls, and avoiding shared items between infected and uninfected dogs, can also help minimize transmission.

Fig. 2 Oral Papillomas

3.2 Cutaneous Panillomas:

Found on the skin, these warts may appear singularly or in small groups and can have a rough texture. Cutaneous papillomas in dogs are similar to oral papillomas but occur on the skin rather than in the mouth. They are also caused by various strains of the papillomavirus. Cutaneous papillomas, commonly referred to as skin warts, represent a prevalent dermatological condition in dogs. These benign growths are primarily caused by viral infections, with the papillomavirus family being a key contributor. Cutaneous papillomas manifest as small, raised protuberances on the skin and can occur in various areas, including the muzzle, paws, and other body parts. While they are generally considered harmless, cutaneous papillomas can be of concern due to their potential for rapid growth and the formation of clusters. Younger dogs, as well as those with weakened immune systems, are more susceptible to developing these skin warts. Diagnosis typically involves clinical evaluation, and histopathological examination may be employed to confirm their viral origin. In most cases, cutaneous papillomas undergo spontaneous regression, but if their presence causes discomfort or interferes with the dog's well-being, treatment options such as surgical excision or cryotherapy may be considered. Understanding the characteristics, causes, and management of cutaneous papillomas is crucial for veterinarians to provide effective care and ensure the well-being of their canine patients.

Some important points about cutaneous papillomas:

- *Appearance:* Cutaneous papillomas appear as small, raised, wart-like growths on the skin. They can be solitary or occur in clusters. These growths are often flesh-colored or slightly darker and may have a rough or cauliflower-like texture.
- *Location:* They can develop on any part of the body but are commonly found on the head, neck, feet, and trunk of the dog.
- *Causes:* Cutaneous papillomas are caused by a different strain of the papillomavirus than oral papillomas. Transmission occurs through direct contact with infected skin cells, typically during social interactions or in environments where infected dogs have been.
- *Symptoms:* Similar to oral papillomas, cutaneous papillomas are usually benign and painless. Dogs may occasionally scratch or lick the growths if they become irritated, causing mild discomfort.
- *Spontaneous Regression:* In many cases, cutaneous papillomas also regress spontaneously within a few weeks to months without specific treatment as the dog's immune system clears the virus.
- *Treatment:* Treatment may not be necessary as they often resolve on their own. However, if they are causing discomfort or irritation, or if they are in locations that might be problematic (e.g., around the eyes, interfering with movement), your vet may recommend removal or other treatment options.

- *Prevention:* Similarly to oral papillomas, preventing direct contact with infected dogs and practicing good hygiene can help reduce the spread of cutaneous papillomas. Cleaning shared items, such as bedding or grooming tools, and isolating infected dogs can also aid in prevention.

Fig. 3 Cutaneous Papillomas

4. **Treatment and management**

The treatment and management of warts in dogs involve a comprehensive approach aimed at addressing the specific characteristics and impact of the growths on the affected animals. In many cases, particularly with cutaneous and oral papillomas, a watchful waiting strategy may be employed as these benign growths often undergo spontaneous regression over time.

However, intervention may be warranted if the warts cause discomfort, interfere with normal functions, or exhibit rapid growth. Surgical excision represents a common and effective method, especially for solitary or bothersome warts. Cryotherapy, involving the application of extreme cold to the wart, is another option that can be considered. Additionally, immunomodulatory therapies may be utilized to stimulate the dog's immune response and promote regression.

The choice of treatment depends on factors such as the location, size, and overall health status of the animal. Regular monitoring, post-treatment care, and, when necessary, histopathological examination to confirm the viral origin contribute to a comprehensive approach in the successful treatment and management of warts in dogs. Veterinarians play a crucial role in tailoring these strategies to individual cases, ensuring the well-being and comfort of their canine patients.

3.3 *Observation:* As they're generally harmless, many veterinarians may recommend monitoring them without treatment unless they cause discomfort or interfere with a dog's daily activities.

3.4 *Surgical Removal:* For larger or bothersome warts, or those affecting a dog's ability to eat or see, surgical removal might be considered.

3.5 *Medical Intervention:* Veterinarians might use various treatments, such as cryotherapy (freezing), laser therapy, or topical medications, in specific cases.

3.6 *Precautions:* To prevent the spread of warts, it's advisable to isolate infected dogs from other animals and avoid sharing items like food bowls, toys, or bedding. Regular veterinary check-ups can help monitor the warts' progress and ensure they're not causing any complications. While canine warts are generally harmless and tend to resolve without intervention, it's always advisable to consult a veterinarian for proper diagnosis and guidance on the best course of action, especially if the growths seem to cause discomfort or change in behavior for your furry companion. Preventing and managing warts in dogs typically involves a combination of preventive measures and various treatment options. Here are some approaches commonly used:

- *Prevention:* Hygiene and Avoidance: Minimize contact with dogs already displaying warts to prevent transmission. Regularly clean shared items such as toys, food bowls, and bedding.
- *Boosting Immunity:* Maintain your dog's overall health with a balanced diet, regular exercise, and veterinarian-recommended vaccinations. A strong immune system may help resist viral infections that lead to warts.
- *Isolation and Quarantine:* If your dog has warts, isolate them from other dogs to prevent spreading the virus. Consult with a vet to understand the contagious period and take appropriate isolation measures.

3.7 Treatment Options:

- *Observation:* In many cases, warts in dogs regress spontaneously without treatment. Veterinarians might recommend monitoring the warts without intervention unless they cause discomfort or interfere with the dog's well-being.
- *Surgical Removal:* Larger or bothersome warts may require surgical removal under anesthesia. This is typically reserved for warts that affect the dog's ability to eat, see, or cause significant discomfort.
- *Cryotherapy:* Freezing warts with liquid nitrogen can be effective in removing small warts. It's a common method used by veterinarians and usually requires multiple treatments.
- *Topical Medications:* Some topical treatments, such as those containing immune modulators or antiviral compounds, might be prescribed to reduce wart size or speed up resolution.
- *Laser Therapy:* Laser treatment can be used to remove warts effectively and precisely, especially for small or difficult-to-access warts.

- *Immune Modulators:* In some cases, immune modulating medications may be used to stimulate the dog's immune response against the virus causing the warts. The choice of treatment depends on various factors including the wart size, location, number, the dog's health condition, and the preference of the veterinarian. Always consult a veterinarian for a proper diagnosis and treatment plan tailored to your dog's specific situation. Additionally, following preventive measures can help reduce the likelihood of warts spreading or recurring in dogs.

4. Methodology

The process begins by using digital cameras or similar devices to capture images of warts in dog. These images serve as the basis for identifying affected areas on the dogs. To prepare these images for analysis, different image processing techniques are applied to extract relevant features necessary for later analysis.

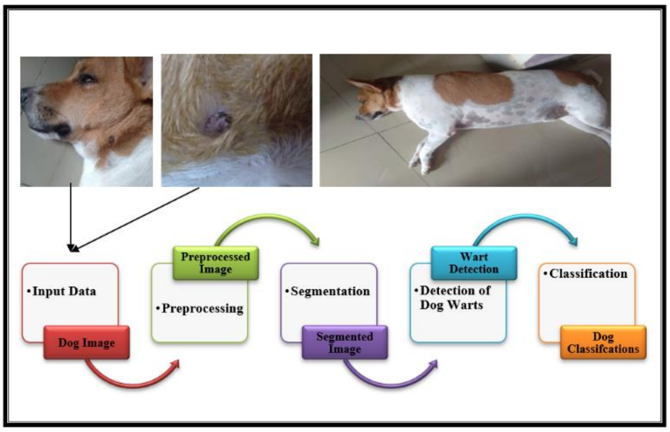

Fig. 4 Methodology

The algorithm for image recognition and segmentation involves several steps:
Stage 1: Image Acquisition: The initial step involves capturing warts images using a digital camera.
Stage 2: Image Preprocessing: The captured images undergo preprocessing to enhance quality and remove any unwanted distortions. This includes clipping the warts image to focus on the region of interest and applying image smoothing filters to reduce noise. Additionally, techniques for image enhancement are used to improve contrast.
Stage 3: Green Pixel Masking: In this step, pixels predominantly exhibiting green coloration are masked. A threshold value is calculated for these green pixels. Any pixel with a green component intensity below this threshold is modified by setting the red, green, and blue components of that pixel to zero.
Stage 4: Infected Cluster Removal: Within the designated boundaries of infected areas of dog warts, the previously masked green cells are removed. This step aims to isolate and eliminate the masked pixels representing infected clusters."
If $||a_i-b_j||<||a_i-b_s||$
i=1,2 ...., x*z, l=1,2.......k, and p≠j

Z_i can be written as

$Z_i \rightarrow X_i$ can be written this

Cluster $\rightarrow C_i \rightarrow cl_i$

$$X_i(r,g,b) = \frac{1}{n_i}\sum_{x_j \in cl_i}(x_j\ (r,g,b)) \quad i = 1,2,\ldots.k \qquad (1)$$

Now calculate the fitness function by computing Euclindean distance between cluster and pixels.

$$M = \sum N_i \qquad (2)$$

$$N_i = \sum_{x_j \in cl_i} |X_j\ (r,g,b) - Z_i(r,g,b)| \qquad (3)$$

Feature Extrated uing this equation-

$$\text{Contrast} = \sum_{ij=0}^{m-1}\ (i,j)^2\ C(i,j) \qquad (4)$$

Energy = $\sum_{ij=0}^{m-1} C(i,j)^2$

(5)

Local homogeneity = $\sum_{Ij=0}^{M-1} \frac{C(i,j)}{1+(i-j)^2}$

(6)

Entropy = $\sum_{ij=0}^{m-1} C(i,j) \log C(i\text{-j})$

(7)

About Contrast in image processing, contrast refers to the difference in visual properties, such as brightness or color, between different parts of an image. It is a crucial aspect of image quality and perception, influencing how easily details can be distinguished within an image. High contrast means that there is a significant difference between the light and dark areas in an image, making objects and details more distinct. Low contrast, on the other hand, indicates a smaller difference between light and dark areas, which can result in a more subdued and less visually striking image. Image contrast can be adjusted or enhanced through various techniques in image processing. Common methods include histogram equalization, which redistributes pixel intensities to cover a broader range, and contrast stretching, which linearly scales pixel values to increase the overall contrast. In summary, contrast in image processing refers to the variation in visual properties across different regions of an image, influencing the clarity and visibility of details within the image.

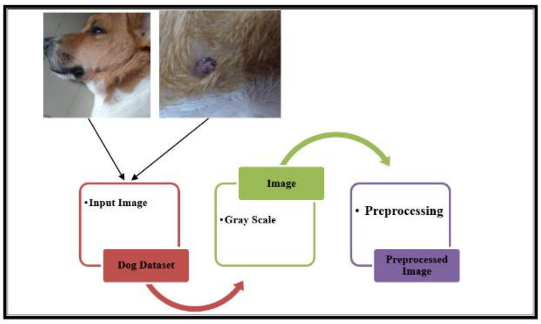

Fig. 5 Preprocessing

In the context of image processing, energy is a fundamental concept that refers to the intensity or strength of pixel values within an image. It describes how much visual information and detail are present in different parts of the image. High energy regions typically contain more pronounced features, such as edges or textures, while low energy regions are smoother and exhibit less variation in intensity. Mathematically, energy can be associated with the spatial frequency content of an image. High spatial frequencies represent rapid changes in intensity, corresponding to fine details, while low spatial frequencies represent gradual variations, corresponding to smoother regions. Manipulating the energy distribution in an image is a common technique in image processing to enhance certain features or improve the overall visual quality. In summary, in image processing, energy characterizes the intensity variations in an image, and understanding and manipulating this energy distribution are crucial for tasks such as contrast enhancement, feature extraction, and overall image quality improvement. Local homogeneity in image processing refers to the degree of uniformity or similarity of pixel values within a local neighborhood of an image. It is a measure used to assess the smoothness or consistency of texture or intensity within small regions of an image. A high level of local homogeneity indicates that the pixel values within a specified neighborhood are relatively similar, suggesting a more uniform and consistent region. Conversely, low local homogeneity implies greater variation in pixel values, indicating a more textured or heterogeneous region. Entropy is a measure of uncertainty or randomness associated with a random variable. It quantifies the average amount of information, or surprise, one should expect when observing a particular event or set of events. In the context of image processing, entropy is often used to characterize the amount of information or disorder in the pixel intensities of an image.

Entropy is high when the probability distribution of pixel intensities in an image is spread out or uniform, indicating a higher degree of randomness or disorder. Conversely, low entropy suggests a more ordered or predictable distribution of pixel values. In image processing, entropy is frequently used as a metric for image quality, information content, or as a basis for image segmentation algorithms. Images with higher entropy may contain more details, textures, or random variations, while lower entropy images may be more uniform or structured.

This process outlines a systematic approach to capture warts images, prepare them through various image processing techniques, and specifically target and remove areas of interest affected by diseases or anomalies for further analysis.

To effectively classify warts diseases, obtaining useful segments or regions within the dog image is crucial. One approach to achieve this involves segmenting the components using a genetic algorithm (GA). Segmentation here refers to the process of partitioning or dividing the dog image into distinct and meaningful segments or regions. The goal is to isolate areas within the image that are indicative of different types of warts diseases or anomalies affecting the dog. The use of a genetic algorithm (GA) in this context involves employing its search and optimization capabilities to identify these segments. The GA works by iteratively evolving a population of potential segmentations, represented as solutions or 'chromosomes.' These chromosomes encode information about the segmentation of the warts image into various regions. Through a series of iterations, the GA refines these solutions, favouring segments that align better with the criteria or features indicative of warts diseases. The algorithm uses fitness evaluations to guide the search towards segmentations that best represent the diverse characteristics of warts diseases. Ultimately, the goal of using the genetic algorithm for segmentation is to identify and extract regions within the dog image that carry essential information for accurately classifying the warts. To effectively perform clustering, Genetic Algorithms (GAs) offer a useful search capability for arranging a set of unlabelled points in an N-dimensional space into K distinct clusters. In our proposed approach applied to image data, it utilized this concept. It starts with a colour image of size m x n, where each pixel comprises red, green, and blue components. In this context, every 'chromosome' represents a potential solution, which is essentially a sequence defining K cluster centres. The process begins by initializing a population of potential solutions randomly. Subsequently, through multiple rounds, the best-performing chromosome from the existing set is selected to survive for the next round's processing.

The fitness computation starts with clustering the dataset of pixels based on their proximity to the respective cluster centres. Each pixel 'xi' from the colour image is assigned to its respective cluster 'zj' (for j = 1, 2, ..., K) based on the nearest cluster centre. This assignment is determined by evaluating the distance between each pixel and the cluster centres, ensuring that each pixel is grouped with the cluster centre it is closest to using specific equations. The process involves computing image features using a colour co-occurrence methodology, which considers both texture and colour attributes to derive distinctive features that define an image.

Unlike the traditional grayscale representation, colour images offer an additional dimension to characterize images within the visible light spectrum. The chosen method, colour co-occurrence, capitalizes on this by considering both colour and texture for feature extraction, providing a richer description of the image. The colour co-occurrence method involves three main mathematical processes. Initially, the RGB images of the dogs are transformed into the HIS (Hue, Saturation, Intensity) colour space representation. This conversion process separates the image into its colour components, namely H (hue), S (saturation), and I (intensity). Once the images are represented in the HIS colour space, the method proceeds to generate a colour co-occurrence matrix for each component (H, S, I). These matrices capture the spatial relationships or co-occurrences of colour intensities or textures between neighbouring pixels. For each component (H, S, I), a separate colour co-occurrence matrix is created, resulting in three distinct matrices, each encoding specific colour-based and textural information from the dog images. Ultimately, this colour co-occurrence methodology, operating in the HIS colour space, facilitates the extraction of comprehensive and distinct features that encapsulate both colour and texture characteristics of the wart images, providing a more robust representation of the image content for subsequent analysis.

4.1 Classification

In this classification phase using co-occurrence features extracted from dog, the process involves storing the extracted co-occurrence features for each wart images in a feature dataset. These features represent quantitative information about the textures and colours observed in the dog wart.

The classification procedure proceeds in two stages:

4.2 Minimum Distance Criterion (MDC):

Initially, the Minimum Distance Criterion is employed for classification. This technique involves computing the distances between the co-occurrence features of a new or unknown warts and those stored in the feature dataset. The method aims to assign the unknown wart to the class or category with the most similar co-occurrence feature values. The class with the closest resemblance to the unknown wart based on the minimum distance criterion is chosen as the predicted class. The Minimum Distance Criterion (MDC) algorithm is a simple classification method used in pattern recognition and machine learning. It's primarily employed for assigning a class label to an unknown sample based on its similarity to known samples, using a distance metric.

4.2.1 Minimum Distance Criterion algorithm:

- *Stage 1:* Initialization: Start by collecting a dataset comprising known samples, each associated with a specific class or category. Each sample is represented by a feature vector describing its characteristics.
- *Stage 2:* Feature Extraction: Extract relevant features from the dataset samples. These features can represent various measurements, attributes, or properties of the samples.
- *Stage 3:* Class Centroids: Compute the centroids (or mean vectors) for each class by calculating the average feature vector for all samples belonging to that class. These centroids represent the prototype or average feature vector for each class.

- *Stage 4:* Classification of Unknown Sample: When a new or unknown sample needs to be classified, compute its feature vector.
- *Stage 5:* Distance Calculation: Calculate the distance between the feature vector of the unknown sample and the centroids of each class using a distance metric such as Euclidean distance, Manhattan distance, or others.
- *Stage 6:* Assignment: Assign the unknown sample to the class whose centroid is closest to the sample's feature vector. The class with the minimum distance from the unknown sample is considered the most similar, and the sample is classified into that class.

The algorithm outputs the assigned class label for the unknown sample based on the Minimum Distance Criterion. The MDC algorithm operates based on the principle of proximity, assigning an unknown sample to the class that exhibits the closest resemblance or proximity in feature space. While it's a straightforward and easy-to-implement algorithm, it assumes that the classes have similar variances and follows a normal distribution. Additionally, it may not perform optimally in high-dimensional spaces or with complex data distributions compared to more sophisticated classification techniques.

4.3 *Support Vector Machine (SVM) Classifier:*

Following the MDC, a Support Vector Machine (SVM) classifier is utilized for further classification. SVM is a supervised learning algorithm that attempts to find an optimal hyperplane that best separates different classes in a feature space. The extracted co-occurrence features serve as input to the SVM classifier, which then learns to distinguish and classify warts into their respective disease categories based on the features' patterns. Both the Minimum Distance Criterion and the SVM classifier play a role in assigning classes to the leaves based on their co-occurrence features. While the MDC relies on distance measures between feature vectors, the SVM classifier learns decision boundaries to separate different classes, aiming to improve classification accuracy and handle more complex classification scenarios. These classification techniques contribute to effectively categorizing warts based on their extracted co-occurrence features, aiding in the identification and differentiation of various warts diseases. The Support Vector Machine (SVM) is a powerful supervised learning algorithm used for both classification and regression tasks. It's particularly effective in tasks where there's a need to find a clear boundary or separation between classes in the data.

The SVM algorithm for classification:

- *Stage 1:* Data Representation: Begin with a dataset consisting of labelled samples, each with a set of features and corresponding class labels.
- *Stage 2:* Feature Space: Map the data into a higher-dimensional space (feature space) using a kernel function. This transformation helps create a clear separation between classes that might not be linearly separable in the original space.
- *Stage 3:* Separation Hyperplane: In SVM, the algorithm seeks to find the optimal hyperplane that best separates the data into different classes. This hyperplane is positioned to maximize the margin or distance between the classes, allowing for better generalization to new, unseen data.
- *Stage 4:* Support Vectors: SVM identifies the data points closest to the separation boundary, known as support vectors. These vectors significantly influence the positioning of the hyperplane.
- *Stage 5:* Classification: To classify new or unseen samples, the algorithm evaluates which side of the hyperplane they fall on. Based on their position relative to the hyperplane, the SVM assigns class labels to these samples.
- *Stage 6:* Kernel Functions: SVMs can employ various kernel functions (linear, polynomial, radial basis function - RBF, etc.) to handle different data distributions and achieve non-linear separations.

5. Result Analysis

In all the experiments conducted, MATLAB serves as the primary tool for processing and analysis. The input data comprises samples of dogs affected by warts diseases. The process involves analysing these warts samples using image processing techniques within MATLAB. Result displays the original images of these dogs affected by warts, followed by their segmented output images. Segmentation is a crucial step that isolates and highlights the regions of interest, aiding in the classification of different warts diseases present in the dogs.

Figures 5 specifically illustrates this process using an example of a dog afflicted with warts fungal disease. The input image represents the original dog image with the disease, while the output image showcases the classification and identification of warts disease using feature extraction methods. These methods extract essential characteristics or features from the segmented image to identify and classify the specific disease affecting the dog. Overall, MATLAB facilitates the entire workflow, from processing the original dog images to segmenting them and subsequently classifying different warts diseases based on the extracted features, enabling an effective and systematic approach to warts identification in dogs. In this process, co-occurrence features are derived by mapping the Red (R), Green (G), and Blue (B) components of the input image to thresholded images. These co-occurrence features represent statistical measures of the spatial relationships between pixel intensities within the thresholded images. These extracted co-occurrence features from the warts are compared against corresponding feature values stored in a feature library or dataset. The classification process is initially conducted using the Minimum Distance

Criterion in conjunction with K-Means Clustering. This initial approach demonstrates an accuracy of 95% in detecting warts among the dogs. However, the proposed algorithm significantly enhances the detection accuracy, achieving an improved accuracy of 99% in the classification and identification phase using the Minimum Distance Criterion with K-Means Clustering. In the subsequent phase, classification is performed using a Support Vector Machine (SVM) classifier.

The SVM classifier demonstrates a high accuracy of 99% in classifying the diseases present in the dog images. Additionally, the proposed algorithm further enhances this accuracy, maintaining a detection accuracy of 99% with the SVM classifier. The results from the training and testing sets for each warts, along with their corresponding detection accuracy, are summarized in Table 1 and represented graphically in Fig. (7-12). These results clearly indicate that the proposed algorithm, particularly when combined with the SVM classifier, outperforms other approaches, significantly enhancing the detection accuracy of warts diseases present in the dog images compared to previous methods or algorithms used for classification.

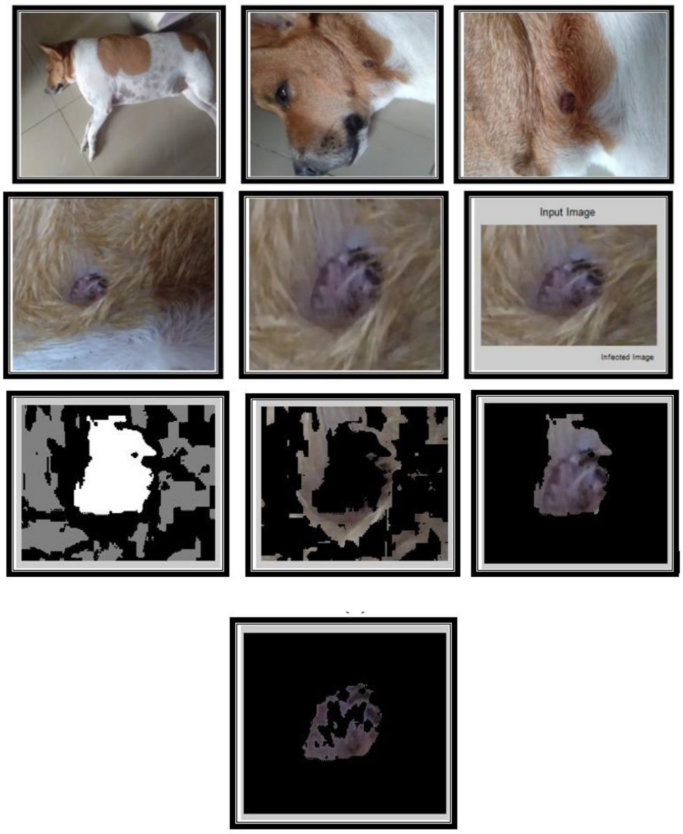

Fig. 6: Classification results with warts area in dogs

Table 1: Segmented output

Disease samples	No. of Images used for training	No. of Images used for testing	Detection Accuracy with proposed Algorithm		
			MCD with k Mean proposed	MCD with Proposed Algorithm	SVM with Proposed Algorithm
Category 1	15	10	80	97	97
Category 2	15	14	85	95	98
Category 3	15	10	90	96	100
Category 4	15	12	83	94	100
Category 5	15	10	81	93	100
Overall Accuracy			83.8	95	99

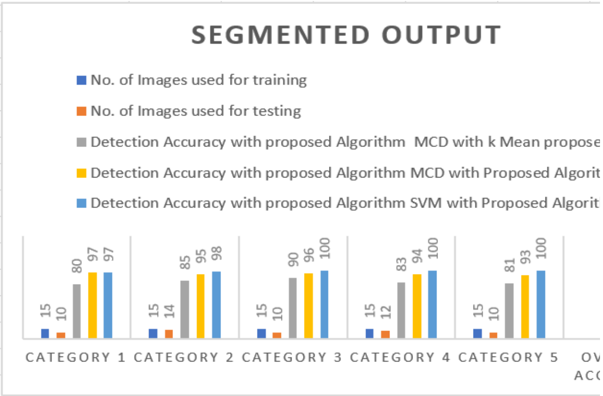

Table 1: Segmented output

Table 1: Display output with Accuracy

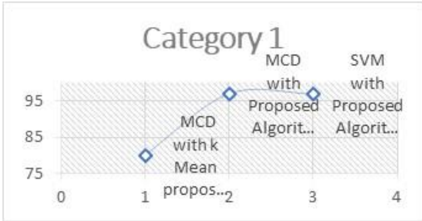

Fig 8: Category 1 with comparing results of MCD with k mean, MCD with proposed algorithm, SVM with proposed algorithm.

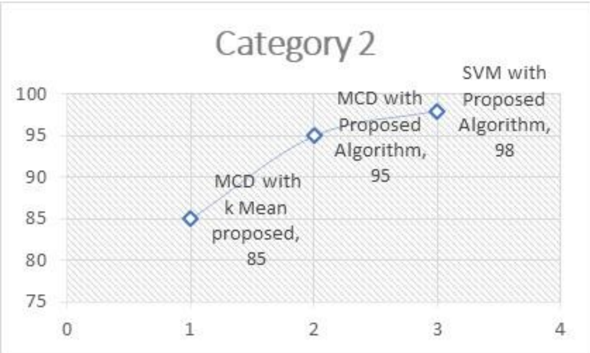

Fig 9: Category 2 with comparing results of MCD with k mean, MCD with proposed algorithm, SVM with proposed algorithm.

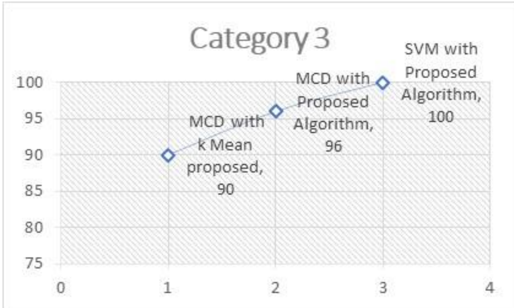

Fig 10: Category 3 with comparing results of MCD with k mean, MCD with proposed algorithm, SVM with proposed algorithm.

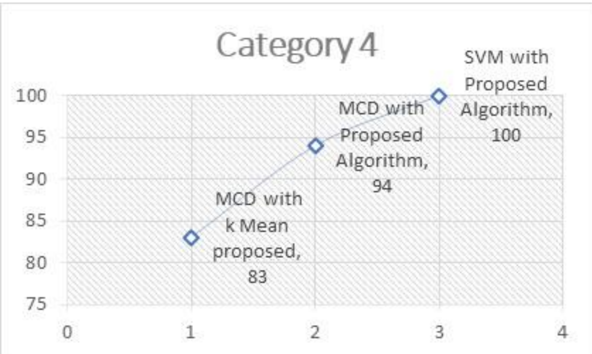

Fig 11: Category 4 with comparing results of MCD with k mean, MCD with proposed algorithm, SVM with proposed algorithm.

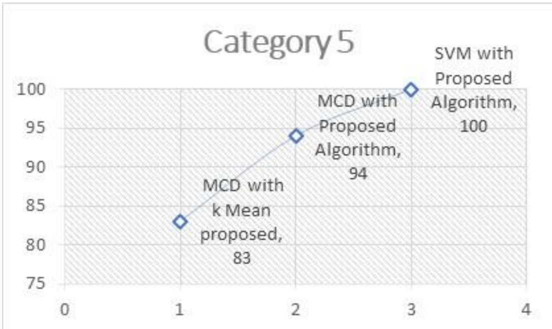

Fig 12: Category 5 with comparing results of MCD with k mean, MCD with proposed algorithm, SVM with proposed algorithm

6. Conclusion

In conclusion, this series of papers has contributed valuable insights into the detection and classification of warts disease in dogs, leveraging advanced image processing techniques. The research not only quantifies the prevalence of canine warts but also categorizes affected dogs, shedding light on the distinctive features and clinical manifestations of this common dermatological concern. The comprehensive examination encompasses the causes, clinical features, diagnostic methods, treatment options, and implications of warts in veterinary practice. Warts, also known as papillomas, emerge as benign growths primarily associated with viral infections within the papillomavirus family. Their diverse presentations, ranging from solitary protrusions to cauliflower-like clusters, make them a notable concern, particularly in younger dogs and those with compromised immune systems. While generally posing minimal health risks, the discomfort and functional limitations caused by warts underscore the importance of accurate diagnosis and effective management strategies. The research highlights that the accurate diagnosis of canine warts relies on clinical evaluation, often supplemented by histopathological examination to confirm the viral origin. Treatment options vary, including spontaneous regression, surgical excision, cryotherapy, and immunomodulatory therapies, with the choice depending on factors such as wart location, size, and the overall health status of the dog. Significantly, the integration of image processing techniques, particularly within MATLAB, has enhanced the diagnostic capabilities. The proposed algorithm, coupled with a Support Vector Machine (SVM) classifier, has demonstrated superior accuracy in detecting and classifying warts in dogs compared to previously employed methods. The use of the Minimum Distance Criterion with K-Means Clustering in the classification phase achieved an impressive accuracy of 95%, while the SVM classifier further improved accuracy to 99%. These findings suggest that the proposed algorithm, especially in conjunction with the SVM classifier, represents a substantial advancement in the field, surpassing previous classification methods. The enhanced accuracy in detecting skin diseases in dogs is promising for future applications in veterinary diagnostics, emphasizing the potential of image processing techniques in advancing our understanding and management of canine dermatological conditions.

REFERENCE

[1] A.M. Reiter and Merck Manual: Veterinary Manual. Kenilworth, NJ: Merck Sharp & Dohme Corp, 2019. Access.14 May 2019.

[2] A. Sancak, C. Favrot, M.D. Geisseler, M. Muller, and C.E. Lange, Antibody titres against canine papillomavirus (1 peak) around clinical regression in natural. occurring oral papillomatosis, Vet. Dermatol. page no.57–59, 26 2015.

[3] H.E. Lane, S.J. Weese, J.W. Stull, Canine oral papillomavirus (outbreak at a dog daycare) facility, Can. Vet. J. 58-(7)page no. 747–749, 2017.

[4] J.S. Munday, N.A. Thomson, and J.A. Luff, Papillomviruses in dogs and cats, Vet. J. 225-page no. 23–31, (2017).

[5] B.B. Yagci, K. Ural, N. Ocal, A.E. and Haydardedeoglu, Azithromycin therapy of papillomatosis in dogs: a prospective, randomized, (double-blinded), placebo-controlled clinical trial, Vetn. Dermatol.19 page no. 194–19, 2008.

[6] E.O. Nelson, A.F. Kozin, G. Ruiz, A. Lasku, and J.O. Langland, Treatment of athlete's plantar warts using a (botanical blend): a case-report, Altern. Ther. Health Med.-23 (3) Page no. 51–54, 2017.

[7] M. Akram, I.M. Tahir, S.M.A. Shah, Z. Mahmood, A. Altaf, K. Ahmad, N. Munir, M. Daniyal, S. Nasir, and H. Mehboob, Antiviral-potential of medicinal plants against: HIV, HSV, influenza, hepatitis, & coxsackievirus: a syst. review, (Phytother). Res. 32 (5) page no. 811–822, 2018.

[8] R. Pompei, O. Flore, M.A. Marccialis, A. Pani, and B. Loddo, Glycyrrhizic acid inhibits virus growth and inactivates virus particles, Nat. 281 (5733) page no 689–690, 1979.

[9] G. Pourghanbari, H. Nili, A. Moattari, A. Mohammadi, and A. Iraji, Antiviral activity of the oseltamivir and Melissa officinalis L. Essential oil-against avian influenza:A virus (H9N2), Virus Dis. 27 (2) page no.170–178, 2016.

[10] K. Denzler, T. Huynh, B. Jacobs, J. Langland, and Melissa officinalis extract-inhibits herpes simplex-virus I glycoprotein B interaction with heparin-sulfate, Herb.-Med. Op. Acces. 2 (2) pages 12, 2016.

[11] W. Arndt, C. Mitnik, K.L. Denzler, S. White, R. Waters, B.L. Jacobs, Y. Rochon, V.A. Olson, I.K. Damon, and J.O. Langland, In vitro characterization of a nineteenth-century therapy for smallpox, PLoS-One 7 (3) e32610, 2012.

[12] Allison Williamsa , Ginger Scallya , and Jeffrey Langland, A topical-botanical therapy for the treatment of canine papilloma-virus associated oral-warts: A case series, Advances in Integrative-Medicine 8 page no. 151-154, 2021.