EPIDEMIOLOGY, ZOONOTIC POTENTIAL, HAEMATOLOGY, AND CHEMOTHERAPY OF SARCOPTIC MANGE IN CAMEL IN PUNJAB

By

MUHAMMAD IRFAN ZAHID
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To,

The Controller of Examinations,
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Lahore.

We, the Supervisory Committee, certify that the contents and form of the thesis, submitted by Muhammad Irfan Zahid, have been found satisfactory and recommend that it be processed for the evaluation by the External Examiner(s) for the award of the degree.

SUPERVISOR

Prof. Dr. Azhar Maqbool

CO-SUPERVISOR

Prof. Dr. Shazia Anjum

MEMBER

Prof. Dr. Kamran Ashraf

MEMBER

Prof. Dr. Muhammad Sarwar Khan
DEDICATION

I Dedicate

This

Humble Effort and Study

To

My Beloved Mother (Late)

Whom, I Miss a Lot

on every occasion of My Success

as Her everlasting Prayers

are always with Me
ACKNOWLEDGEMENTS

All praises are for The ALLAH ALMIGHTY, The Most Merciful, The Beneficent, The Creator and Controller of everything around in the universe and blessed us with his last Prophet MUHAMMAD (S.A.W.) who is forever a role model of guidance and knowledge of the entire humanity. I bow my head before ALLAH ALMIGHTY who blessed me with sincere, helpful & encouraging wife, sincere friends, talented teachers, and above this good health, courage & potential in me at this stage of age to materialize this achievement.

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TABLE OF CONTENTS

DEDICATION---------------------------------------------------------------i
ACKNOWLEDGEMENTS-----------------------------------------------------ii
LIST OF TABLES---------------------------------------------------------v
LIST OF FIGURES--------------------------------------------------------vi

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>CHAPTERS</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>REVIEW OF LITERATURE</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>MATERIALS AND METHODS</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>RESULTS</td>
<td>67</td>
</tr>
<tr>
<td>5</td>
<td>DISCUSSION</td>
<td>107</td>
</tr>
<tr>
<td>6</td>
<td>SUMMARY</td>
<td>122</td>
</tr>
<tr>
<td>7</td>
<td>LITERATURE CITED</td>
<td>125</td>
</tr>
<tr>
<td>Table No.</td>
<td>Title</td>
<td>Page No.</td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>1</td>
<td>Lesions of mange/mite infestation on various body areas of camels</td>
<td>68</td>
</tr>
<tr>
<td>2</td>
<td>Month wise Prevalence of <em>Sarcoptic</em> mange infestation in Camels</td>
<td>70</td>
</tr>
<tr>
<td>3</td>
<td>Season wise Prevalence of <em>Sarcoptic</em> mange infestation in Camels</td>
<td>72</td>
</tr>
<tr>
<td>4</td>
<td>Sex wise Prevalence of <em>Sarcoptic</em> mange infestation in Camels</td>
<td>74</td>
</tr>
<tr>
<td>5</td>
<td>Age wise Prevalence of <em>Sarcoptic</em> mange infestation in Camels</td>
<td>76</td>
</tr>
<tr>
<td>6</td>
<td>Average Monthly Meteorological Data</td>
<td>78</td>
</tr>
<tr>
<td>7</td>
<td>Presence of lesions on various parts of the body of camel riders</td>
<td>81</td>
</tr>
<tr>
<td>8</td>
<td>Haematological Profile of Mangy / Treated and Healthy Camels</td>
<td>84</td>
</tr>
<tr>
<td>9</td>
<td>Biochemical Profile of Mangy / Treated and Healthy Camels</td>
<td>86</td>
</tr>
<tr>
<td>10</td>
<td>Electrolytes Profiles of Mangy / Treated and Healthy Camels</td>
<td>88</td>
</tr>
<tr>
<td>11</td>
<td>Effect of <em>Azadirachta indica</em> (Neem) against <em>Sarcoptic</em> mange in camels</td>
<td>91</td>
</tr>
<tr>
<td>12</td>
<td>Effect of <em>Azadirachta indica</em> (Neem) against <em>Sarcoptic</em> mange in camels (recovery percentage)</td>
<td>91</td>
</tr>
<tr>
<td>13</td>
<td>Effect of <em>Nicotiana tobacum</em> (Tobacco) against <em>Sarcoptic</em> mange in camels</td>
<td>93</td>
</tr>
<tr>
<td>14</td>
<td>Effect of <em>Nicotiana tobacum</em> (Tobacco) against <em>Sarcoptic</em> mange in camels (recovery percentage)</td>
<td>93</td>
</tr>
<tr>
<td>15</td>
<td>Effect of <em>Eruca sativa</em> (Taramera oil) mixture against <em>Sarcoptic</em> mange in camels</td>
<td>95</td>
</tr>
<tr>
<td>16</td>
<td>Effect of <em>Eruca sativa</em> (Taramera oil) mixture against <em>Sarcoptic</em> mange in camels (recovery percentage)</td>
<td>95</td>
</tr>
<tr>
<td>17</td>
<td>Effect of <em>Ivermectin</em> (Ivomec) against <em>Sarcoptic</em> mange in camels</td>
<td>97</td>
</tr>
<tr>
<td>18</td>
<td>Effect of <em>Ivermectin</em> (Ivomec) against <em>Sarcoptic</em> mange in camels (recovery percentage)</td>
<td>97</td>
</tr>
<tr>
<td>19</td>
<td>Effect of <em>Cypermethrin</em> (Ecoflee) against <em>Sarcoptic</em> mange in camels</td>
<td>99</td>
</tr>
<tr>
<td>20</td>
<td>Effect of <em>Cypermethrin</em> (Ecoflee) against <em>Sarcoptic</em> mange in camels (recovery percentage)</td>
<td>99</td>
</tr>
<tr>
<td>21</td>
<td>Untreated (Control Group) details about live <em>Sarcoptic</em> mange</td>
<td>101</td>
</tr>
<tr>
<td>22</td>
<td>Comparison of different medicines on the basis of live mite/gm of skin scrapings recorded on different days of treatment</td>
<td>101</td>
</tr>
<tr>
<td>23</td>
<td>Comparison of different medicines based on reduction in live mite/gm of skin scrapings on different days of treatment</td>
<td>102</td>
</tr>
<tr>
<td>24</td>
<td>Comparison of different medicines on the basis of recovery percentage recorded on different days of treatment</td>
<td>103</td>
</tr>
<tr>
<td>25</td>
<td>Economic Viability of Medicines Used</td>
<td>106</td>
</tr>
</tbody>
</table>
**LIST OF FIGURES**

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Title of Figure</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Month wise prevalence of Sarcoptic mange in Camels</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>Season wise prevalence of Sarcoptic mange in Camels</td>
<td>72</td>
</tr>
<tr>
<td>3</td>
<td>Sex wise prevalence of <em>Sarcoptic</em> mange infestation in Camels</td>
<td>74</td>
</tr>
<tr>
<td>4</td>
<td>Age wise prevalence of <em>Sarcoptic</em> mange infestation</td>
<td>76</td>
</tr>
<tr>
<td>5</td>
<td>Percentage wise body parts of camel riders / handlers involved in scabietic lesions</td>
<td>81</td>
</tr>
<tr>
<td>6</td>
<td>Haematological Profile of Mangy / Treated and Healthy Camels</td>
<td>84</td>
</tr>
<tr>
<td>7</td>
<td>Biochemical Profile of Mangy / Treated and Healthy Camels</td>
<td>86</td>
</tr>
<tr>
<td>8</td>
<td>Electrolytes Profiles of Mangy / Treated and Healthy Camels</td>
<td>88</td>
</tr>
<tr>
<td>9</td>
<td>Effect of <em>Azadirachta indica</em> (Neem) against <em>Sarcoptic</em> mange in camels</td>
<td>91</td>
</tr>
<tr>
<td>10</td>
<td>Effect of <em>Nicotiana tobacum</em> (Tobacco) against <em>Sarcoptic</em> mange in camels</td>
<td>93</td>
</tr>
<tr>
<td>11</td>
<td>Effect of <em>Eruca sativa</em> (Taramera oil) mixture against <em>Sarcoptic</em> mange in camels</td>
<td>95</td>
</tr>
<tr>
<td>12</td>
<td>Effect of <em>Ivermectin</em> (Ivomec) against <em>Sarcoptic</em> mange in camels</td>
<td>97</td>
</tr>
<tr>
<td>13</td>
<td>Effect of <em>Cypermethrin</em> (Ecoflee) against <em>Sarcoptic</em> mange in camels</td>
<td>99</td>
</tr>
<tr>
<td>14</td>
<td>Effect of different medicines for treatments of Sarcoptic mange</td>
<td>104</td>
</tr>
</tbody>
</table>
A camel is a very hardy ruminant animal, which can survive under harsh climatic conditions very effectively by utilizing the marginal areas with excellent capabilities and produce under such conditions (Hjort and Hussein, 1986; Abbas and Tilley, 1990). Camel is an important animal as it is well adopted in unique manners in the hot, arid and semi-arid environments (Schwartz, 1992). It can survive without water and food for many days and this unique ability of camel makes it an ideal for such harsh conditions for which it is also commonly known as “The Desert Ship”. In spite of the fact that camel is an important member of a group of animals which produces food for human consumption in the shape of milk and meat, yet it is the most neglected one in the field of scientific research. It may be due to the fact that camel belongs to such areas of the world which are arid, semi-arid or rain fed in nature, having harsh climatic conditions, where poor nutrition and poor management are the major issues (Sohail, 1983).

It is an established fact that diseases originating from parasites lead to the main health hazard issues in animals. These parasites survive at the expense of the host animals causing lot of health problems, like skin irritation, anemia leading to weakness and debility. Some of the parasites have zoonotic importance and may become a source for the transfer of many contagious diseases like scabies to the human beings (Dominguez et al. 1978). McClain et al. 2009, observed the scabies as a major health problem globally both for humans and animal population. *Sarcoptes scabiei* is an ectoparasite which is a cause of scabies, a skin problem in the human beings worldwide and the similar species of mites do also produce a similar type of disease in a large variety of wild and domesticated mammals (Pence and Ueckermann, 2002; Fitzgerald et al. 2004). Fain, 1978, reported that more than fifteen (15) different species of *Sarcoptes scabiei* morphologically and genetically distinct from each other have been identified in different hosts.
Sarcoptic mange is the second important problematic disease of camel after Trypanosomiasis (Nayel and Abu-Samra, 1986). Scabies caused by Sarcoptes scabiei var cameli is a serious & highly contagious skin problem and also economically important disease of the camels (Pegram and Higgins, 1992). Camels, which are reared with deficient nutrition, poor management and under unhygienic conditions are mostly affected by this disease (Kumar et al. 1992).

A large group of people and communities living in arid diverse ecozones in the entire world, particularly in harsh climates earns their livelihoods by depending on camels. This dependence may spread to the utilization of camel milk, meat, wool and leather besides its use in transportation, riding and sports (Wilson, 1984; Snow et al. 1992). In Pakistan camels are also raised by the people for meat, milk, riding, transportation and sports purposes in the deserts, semi desert & rain-fed / warm areas of the entire country being a hardy animal as it can tolerate easily the rugged climate as well as extremes of temperatures of such areas.

The natural harsh and adverse climatic conditions, particularly during long dry seasons lead to a paucity of feeding regimes resultantly the camels raised in such areas are subjected to stress conditions which lower their resistance and make them easily vulnerable to diseases (Abbas et al. 1993; Agab, 1993). Abbas & Tilley, 1990; Saint-Martin et al. 1992; Abbas and Agab, 2002; Pathak and Chhabra, 2010; while reviewing the parasites & parasitic diseases of camel population in India were of the opinion that Sarcoptic mange is a serious, debilitating, dreaded and widely prevalent disease of camels in India.

Besides other infectious diseases of bacterial and viral origin, camels are exposed to a wide range of internal & external parasitic infestations. Amongst other so many external parasites to which camels are exposed, the Sarcoptic mange is recognized to be one of the most
serious and damaging disease. This disease is caused by a mite known as *Sarcoptes scabiei var cameli* which belongs to genus *Camelus* of SARCOPTIDAE family in Veterinary Entomology.

It is an extremely pruritic, contagious and debilitating skin disease which is very frequently and sudden in onset. It is also ranked as one of the most serious and important disease of the camels. *Sarcoptic* mange infestation is very common in the areas of thin skin, the head, neck, flanks, medial aspect of thighs or inguinal region, mammary glands and prepuce. The head is usually affected very rapidly as the animal uses its teeth for scratching the affected areas. Besides linking the occurrence of the disease with poor camel management, malnutrition and contact with infected objects, the stray & infected camels also often become a focus of infecting the healthy animals when mingling with them particularly at watering places for drinking purpose (Richard, 1987; Abdel-Rehman et al. 2001).

*Sarcoptes* is a burrowing mite as it penetrates deeply through the skin surface of the infected camel. This burrowing of mites in the skin helps these parasites lead to intense pruritus and exudative dermatitis. In pruritus, mites penetrate deep into muscular areas, damaging the flesh and lowering the quality of meat. The early inflammatory reaction of the host body towards the mites becomes evident in the shape of small popular elevations, invasion and injuries leading to formation of hairless areas, scaly crust formation or scabs on the affected parts and the skin become dark and thickened. Skin of mangy camel show hemorrhages, and subcutaneous odema after the development of fissures in the underlying epidermis (Kumar et al. 1992; Amer et al. 2006).

The fertilized female mites create winding burrows or tunnels in the upper layers of the epidermis of the skin of the host animal and feeding on the serous exudate, a liquid oozing from the damaged tissues. The female mites lay about 40-50 fertilized eggs in these tunnels which
hatch in 3-5 days into a six legged larvae. These larvae immediately crawl to the surface and burrow themselves in the superficial layers of the skin and create small molting pockets. In these molting pockets, the larvae molt to next stages of nymph and adult. The adult male then emerges and seeks a female either in the molting pocket or on the surface of skin. After fertilization the female produces new tunnels, either de novo or, by extension, of the molting pockets, lays eggs in these tunnels and a new life cycle starts. The entire life cycle of Sarcoptic mange is completed in 17-21 days.

New hosts can be infected through direct transmission by contact between the animals, presumably from larvae, nymph or adult mites, which are commonly present on the skin surface of the infected animal. Indirect transmission of infestation can also take place through the objects or fomites having mange infection, which come into contact with the affected camel, such as harnesses, blankets, baggage tack, tents and tree trunks (Richards, 1987). The pruritus increases as the mites penetrate deeper in the skin (Al-Rawashdeh et al. 2000, Driot et al. 2011, Bekele et al. 2012). Based on the rate of infection camels can be seriously disturbed by the Sarcoptic infestation as they may stop grazing which can lead to a rapid fall in milk production, and deterioration of health condition. With the increase in the irritation due to scabies, the camel rubs, bites and scratches the affected areas in an attempt to reduce the itchiness. Due to rubbing, biting or scratching, the mites move to the periphery affecting the healthy tissues and resultantly affected area spreads. As the disease prolongs, the skin becomes excoriated, leading to hair loss and the development of scabs. These scabs in turn may be rubbed away and a red surface developed. The animal becomes restless due to severe Sarcoptic mange infestation and involvement of most of the body surface. If the diseased animal is not treated in time, the animal loses its health condition, become emaciated and within two, three weeks the acute stage of
disease may give way to more chronic state (Gorakh et al. 2000, Abubakar et al. 2002, Driot et al. 2011). *Sarcoptic* mites rarely survive long off the host under natural conditions.

A continuous direct contact of animal keepers with their camels can also lead to transmission of diseased condition in human beings which is termed as pseudo scabies. Transmission of infection from camel to man usually takes place during milking, handling or riding. The main symptoms of pseudo scabies can therefore be seen in the inter digital spaces of the hands, on the wrists, forearms, the elbows, the axillary folds and inner side of the thighs. Once a herd is infected with *Sarcoptic* mange, continuous reinfection of the disease occurs (Schillinger 1987, Singh & Veer 2005, Premalatha et al. 2010).

*Sarcoptic* mange is usually considered to be a seasonal disease and is often reported severe during the winter months as in cold weather the disease had an acute course. However, there is some evidence that in some countries hot weather predisposes to acute outbreaks of camel mange and in the cooler, winter season the rate of mange infestations are at the lowest. In the summer the activity of the mite seems to decline or disease becomes chronic. Dietary intake is an important factor in mange infestation. Nomadic camels on a low nutrition plan, probably carrying heavy worm burdens in hot desert conditions are likely, therefore, to be highly prone to *Sarcoptes* at this time (Dinka et al, 2010). During such periods of great activity, the mites are readily transmissible from one animal to other animals (Richards, 1987, Banaja & Ghandour, 1994, Tefera & Gebreah, 2001).

Mange can easily be diagnosed clinically from the occurrence of pruritus, depilation, alopecia, thickened skin, folds around the joints and encrusted plaques being the main characteristics of this parasitosis. In order to control this zoonotic disease, it is essential to treat
both camel and man along with effective checks over other predisposing factors of the disease such as hygiene and nutritional requirements of the animals.

The skin diseases like the scabies both in human beings and animals are being treated with a variety of allopathic drugs now a day, but the role of herbal plants in use since centuries in different shapes cannot be ignored at all, especially in the rural lifestyle. Further with the continuous use of different acaricidal drugs, the issue of resistance development has come across as a challenge for the researchers to find some alternatives for the purpose. Accordingly the research work on the use of traditional herbal medicines is gaining attention day by day.

Although there are many reports and studies regarding the prevalence of Sarcoptic mange in camel from different parts of the world, only few preliminary reports are available for Pakistan and none of them provide detailed epidemiology of Sarcoptic mange and its effect on host health. Therefore, keeping in view the importance of the mange problem in camel population of the country, the present project was designed to determine the prevalence of Sarcoptic mange infestation, factors in its occurrence its zoonotic importance, effect on blood physiology and different treatment options in the camel population of Punjab, province in Pakistan.
2.1 EPIDEMIOLOGY

Camel mange was reported in 1827 by the Corsican Anatomical Assistant in the King Garden in Paris. The Egyptian veterinary service, in its annual report noted that more than half of the camel population in Egypt was suffering from the diseases (Said, 1946). Since then mange has been reported from various camel rearing countries. It is thought that Sarcoptes mite originated from a human ancestor which later on spread to domesticated, wild animals (Walton et al. 2004) and at present this ectoparasite affects more than 100 species of mammals all over the world (Pence and Uechermann, 2002).

Camel mange caused by an ectoparasite, Sarcoptes scabiei var cameli, is an extremely pruritic and contagious skin disease (Higgins, 1983 & 1985; Raisinghani and Kumar, 1990; Kumar et al. 1992 & 2005, Al-Rawashdeh et al. 2000, Abubakar et al. 2002, Pathak & Chhabra 2010, Driot et al. 2011). The disease is caused by a specific species of mange known as Sarcoptes scabiei var cameli which is a minute and roughly circulate parasite. The female measures 407 to 471 x 210 to 310 μm and the male 214 to 255 x 161 to 184 μm. The eggs measure 139 to 175 x 72 to 92 μm. The female mite digs tunnels in the skin to deposit 40 to 50 eggs. Within two to four days, six legged larvae emerge which molt to eight legged nymphs after two to three days. In a further three to four days, adult mite is produced. Larvae and nymphs usually develop within the tunnels and may burrow deeply into the skin. They later emerge by their own efforts or excoriation of the skin caused by rubbing and scratching. All stages are capable of infecting other animals. Transmission of the disease may take place both directly as well as indirectly. By direct contact, a healthy animal can attract the disease from diseased one.
and indirectly via fomites such as blankets, baggage, tack, etc. Infected camels in an effort to reduce the itchiness by rubbing against their calves, other healthy camels or trees, are frequent sources of spread of infection in a herd.

Mustafa (1984) and Agab (1993) have described the camel scabies a disease caused by *Sarcoptic* mange as one of the most important and serious disease in the camel population of Saudi Arabia and Sudan with a very high rate of incidence, leading to a lot of health and production issues in camels of the area.

The animals affected with *Sarcoptic* mange may stop grazing leading to milk and meat production loss of affected animals. With the increase of disease, irritation increases and the animal become more and more disturbed. Due to increased irritation and disturbance, there is more rubbing, scratching and biting of the affected parts by the animal in an attempt to alleviate the itchiness. In severe forms of the disease, if not treated in time, most of the body surface is involved due to skin excoriation, hair loss and scab development. In such cases the animal rapidly loses health condition leading to even death of the animal (Higgins, 1985).

Richard (1987) reported the prevalence of *Sarcoptic* mange in camels. These mites are transmitted by both direct and indirect routes. The mite infestation starts from the areas of thin skin, the head, and base of neck, mammary glands, prepuce and flank. *Sarcoptic* mange occurs where ever dromedaries or camels are kept being the commonest and frequently communicable disease of these animals. The main & principal factor favoring the infestation is the poor condition of the animals. Very young and too old animals are more susceptible to disease. Cold weather and rainy seasons also play a vital role in the spread of disease. The head becomes affected rapidly in every case as the animal uses its teeth to scratch affected areas. The incubation period of mange is 2-3 weeks. The invasion phase is characterized by erythema and
numerous small vesicles, accompanied by intense pruritus. Within about 2 weeks, there is loss of hair and skin become reddened and moist, later the skin becomes dry and hard (Mourad et al. 1987, Schalm et al. 1975). The initial lesions often start on the ventral surface of the body, but sometimes at the root of the tail or just above the foot pad. The scratching and biting by the camels at the lesions often leads to the spread of the disease rapidly to the sheath or flank, lips and face. Lesions may also start around the chest pad and axillary regions. The camel endeavors’ to scratch with the toes of the hind limb, thus spreading the infection to the toes and upward on the limbs. The hump region is rarely affected.

Prior to the appearance of lesions, the hair becomes erect and camels start to rub and scratch against each other or hard objects resulting in alopecia. The lesions then start appearing, consisting of papules and vesicles, which become small scabby patches within about seven days. The lesions become red and moist due to spread of oozing plasma to surrounding areas. The most severe lesions are found on the neck, in the axillae, inner surface of the thigh and around the tail and head. In chronic cases, loss of hair, scab formation, keratinization and proliferation of connective tissue lead to thickening of the skin, which becomes corrugated with mites deeply penetrated in the skin tissues. At this stage, the skin has a sandy appearance with a chalk like covering of scurf (Nayel & Sharma, 1986; Mourad et al. 1987; Raishingani & Kumar, 1990). A tentative diagnosis of *Sarcoptic* mange can primarily be made on the basis of clinical symptoms and confirmed by finding the mites in skin scrapings with the help of microscopic examinations. Deep skin scrapings should be taken from the edges of suspected active lesions and valleys of the wrinkled skin and treated with 10% KOH. Sediment should be examined for different stages of *Sarcoptic* mange mites and their eggs (Grigoryan, 1987; Tefera & Gebreah, 2001; Kataria et al. 2009)
Higgins et al. 1984, during a study on the incidence of *Sarcoptes* scabies in camels in Saudi Arabia reported a high incidence during hot summer and suggested that during hot weather, watering points were reduced and contact between camels increased at these points which could lead to a higher incidence. He further reported that one reason for the disease peaking in summer when the temperature is the highest, could be poor health of animals due to reduced grazing areas, while in winter mites are less active in terms of feeding and egg laying stress. The age, malnutrition, overcrowding, poor skin condition and worm burden of the host animal have all been suggested as important predisposing factors for scabies due to camel mange. Young and aged camels are more prone to infection, probably reflecting lowered body's defenses. Camels appear particularly susceptible while this may be due to a low plan of nutrition, high worm burden and debilitated health condition either due to malnutrition or as an effect of any other disease problem of animals.

Nayel and Shamra (1986) in a study on experimentally infected camels and goats with *Sarcoptes* mange observed more severe lesions when the mites were applied to lacerated than to Scarified or non-scarified areas and moistened than dry areas. Histopathological skin changes having severe degenerative and necrotic lesions were also observed in both camels & goats with thick keratin and scab formation beneath which mites could be seen.

Fassi-Fehri (1987) while analyzing the camel diseases in African and Asian countries reported that scabies caused by *Sarcoptes scabiei var cameli* as the most common skin disease in camels with great economic impact due to high morbidity. He further reported that the disease is very common during cold, damp season in the Indian region, whereas malnutrition and vitamin A deficiency play the role as predisposing factors and the disease is mostly transmitted by direct contact with the affected animals. The disease can be seen in all three forms, i.e. acute, chronic
and latent with main symptoms of pruritus, loss of hairs and hyperkeratosis of skin and the lesions can be observed in the neck, axillae, around the tail, face, around the eyes and inguinal region. He also reported that the disease has a zoonotic importance as it is transmitted to human beings.

Tikaram et al. (1987) in a study of incidence of mange in camels found one animal suffering from severe mange also developed severe orchitis as a secondary infection. They also observed that secondary infection leading to severe orchitis developed due to excessive keratinization and proliferation of connective tissues resulting in corrugation of skin.

Grigoryan (1987) reported sub-acute and chronic mange during autumn, winter and spring and suggested that a lower incidence during the summer might be due to high ambient temperatures leading to a reduction in the activity of mites which may hide in folds of skin to protect themselves from sunlight, while Raisinghani and Kumar (1990) recorded mange mite infestation throughout the year with a comparatively higher rate of incidence during winter / spring seasons i.e. from December to April.

Mansoor (1991) in a study on the taxonomy and chemotherapy of different species of Sarcopes infesting camels in North West Frontier Province (NWFP), Pakistan reported significantly high rate of mange mite infestation in nomadic camels as compared to local population kept by the farmers. He further reported that the only mite observed from the scabies lesions was Sarcopes scabiei var cameli.

Banaja & Ghandour (1994) while studying the details about the scabies disease incidence, its mode of transmission and disease pattern confirmed variation with respect to
season and location and reported a higher incidence during winter months as compared to other seasons of the year.

Basu et al. (1995) reported that scabies is a skin disease of camels which is caused by *Sarcoptes scabiei var cameli* and is also known as red mange of camels. Its life cycle from egg to egg takes place in 21 days and the disease is very common in winter season. The disease can be identified from its specific clinical lesions and microscopic examination of skin scrapings for different stages of mange mites.

Jesus et al. (1997) while reviewing the dynamics of *Sarcoptic* mange in Ibex population in Spain comprising of four years, with reference to the climatic factors reported that the occurrence of disease was significantly higher in females than males. Similarly, they further reported that the prevalence rate of scabies in the Ibex population was higher in winter months and during the period when there was high relative humidity.

Anwar and Khan. (1998) conducted a study on Parasitism of camels in Pakistan under the auspices of the Department of Veterinary Parasitology, University of Agriculture, Faisalabad, Pakistan. This study was based on the animals brought for slaughtering in the local Abattoir and reported a high rate of worm burden both for endoparasites and ectoparasites. It was reported that the overall prevalence of ectoparasites was 57% of which 13.4% was due to mites and the rest was due to ticks, lice or mixed infestation. The only specie of mite identified was *Sarcoptes scabiei var cameli*. They further reported that the parasitic fauna of the camel is not only a threat to the health of camels, but also is a potential danger for the human population as the disease has its zoonotic importance.
Gebrehiwet (1998) reviewed the common diseases of camel in Eritrea (Africa) and reported that in order of prevalence, *Sarcoptic* mange infestation was the highest of the total animals surveyed in one year and observed it a highly contagious disease of camels in Eritrea. He further noticed that the highest incidence of *Sarcoptic* mange was during the summer rainy season and lower in winter. It was also observed that female animals affected by mange disease gradually became emaciated with reduced milk production and the male animals showed a drastic reduction in their performance.

Al-Rawashdeh et al. (2000) conducted a survey on live as well as slaughtered camels regarding diseases of camel (*Camelus Dromedarius*) in four different geographical regions of Jordan, Africa and reported that about 98% animals were involved in internal parasitism and almost all the animals examined were suffering with one or more species of external parasites mostly with different species of ticks. They further reported that 32 camels were showing one or more clinical lesion related to mange mite infestation and 83% of the animals suspected for mange were found positive for *Sarcoptes* and confirmed *Sarcoptes scabiei var cameli* as the cause of disease.

Tefera and Gebreah (2001) while conducting a study on the productivity and diseases of camels in eastern Ethiopia, Africa, observed three clinical phases of camel mange due to *Sarcoptes*. They reported that in the active phase, there was marked irritation with itching on the head or genitalia and the scratching resulted in secondary trauma. The lesions spread over the body with itching and secondary traumatic wounds were observed in the invasive stage. In the last or terminal phase, the skin becomes hard, dry and hyperkeratinous. They further reported a higher prevalence rate in young stock / calves and females and observed that the most important way of transmission of the disease was from dam to calf and vice versa during sucking. It was
also noted that the poor body condition and the large size herd significantly affect the tick & the mite burden on camels. They concluded that the number and species of infested mange mites encountered were significant enough to pose a potential health hazard.

Lee (2001) in a study on *Sarcoptic* mange in free living common wombats reported that all developmental stages of mite i.e. egg, larvae, nymph and adult with the clinical symptoms of scale crusts of skin, loss of hairs or development of alopecia were available in the diseased animals. He further reported that severe mange infestation, lead to poor health conditions, including emaciation, anemia and starvation, which, if not handled, ultimately may terminate at the death of animals.

Abdel-Rehman et al. (2001) reported that one humped camel in Sudan (North Africa) was affected with a large range of parasitic diseases, including *Sarcoptic* mange and described it as the most important disease that threat camel’s health. They further reported that debilitating health conditions of animals due to other diseases such as Surra or Tuberculosis also precipitate the disease.

Bornstein et al (2002) reported that scabies caused by *Sarcoptes scabiei var cameli* as the most common and serious skin disease prevalent in camels. The disease has a very short incubation period as the animals may start showing scabies symptoms within two weeks time of its infestation and most of the animals are involved within three week’s time. The clinical symptoms, i.e. itching, pruritus and development of papules can be seen on different parts of the body, especially on the axillae, upper parts of the extremities and the perineum.

Ljunggren et al. (2002) in a study discussed that scabies or *Sarcoptic* mange as a widespread and highly contagious parasitic skin disease of large number of mammals, including
man and is caused by a tiny mite *Sarcoptes scabiei*. The clinical symptoms reported by them include irritation, itching and scratching due to the reason that mites burrow in the skin where these reproduce and also get fed.

Khan et al. (2003) reported that scabies a contagious skin problem caused by *Sarcoptes scabiei var cameli* as a widespread disease of camels which is transmitted through close physical contact with the contaminated objects or infected animals. Young, weak, stressed animals are more prone to the infestation and the poor management and inclement weather can also play its role in the increase of morbidity and mortality rate due to mange infestation. The lesions which can be observed on the head, axillary, inguinal and perennial areas include intense pruritus, loss of hair, scab formation and thickening of skin with disrupted productivity. The disease is also transmitted to human beings who have close contact with the infected animals.

Brown (2004) reported that *Sarcoptic scabies* caused by *Sarcoptes scabiei var cameli* as a highly contagious skin disease that spread very rapidly in young camel when they are yarded for a period. The stress of yarding is a very important factor in the causation of the disease. Their larvae burrow into the epidermis forming tunnels with the symptoms of intense pruritus, loss of weight, alopecia and exudative dermatitis. In some cases due to release of exudative fluid, subcutaneous odema is also seen.

Colebrook and Richard (2004) reported mange infestation caused by the *Sarcoptes scabiei* as an important disease of domesticated livestock and wild animals in Europe and Mediterranean region. The female mites develop permanent tunnels up to 1 cm in the skin where they feed and lay eggs. Due to mite infestation and cutaneous hypersensitivity to mite fecal antigens the symptoms of cutaneous inflammation with intense pruritus, exudation and
hemorrhages on the skin are observed. The inclement weather, poor hygiene and debilitated health conditions do play its role in the spread of mange in animals.

Martinez et al. (2002) while diagnosing the *Sarcoptic* mange in wild goats on the basis of lesions of mange including pruritus, loss of hairs, etc. reported that the prevalence of mange infestation was much higher in males particularly during breeding season as compared to the females.

Rapp et al. (2006) reported that *Sarcoptes scabiei* is a burrowing and non-blood feeding ectoparasite mite of their mammalian hosts. These mites are burrowing in nature, as these form tunnels in the epidermis and survive on by ingesting the extracellular fluid (serum) that seeps or oozes into the burrow formed in the stratum corneum from dermis.

Muhammad et al. (2006) in a review study regarding passive surveillance of clinical disorders in cart pulling male camels brought to the Veterinary Teaching Hospital, University of Agriculture, Faisalabad, Pakistan, reported that on the whole 34 different disorders / diseases were observed in all such animals. Amongst the different diseases noticed in these camels, the prevalence of *Sarcoptic* mange was rated as the highest (35%), followed by anhydrous lymphatic, nervous, respiratory and ocular systems. Accordingly, they concluded that *Sarcoptic* mange is the potential threat for the camel population in the said area followed by other parasitic infestations.

Agab (2006) reported that mange is one of the most important diseases of camels with high morbidity, among the ten most commonly prevalent diseases in Saudi Arabia. The disease is caused by a skin mite *Sarcoptes scabiei var cameli* with the lesions of itching, pruritus, loss of hairs and scab formation.
Peri Lau et al. (2007) reported that the Alpacas a member of the camelid family are affected by *Sarcoptic* mange with clinical lesions of alopecia, erythema, crusting of skin available on different parts of the body including abdomen, upper limbs, axillae, groin region and around ears & eyes. They further reported that use of *Ivermectin* at the rate of 0.2mg / kg body weight as s/c injection with 10-16 days interval can eradicate the *Sarcoptes* mite infestation from camels and alpacas.

Walton and Currie (2007) while discussing the problems in diagnosing the scabies in human and animals being a global disease reported that the *Sarcoptes scabiei* (mange) causes scabies in most of the animal species. The main clinical symptoms due to mange infestation are slightly raised papules on those body regions where hairs are less, pruritus, scratching, excoriation and inflammation of skin leading to alopecia; crusting and scab formation due to dried exudate of serum and even pyoderma may also develop. They further reported that there exists a little evidence of interbreeding of different strains of mites as most of the mites are host specific. They also reported that following the exposure of human populations to the animal scabies, occasional cases of human scabies were also observed. They also reported that due to the development of resistance against acaricidal drugs, different herbal and oil based drugs, like tea tree oil, lippia oil, *Azadirachta indica* (Neem), camphor oil and turmeric are being used for the treatment of scabies with promising results.

Wilson (2008) conducted a historical review regarding the disease problems in the camel population of Southern Africa and reported that camels imported to Namibia, Zimbabwe, Mozambique, Somalia, and Botswana in the 19th and 20th centuries suffered with different diseases including the *Sarcoptes* mange. The camels imported to Zimbabwe (Rhodesia) from
India were carrying the mange infestation. He further reported that camel mange remained a global problem in the late 19th century.

Parsani et al. (2008) while reviewing the most common parasitic diseases of camel reported that scabies a skin disease caused by *Sarcoptes scabiei var cameli* as a serious problem in camels of India. They reported that the maximum incidence of disease was observed during winter season (December to April) and the age, malnutrition, overcrowding, worm load and poor health condition due to other diseases were noticed as the main predisposing factors for disease incidence in camels. They also reported that face, thighs, inguinal regions were the main parts of the body where lesions including loss of hairs, scab formation, thickening & corrugation of skin could be seen and the affected animals become restless due to itching and pruritus. They further observed the disease as zoonotic in nature as the camel owners being closely associated with the animals were the most sufferers due to scabies.

Oleaga et al (2008) while conducting the disease surveillance in red deer in Spain reported that the scabies caused by *Sarcoptic* mange is a disease of high significance in most of the mammals including humans. They also reported that in wildlife it severely affects the population dynamics of different species and the clinical symptoms observed in red deer include loss of hairs, formation of skin crusts and hyperkeratosis of skin. They further observed that the incidence of disease was much higher in males and adult animals than females & young ones. Furthermore, in winter season the prevalence of disease was observed much higher than the rest of the season.

Foster (2008) while reviewing the ectoparasitic skin diseases of South American Camelids reported the *Sarcoptic* mange infestation as an important skin problem of alpaca herds of the area. He reported that the disease is caused by *Sarcoptes scabiei* having the clinical signs
Review of Literature

of pruritus with hyperemia, papules, pustules with crusts and the symptoms can be observed between toes, thighs, abdomen, chest, axillae, perineum and prepuce. He further reported that the disease can spread to human beings, particularly animal handlers who remain in close association with the diseased animals.

Moallin (2009) reported that scabies due to a mange mite *Sarcoptes scabiei var cameli* is a highly contagious and zoonotic disease which severely damages the skin. The lesions are mostly seen on head, neck, thighs, flank and shoulder region. In severe cases camel can be seen biting the affected parts leading to thickness of skin, alopecia and the exudation which lead to the formation of scabs on the skin. He further reported that mange infestation treated with *Ivermectin* showed very effective results.

Twomey et al. (2009) reported that alpacas suffering an outbreak of *Sarcoptic* mange showed the clinical signs of poor health condition, pruritus, thickened skin, alopecia, and erythema and crust formation mainly on legs, abdominal region, face and ears. Histopathological examination of skin revealed multifocal hyperkeratosis with large number of mites within the epidermis. The use of *Ivermectin* s/c at the rate of 0.2 mg / kg b.w. successfully controlled the outbreak.

Bornstein (2010) in a presentation regarding important ectoparasites of Alpaca known as South American Camels or New World Camels reported that mange *Sarcoptes scabiei* as an important ectoparasite of camelids. The symptoms of *Sarcoptic* mange include pruritus with erythema, pustules, alopecia and thickening of the skin with most of the lesions visible on medial thighs, limbs, chest, perineum, prepuce and head region. The prevalence rate at the farmer’s level was observed between 20-40%, but in the areas where medicines such as *Ivermectin* are being used as acaricidal for the treatment of mange, the rate of infestation has reduced. The *Sarcoptes*
mange reportedly do not survive more than three weeks off the host. He further reported that some variants of *Sarcoptes scabiei* are famous for their cross-infection to humans resulting in pseudo scabies, giving it an importance of being zoonotic.

Dinka et al. (2010) conducted a cross sectional epidemiological study on major external parasites of camel population in and around Dire Dawa, Eastern Ethiopia. The study was carried out on the camels brought to town veterinary clinic for treatment, municipal abattoir for slaughtering and available with six peasant associations to ascertain the rate of prevalence of external parasites infecting camels and to find out the factors contributing these parasitic infestations. They reported that besides three different species of ticks, *Sarcoptes* was the only one genus of mange / mite identified to be involved in such infestations at all the sites in the said study conducted in Eastern Ethiopia. Furthermore, no significant variation in the prevalence rate of mite infestation between age groups and the sexes was observed besides a slight increase in the prevalence of mite infestation in males and young camels. The explanation to this fact was recorded as that the males are usually used for transportation from place to place which could be a predisposing factor for such ectoparasitism and on the other hand young animals could have less acquired immunity. It was further reported that a shortage of feed resources could be another factor which may be helpful in the spread of such infestations as under such conditions animals can have close contact with each other at the available feeding / grazing and watering sites.

Desei et al. (2010) in an epidemiological study regarding mange / mite infestation in small ruminants in Southern Ethiopia reported that the mange infestation rate in goats was much higher than sheep. They also observed a non-significant difference between different age groups or sexes of small ruminants however the disease incidence was slightly higher in young and male
population. They further reported that the prevalence was higher in the lowland area followed by midland and highland.

Driot et al. (2011) reported similar lesions in camels infected experimentally with \textit{Sarcoptes scabiei var cameli} with that of \textit{Sarcoptes scabiei var ovis}. However, cross infection has not been confirmed. It was noted that affected camels lack proper rest because of the intense pruritus and they spend much time in scratching and rubbing the affected area. Their feeding patterns are disturbed and thus nutritional intake is affected severely, often leading to weakness, emaciation and marked reduction in milk production & working capacity.

Asghar et al. (2011) in a study regarding the prevalence of scabies in sheep and goats during Hajj season in Makkah, Saudi Arabia, reported that mange infestation was identified in both sheep & goat flocks and the rate of incidence was higher in native breeds than the imported animals. They further reported that \textit{Sarcoptic} scabies was most common amongst identified mite species.

Holz et al. (2011) reported the prevalence of \textit{Sarcoptic} mange in a wild swamp wallaby (\textit{Wallabia bicolor}) in Australia. The animal showed the lesions of hyperkeratosis, with cracks in the skin over the head and shoulder regions with swollen eyelids and shallow abrasions of skin on thorax and abdomen. Histological examination also revealed hyperplasia with marked hyperkeratosis of the skin. The affected skin layer was found transected by tunnels caused by mites showing clear spaces containing different stages of mites in them.

Al-Saad et al. (2012) reported the \textit{Sarcoptes scabiei} infestation in wild Giraffes in Kenya with lesions of hair loss on muzzle, neck, shoulders and the legs. The skin becomes thickened along with erythematous eruptions with the presence of papules. Egg shells and different
developmental stages of mites were present in the skin scrapings examined for the purpose. They attributed this scabies outbreak to the mingling of healthy giraffes with other mange infested animals sharing the pastures and watering points due to severe drought conditions in the area.

Biu and Kyari (2012) conducted the studies on the prevalence of dromedarian (camel) mange in Maiduguri area of Nigeria, Africa and reported that on the basis of physical and laboratory examinations, 13.7% camel population was found suffering with mange/mite infestation caused by *Sarcoptes scabiei var cameli*. They further reported that the mange infestation rate in male camels was much higher than the females. As regards to the involvement of different parts of the body was concerned, they reported that the mite showed a higher presence in the saddle area followed by generalized form, neck region, shoulder area, hump, flank area and the thighs.

Megersa et al (2012) conducted a cross sectional study on camels for mange / mite infestation of Borana lowlands, Southern Ethiopia and found that scabies infestation was the second highest skin problem in camels after ticks. They also reported that only one specie i.e. *Sarcoptes scabiei var cameli* was the cause of mange infestation in the camel population. They did not observe any significant variation in the prevalence of mange infestation between different age groups, sexes, herd size, body conditions and the ethnic groups. However, they also found mange as an important parasitic skin problem being significant enough to pose a potential health hazard leading to production loss for the camel population of the Borana area of Ethiopia.

Gakuya et al. (2012) in an epidemiological study in a wildlife / livestock system reported that all the wildlife and domesticated animals except sheep were suffering from skin problem caused by *Sarcoptes scabiei*. The highest rate of prevalence of *Sarcoptes* infestation was observed in cheetahs whereas it was also observed that disease incidence in females and young
animals was more than males and aged ones. Furthermore, it was also reported that the prevalence of disease was higher during dry and winter seasons.

Hafeez (2012) while reviewing the parasitic diseases of camels reported that scabies caused by *Sarcoptes scabiei var cameli* as the second important disease of camels after Trypanosomiasis. He further reported the disease as highly contagious as it can spread through direct contact of healthy animal with the diseased one or indirectly through the fomites under use. He also reported that in most of the world, it is more common in winter and rainy season, whereas in the Middle East its prevalence is more in summer.

Vishe et al. (2012) while studying the mange infestation in buffaloes reported that disease incidence was much more in the winter and early summer months, i.e. October to May. They further reported that the young and male animals were more prone to the disease than the adult and females.

Bornstein and Mario (2013) reviewed the veterinary research on camels of Kenya and reported that scabies caused by *Sarcoptes scabiei* a small parasite is the most common skin disease of camels with symptoms of itching, loss of hairs, crusting & fissuring of skin. The disease being infectious one spreads to other healthy animals of the herd very rapidly and if the diseased animals are not properly treated in time, the owner may face huge economic loss due to a reduction in production of milk and meat with poor health status of the diseased animals.

Gnani et al. (2013) observed the signs of *Sarcoptic* mange affected camels. These include pruritus lesions, loss of hair, swollen and wrinkled skin on hind quarters, thighs and hock joint. They confirmed the mange infestation by examining the skin scrapings microscopically. They treated the scabies diseased animals with *Ivermectin* @ 200 microgram per kilogram body
weight at an interval of fifteen days and found it highly effective against *Sarcoptic* mange infestation as the same was recovered from the disease.

Al-Kardi (2013) in a study on mange mite infestation in sheep in Iraq reported statistically significant differences according to the age and sex of animals as the prevalence rate of disease was much higher in adult and female sheep than young and male animals.

Awol et al. (2014) conducted a cross sectional study to determine the camel mange infestation in Raya-Azebu a district of northern part of Ethiopia, Africa and reported that the only mange specie detected / identified on the basis of laboratory diagnosis carried out from the skin scrapings was *Sarcoptes scabiei var cameli*. They observed the clinical signs in these suspected mangy infected animals as the hair loss, scab formation, thickening and corrugation of skin and severe itching. The infected animals showed the mange mite infestation lesions in different parts of the body with different severity. The lesions were mostly observed on face, neck region, and abdominal region, inner side of the thighs and inguinal region of the infected camels. They did not observe any significant difference with respect to age and sex in the prevalence of the disease, however the incidence of disease in male and female camels was quite different from each other with more females found involved than males in the disease.

Yi-Zhou Chen et al. (2014) in a study on the *Sarcoptes scabiei* infestation in pet dogs in Southern China reported that the prevalence rate of the scabies disease on the higher side in younger and female dogs than the older and males. Furthermore, they reported that the disease incidence was more in winter and rainy season.

Sabiha et al. (2014) in an assessment made regarding risk factors of biological and physical environment on the prevalence of *Sarcoptic* mange in pet dogs reported that the
prevalence rate of mange infestation in young dogs was much higher as compared to the older ones. They further reported that climatic weather conditions and temperature also plays a significant role in the spread of disease as the disease incidence increased in wet and cold weather.

2.2 ZOONOTIC IMPORTANCE

Schillinger (1987) reported that the human beings who work with their camels as herdsmen do develop skin problems termed as pseudo scabies. The transfer of disease, i.e. pseudo scabies from camel to man may usually take place during milking, handling or riding. The main symptoms can be observed in inter digital spaces of the hands, wrists, forearms, the elbows, folds and between the thighs. Treatment of both animals and the camel handlers can help in controlling this zoonotic problem.

Mitra et al. (1993) reported an outbreak of scabies in animals during the winter months of 1991 in two adjacent villages of West Bengal, India caused by Sarcoptes scabiei and observed that besides mortality in animals which could not be provided with any treatment, the disease spread to human population particularly to those who were attending and rearing the animals as they had a close contact with the infected animals.

Bornstein et al. (2002) in a study on Sarcoptic mange reported that camel scabies due to Sarcopes Scabiei do have a zoonotic importance. They observed that almost all the attendants or camel handlers who remained in close contact / exposed to diseased animals developed the pseudo-scabies.
Burroughs and Elston (2003) reported that the causative strain of canine scabies infestation, *Sarcoptes scabiei var canis*, can produce pruritic rash lesions in human beings which generally appear within four days of contact with the scabies affected dog.

Walton et al. (2004) reported the scabies as a global problem both in human and animal populations resulting from a tiny mange mite *Sarcoptes scabiei*. In some cases the patients can experience very severe effects of symptoms and complications of skin, especially where overcrowding of population and unhygienic conditions develop. They also reported that there exists an effective chemotherapy of scabies infection.

Ghubash (2006) while reviewing the parasitic miticidal therapy in dogs and cats reported that scabies caused by *Sarcoptic* mange is a serious and highly contagious disease of animals which can also spread to other mammals, including human beings termed as pseudo scabies. The disease severely affects the skin of different parts of the human body, causing irritation, pruritus with the development of other secondary infections.

Heukelbach and Hermann (2006) reported that scabies or skin scabs are a major public health problem of poverty hit regions in the world since 1687. The disease is caused by a small mite *Sarcoptes scabiei* which burrow into the epidermis giving it a look of the short wavy line. The lesions include the development of papules which later on develop into vesicles, excoriations, eczema, secondary infections and crusts and the symptoms are commonly visible in inter digital spaces of the hands, wrists, penis, face and neck. The disease is being successfully treated with *Ivermectin* but the herbal plant or their extracts like tea tree oil, neem (*Azadirachta indica*) and turmeric are also showing promising results.
Hengge et al. (2006) reported that scabies, a pruritic skin disease from animal origin can be transmitted to human beings. The disease spreads to humans, especially the animal handlers through direct contact with the diseased animals or becoming in contact with fomites of animals and produces pruritic papules and itch in humans. The animal scabies are self-limiting in humans as the mites cannot complete their life cycle.

Al-Saad et al. (2011) reported that Sarcoptic mange, a disease of livestock, wildlife and humans worldwide is caused by Sarcoptes scabiei. Human beings may get infected with animal varieties of scabies, but the disease remains self-limited.

Torgerson and Calum (2011) reported that besides other so many diseases, the scabies originating from Sarcoptes species, an arthropod, has its own significance and revealed that 21.5% of children in India with the skin issues were found positive for scabies infestation. They further reported that the zoonotic diseases are very common in India, but neglected, despite the fact that these cause considerable losses to human & animal health and economic burden for the livestock industries.

Jackson and Villarroel, (2012) conducted the survey regarding the risk of zoonosis for veterinarians and reported that zoonotic material can be transmitted through various routes including direct contact, oral, skin break and inhalation. They further reported that the morbidity rate of scabies in veterinarians due to animals was the third highest one in Oregon State, USA where the survey was conducted.

Al-Saad et al. (2013) reported that humans are occasionally infected with Sarcoptes scabiei originating from different domesticated animals, including large and small ruminants, canines, equines and also wild animals like llamas, chamois, coyote, ferret, fox, wombat and
gazelle and is termed as pseudo scabies. The people who are mostly affected by the mange mite of animal origin, which is known as pseudo scabies include farmers, pet owners, slaughterhouse workers, veterinarians, researchers and employees working in animal pens and livestock & wildlife biologists.

Bandi and Saikumar (2013) reported that the *Sarcoptes scabiei var canis* is the *Sarcoptic* mange of dogs which is transmissible to human beings through contact with the infected animals. The symptomatic picture of scabies transferred from animals to man is quite different from that which is produced by the *Sarcoptes scabiei var hominis* (human itch mite) infestation in human beings.

Alasaad et al. (2014) in a review of scabies reported that it as a neglected skin disease of wide range of mammals including humans and is caused by *Sarcoptes scabiei*. While detecting the *Sarcoptes scabiei* mite antibodies they further reported that cross reaction of IgG antibodies to the fox, pig and dog mites were 48%, 80% and 84% in the human scabies.

McCarthy et al. (2014) reported that scabies in human caused by *Sarcoptic scabiei* is a very common skin infestation involving inters of digital spaces and flexure region with signs of popular, intensely pruritic eruptions. They also reported that the lesions of human and canine scabies are nearly similar to each other and the scabies causing mange are genetically distinct. They also reported that poverty, overcrowding and hygiene play an encouraging role in the spread of scabies. They further reported that *Sarcoptic* scabies is very significant disease in most of the domesticated and wild mammals in the entire world. It also carries a great economic importance as it can affect the feed conversion efficiency, meat and milk production loss with severe damage to the skin of the animals.
2.3 HAEMATOLOGY

Arlian et al. (1995) studied the pathological changes in the scabies infested dogs to determine the effect of *Sarcoptes scabiei* infestation and observed that dogs infected with mange showed significantly lower average hemoglobin (Hb) red blood cells (RBC) whereas the concentrations of white blood cells (WBC), neutrophils were found on the higher side with an increased erythrocyte sedimentation rate (ESR) and no significant change in the eosinophil concentration. They also observed that all parameters of blood concentrations except neutrophils returned to normal after treatment and recovery of mange infected dogs from the disease. They did not observe any significant difference in serum enzyme, biochemical and electrolyte concentrations between mange infested and mange free dogs.

Arlian et al. (1996) reported that the dogs once infested with *Sarcoptes scabiei* and cured after treatment showed the development of protective immunity. The sequential changes in the scabiei lesions of dogs were observed in the inflammatory / immune cellular infiltrate during infestation (sensitizing), cure and subsequent re-infestation (challenge). The cell mediated response was based on different types of plasma cells in the body. The re-infestation of the disease induced more rapid increase in the densities of these cells as compared to the infestation prior to cure.

Dalapati et al. (1997) reported a significant decrease in hemoglobin (Hb), packed cell volume (PCV) and total erythrocyte count (TEC) in Demodex infested goats as compared to healthy one giving clear indication of anemia. They also reported an increase in TLC, eosinophils and lymphocytes with a decrease in basophils and monocytes of mange infested animals. As regards to biochemical study it was reported that the level of blood glucose, total
serum protein and calcium (Ca), copper (Cu) and Ferrous (Fe) was also reduced in mange affected animals as compared to healthy animals.

Sharma et al. (1997) while evaluating the different acaricidal drugs against Sarcoptic mange infestation in sheep reported that the level of total erythrocytes and leukocytes which was lowered down due to scabies infestation was improved significantly, whereas the level of hemoglobin also increased but not significantly after the treatment which helped in treating the mange infestation.

Gorakh et al. (2000) studied the physiological effects of parasitic infestation on the camels suffering from Sarcoptes mange and reported some changes in the mange affected camels. He reported increase in leukocytes & eosinophils and decrease in hemoglobin, total serum protein, albumin, calcium, inorganic phosphate, copper, iron, zinc, blood glucose, blood urea, nitrogen and serum transaminase which reflects this general deterioration.

Lastras et al. (2000) while evaluating the physiological changes in chamois due to Sarcoptic mange infestation reported that the levels of serum proteins, globulin and IgG increased while the level of albumin / globulin ratio decreased due to Sarcoptes scabiei mange infestation in the animals.

Al-Busadah and Osman (2000) studied the Haematological parameters of different groups of camels and reported that the average values of Red Blood Cells (RBC), hemoglobin (Hb), Packed Cell Volume (PCV), Lymphocytes and eosinophils ranged from 10.1-13.3g/dl, 23.9-30.3%, 9.1-10.8 (10^6/µl), 28.9-38.8% and 1.5-4.5% respectively.

Sotiraki et al. (2002) studied the Haematological changes in indigenous sheep in Greece and reported that the sheep infected with Sarcoptic mange showed higher levels of neutrophils
and eosinophils. They further reported that these changes reverted to normal after the treatment of sheep with Ivermectin.

Mohamed and Beynen (2002) conducted a study to know the effect of parasitic infestations on the Ascorbic acid contents of blood and liver by comparing parasitic infested animals with those of the healthy animals and reported that the vitamin C contents of red blood cells, white blood cells, whole blood, plasma and liver were reduced in all such animals which were suffering from Sarcoptic mange, trypanosomiasis, and other helminth infestations while being kept in similar conditions. They further reported that low status of ascorbic acid (vitamin C) in the parasitic infested animals could be either due to increased utilization of vitamin C or decreased synthesis of the same due to worm burden.

Bickers and Athar (2006) studied the effects of cytokine and reported that cytokine production can help to excessive generation of the reactive oxidants and free radicals in the biological system leading to the physiological change process of the body known as Oxidative stress. They further reported that this Oxidative stress is not only believed as an integral part, but also a major component in the pathogenesis of skin diseases and abnormalities mostly expressed as hypersensitivity, wrinkling, erythema, keratinization, odema, and cancer.

Dimri et al. (2007) observed marked changes in the skin, liver and hemato-biochemical parameters in mange infested buffaloes and reported that animals affected with Sarcoptic mange showed higher concentrations of free fatty acids (FFA) and lower total proteins, hemoglobin and packed cell volume concentrations in the serum as compared to healthy animals. The mange infested animals had poor body conditions, loss of hair, thickened skin, exudative crusts and hemorrhagic & non- hemorrhagic fissures.
Portugal et al. (2007) while conducting studies on the Haematological changes in the mange affected animals reported the extra generation of cytokines. They further revealed that cytokines can also be generated due to the physical stimulation of the burrowing mites, the inflammation of the skin itself and these free radicals play an important role in host defense against such parasitic infestations.

Valko et al. (2007) studied the effects of mange infestation and its relation to the production of free radicals and reported that increased generation of these free radicals can result in metabolic dysfunction and bio molecular oxidative damage in the body, which can lead to certain pathological changes in the body tissues.

Dimri et al. (2008) reported that the *Sarcoptic* mange infested Indian water buffaloes had higher levels of malondialdehyde (MDA) / mg protein in hepatic cells, whereas levels of catalase (CAT), superoxide dismutase (SOD), Copper and Zinc were found toward the lower side than the normal values.

Badawy et al. (2008) studied the Hemato-biochemical parameters in mature female camels in Egypt and reported the Erythrocyte count as 9.6-12.6 (10^6/ mm^3), Packed cell volume 31.1-34.9%, Hemoglobin 10.1-13.5 (g / dl), Eosinophils 2.8-4.3% and 40.1-48.2% respectively.

Dixit et al. (2009) while evaluating the therapeutic effects of herbal medicines in the treatment of mange reported that the levels of hemoglobin (Hb) and total proteins in the blood showed a decreased trend whereas the levels of leukocytes and eosinophils increased in the camels infected with *Sarcoptic* scabies. They also reported that the enzymes, i.e. ALT and AST did not show any significant difference.
Camkerten et al. (2009) in a study regarding *Sarcoptic* mange in dogs reported that the dogs suffering from scabies due to *Sarcoptes scabiei* infestation had significantly higher levels of lipid hydroperoxide (LOOH), oxidative stress index (OSI) and total oxidant status (TOS) whereas the level of sera sulfhydryl (SH) group was on the lower side in the serum of affected dogs.

Nikki (2009) defined a situation where the production of free radicals exceeds the antioxidative process as oxidative stress and reported that this oxidative damage or stress does take place in the animals suffering from scabies resulting in molecular disruption and tissue damage. He further reported that different studies have shown a strong relationship between *Sarcoptic* mange infestation in different animals and oxidative stress, such as buffaloes, sheep (Dimri et al, 2008 & 2010) and dogs (Camkerton et al, 2009).

Premalatha et al. (2010) studied the effect of *Sarcoptic* mange infestation on the hemogram and biochemical assay of the camels kept in captivity and reported that the animals affected with *Sarcoptes* scabies showed a decreased level of hemoglobin (Hb), packed cell volume (PCV), total erythrocyte count (TEC), neutrophils, total protein and albumin. They also reported that the level of white blood cells (WBC), lymphocytes, eosinophils, Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT) and urea was increased in the *Sarcoptic* mange affected animals.

Rahman et al. (2010) reported that the concentrations of acute phase proteins (APP) comprising of acid glycoprotein (AGP) serum amyloid A (SAA), ceruloplasmin (Cp) and Haptoglobin (HP), showed two to five fold higher values in serum of Alpine ibex suffering from *Sarcoptic* mange infestation than the healthy animals.
Patodkar et al. (2010) studied the influence of sex on different biochemical parameters in camels and did not observe any significant variation on the basis of sex particularly with reference to total Proteins, Albumin, Calcium and Phosphorus which were observed at 7.40-7.57 (g / dl), 4.01-4.24 (g / dl), 9.20-10.12 (mg / dl) and 5.59-5.68 (mg / dl) respectively.

Mostafa et al. (2011) during a study to evaluate the changes in the blood chemistry based on oxidative stress of naturally infested camels with mange *Sarcoptes scabiei var cameli* observed that *Sarcoptic* mange infestation is accompanied by such activity of the body which lead to changes in the blood known as oxidative stress process. They further reported that the oxidative stress could be increased with the increase in infestation and directly contribute in the pathogenecity of the disease.

Farooq et al. (2011) studied the average normal Haematological values of camels raised in Cholistan area, a desert in South Punjab of Pakistan and reported a slight difference in blood parameters on the basis of sex. They also reported the means of hemoglobin as 11.34-12.0 g / dl and that of total erythrocyte count (TEC) as 6.83-7.31 (10^6/µl). The mean values of Packed cell volume (PCV), Lymphocytes and Eosinophils were recorded as 32.83-37.21%, 47.50-48.60% and 7.0-7.20% respectively.

Ogundiyi et al. (2012) while studying the Haematological and biochemical parameters of mange infected sheep and goats reported that there does not exist any significant difference between the healthy and diseased animals in terms of hemoglobin, red blood cells and packed cell volume whereas the values of white blood cells were observed towards higher side in mange infected animals. They further reported that the level of total proteins, sodium and potassium were found lower in infected animals as compared with the healthy ones.
Vishe et al. (2012) reported that the buffaloes and the buffalo calves suffering from mange infestation showed higher values of total leukocyte count (TLC), lymphocytes, eosinophils, albumin and albumin globulin ratio, whereas the values of total erythrocyte count (TEC), packed cell volume (PCV), hemoglobin (Hb), monocytes, neutrophils, basophils, total protein, globulin and Zinc were found towards the lower side when compared the healthy animals.

Al-Harbi (2012) studied the different Haematological and biochemical parameters of male camels for the entire year, particularly before and during the Rut season and reported certain variations in different hemato-biochemical parameters of males in the Rut and non Rut periods. The average mean values reported by him are RBC 8.90-10.90 ×10⁶/µl, Hb 14.20-15.20 g/dl, PCV 38.20-41.20%, Lymphocytes 40.00-54.00% and Eosinophils 6.90-9.00%.

Seddiek et al. (2013) reported that the treatment of Sarcoptes scabiei infestation in rabbits with neem (Azadirachta indica) helped in decreasing the increased levels of AST, ALT, creatinine and total cholesterol due to disease. They further reported that the level of albumin, protein and globulin, which were found, decreased in the Sarcoptic mange infested animals also increased towards the normal range while treating the rabbits with aqueous neem extract.

Singh and Dimri (2013) reported that the dogs suffering from mange infestation had higher levels of lipid peroxide contents, erythrocytes MDA and leukocytes whereas the values of total thiol level, glutathione peroxide, glutathione-S-transferase, superoxide dismutase and catalase were found on the lower side than the healthy ones.
2.4 THERAPEUTIC EFFECTS

The Application of Taramera oil (derived from tree *Eruca sativa*) and mixture of sulphur, coal tar and kerosene oil are all practiced in various countries for treatment of camel’s mange. Similarly, Neem, Tea tree oil, Tobacco and many other herbal plants and their Bi-products are in use since centuries very effectively against different skin ailments both in animals and human beings. However, these are time and labor consuming. In many places these traditional acaricides have been replaced by chlorinated hydrocarbon and organophosphate insecticides.

Abdally (2010) reported that there was no shortcut to mange control using chemical washes / sprays and reports of resistance against insecticides, probably reflected incorrect application, unless the animal is thoroughly soaked, the topical application with acaricides will not be fully effective because *Sarcoptic* mites lodges in the tunnels. Higgins 1984, Hassan et al. 1989, Gorakh et al. 2000, Parmar & Singh 2005, Singh Kumar et al. 2005 and Premalatha et al. 2010, evaluated *Ivermectin* in camels naturally infected with *Sarcoptic* mange. They used two doses subcutaneously at 200 µg / kg body weight (bw) at 15 days interval. A spectacular improvement in the condition of the animals was seen within 10 days of the second injection. Itching, scratching, biting and rubbing of the body ceased and the density of mites was reduced from 24 ± 17.3 / cm2 before treatment, to nil 15 days after the second treatment. Moreover anemia, leukocytosis and eosinophilia were not features after the second treatment. By the 45th day of observation, complete cure from mange had been affected. Introduction of *Ivermectin* therapy has provided a spectacular cure for mange infestation in camels (Schillinger, 1987 and Hassan et al, 1989). For the proper control of mange, humans and camels should be treated properly. For humans, it is better to treat them with hexachlorocyclohexane (Schillinger, 1987).
In camels due to lack of sufficient water, incorrect preparation and inadequate application of sprays & washes as well as nomadic living conditions which prevent repeated treatments are all reasons for unsuccessful use of organochlorine and organophosphorus acaricides (Schillinger, 1987). *Ivermectin* therapy, although expensive has distinct advantages over topical therapy with acaricides. First, it is easy to administer as an injection or oral paste, secondly, it is a thorough treatment because the drug penetrates all layers of the skin affecting mites & eggs laid in tunnels (Hassan et al, 1989, Singh et al, 2007).

Hashim & Wasfi (1986) did not observe any adverse effect of *Ivermectin* in pregnant and lactating camels. However, Thimmappa and Yathiraj (1998) recorded depression and anorexia in dogs as the side effects of the medicine which lasted in 24 hours. Tabassam et al. (2008) evaluated the efficacy of the crude of neem (*Azadiracta indica*) seeds kernel against *Sarcoptic* mange of sheep. They found these herbal drugs very effective and reported that these drugs can provide an economical way of treatment of *Sarcoptic* mange problem.

Campbell et al. (1983) studied in detail the mode of action of *Ivermectin* as anti-parasitic drug, its safety and chemistry. They reported that *Ivermectin* is a 22, 23-dihydro derivative of avermectin B1, a microcyclic lactone produced by an actinomycete, streptomycetes avermitilis and found it active at even lower dosage level against a wide range of parasites due to its specific action on the mediation of neurotransmission. Now a day it is being used very effectively for the treatment and control of parasites in different domesticated animals throughout the world, especially against a wide variety of insects and acarine parasites. They further reported that use of *Ivermectin* against all types of mange mites i.e. psoroptes and *Sarcoptes* as a subcutaneous injection at 0.2 mg / kg as well as oral administration proved very effective.
Belot et al. (1984) conducted a study on the treatment of *demodectic* mange in Senegal with *Ivermectin* and found it very effective when used by subcutaneous injection @ 0.4 mg per kg body weight with an interval of 15 days.

Scheidt et al. (1984) conducted a study on chemotherapy of *Sarcoptes scabiei* infested mixed breed dogs naturally infested with the disease. They used *Ivermectin* @ 0.2 mg per kg body weight as s/c injection at 14 day interval and reported it very effective as after the provision of treatment, the microscopic examination based on negative skin scrapings revealed a complete control in all treated dogs by post treatment day 28. The recovery on the basis of symptomatic lesions also supported the results of skin scrapings.

Jasmer and Gill (1987) treated the *Sarcoptic* mange (*Sarcoptes scabiei*) affected young dogs less than three years of age, by using *Ivermectin* as s / c injection at the rate of 40 µg per kg body weight. They reported that dogs treated with *Ivermectin* had recovered from the symptoms of pruritus after four days. The dogs also recovered very effectively from other ascarids and hookworms at the same time and concluded that one treatment with *Ivermectin* as a very effective medicine in controlling the mange mites and gastrointestinal parasites without any side effect.

Hassan et al. (1989) evaluated the effect of *Ivermectin* on the mange infected camels and reported that *Ivermectin* when used at the rate of 0.1mg / kg and 0.2 mg per kg body weight showed excellent results after 60 and 45 days of treatment respectively as almost all the animals recovered completely.

Njanja (1991) evaluated the *Ivermectin* on *Sarcoptic* mange infested camels in Kenya and observed that its use at the rate of 0.2 mg / kg body weight as a single dose or repeated at week
intervals proved very successful as the presence of mange mites examined from skin scrapings of the affected camels totally disappeared by the end of the third week of treatment. It was also observed in the same study that use of Ivermectin at both the dose levels did not produce any adverse reaction.

Pangui et al. (1991) conducted a study on the prevalence and treatment of Sarcoptic mange in sheep and reported that Ivermectin given subcutaneously at the rate of 0.2 mg / kg body weight produced excellent results as the skin scrapings revealed negative results after 15 days of treatment. Ivermectin also helped in eradication of other worm load of animals affected with strongyles and strongyloidae with the same dose.

Yeruham et al. (1991) while studying the therapeutic effects of Ivermectin on the experimentally infected sheep with psoroptic mange reported that Ivermectin remained very effective in eradication and control of disease between the 3rd and 5th week of treatment.

Charles and Charles (1992) studied the use of indigenous herbal preparations of Azadirachta indica (Neem) and Curcuma longa (Turmeric) for the treatment of scabies in human beings and found it very effective in controlling the disease. They further reported that this is a very cheap, easily available and acceptable mode of treatment for the villagers without noticing any toxic or adverse reaction.

O’Brien et al. (1993) conducted a study on the efficacy of Ivermectin in the treatment of Psoroptes infected sheep and reported that Ivermectin when used through s/c injection at the rate of 0.2 mg/kg body weight with an interval of 10 days produced 100% results by completely curing all the animals.
Umur and Irmak (1993) treated the *Sarcoptes* infected sheep with *Ivermectin* by injecting the same at the rate of 0.2mg / kg body weight at an interval of 21 days and reported 100% effective against the mange infestation.

Bates (1994) reported that *Ivermectin* when used as a subcutaneous injection at the rate of 0.2mg / kg body weight with an interval of one week proved 100 percent effective in the treatment of *Psoroptes* mange mite infestation in sheep in seven weeks’ time without any adverse reaction.

Dakshinkar and Sarode (1997) studied the effect of different herbal plants through use of local application of crude extracts of Garlic, *Azadiracta indica* (Neem) and Sitaphalas against *Sarcoptic* mange in dogs and found these herbal plants as a very effective treatment of *Sarcoptic* mange. They also reported that the recovery rate from mange of dogs by using Neem was more effective than other herbal products.

Thimmappa and Yathiraj (1998) used *Ivermectin* in the treatment of *Sarcoptes scabiei* affected dogs at the rate of 0.2 mg / kg body weight as a subcutaneous injection and found it very effective as all the dogs recovered from scabies in a four weeks’ time. They further reported the depression and anorexia as the side effects of the medicine which lasted in 24 hours.

Ozer et al. (1998) conducted an efficacy trial of *Ivermectin* in *Psoroptes ovis* infected sheep and reported that two s/c injections of *Ivermectin* given at 0.2mg / kg body weight at an interval of 10 days proved very effective as all the clinical signs disappeared and no mite could be revealed microscopically after 20 days of treatment.

Mueller and Bettenay (1999) used *Ivermectin* orally for the treatment of demodicosis or scabies in dogs with different levels of dosage ranging from 50 microgram per kg body weight
on day one, 100 microgram/kg body weight on day two, 150 microgram / kg body weight on day three, 200 microgram / kg body weight on day four, to final dose of 300 microgram / kg body weight on day five and reported that as the dose of Ivermectin increased its therapeutic effectiveness also increased for treating and controlling the problem.

Chosidow (2000) while discussing the scabies and pediculosis in a seminar reported Ivermectin as an effective, cheap, safe and very convenient to use in the treatment of scabies in animals and human beings. He also reported that Ivermectin is a broad spectrum antiparasitic drug which helps in controlling a large number of internal and external parasites.

Morsy et al. (2001) conducted a study on the efficacy of Ivomec Super, a mixture of Ivermectin and Clorsulon against the scabies infestation in dogs and reported that when given at a rate of 1ml / 50kg body weight, which is equivalent to 200 microgram of Ivermectin and 2 mg Clorsulon showed very good results and found this combination as very effective against the human strain of Sarcoptes scabiei in experimentally infested dogs. They also reported that scabies due to Sarcoptes infestation is a community health problem of overcrowded and unhygienic areas.

Mercier et al. (2002) reported that treatment of Sarcoptes infected sows with Ivermectin can lead to an effective control program of the disease. They further reported that a single dose of Ivermectin injected to the breeding female pigs (sows) about one week prior to farrowing can be helpful in saving the young piglets from the disease during the suckling period.

Irfan et al. (2003) during a study on the treatment of scabies infested dogs confirmed by laboratory tests and showing the clinical signs of pruritus, alopecia, observed that dogs treated with Ivermectin (0.2 mg / kg and 0.1 mg / kg body weight, respectively) and Cypermethrin, (1 ml
Sharma and Joshi. (2004) reviewed in detail the plants used in the treatment of skin diseases of animals including the scabies and reported that in spite of the fact that a lot of allopathic medicines are now available in the markets for the treatment of skin diseases but still the owners of the animals prefer herbal formulations. They further reported that herbal preparations are considered safer, cost effective, easy to use, environmentally friendly and harmless for human beings who handle them as against the allopathic medicines which are costly with the issues of toxicity and resistance. They reported that different parts of these herbal plants such as seed, fruit, resin, flower, oil, leaves, bark, whole plant, gum, roots, wood and rhizome are in use for the treatment of skin diseases of animals either individually or in combination with others. They further reported that *Allium sativum* (Hindi – Lahsun), *Azadirachta indica* (Neem), *Cedrus deodara* (Deodara), *Jatropha curcus* (Jangli erandi), *Momordica charantia* (Karela) and *Pongamia pinnata* (Karanj) are the main herbs used for the treatment of scabies in animals.

Albanese et al. (2004) evaluated the efficacy of *Ivermectin* and *Selamectin* on Sarcoptic mange infected dogs. They reported that the administration of *Ivermectin* (Ivomec) at 0.3 mg/kg body weight as a subcutaneous injection with repetition after every 15 days for three treatments and Selamectin spot-on (Stronghold) at 6-12 mg/kg body weight at biweekly interval showed 96% and 100% results based on clinical evaluation and negative skin scrapings and both the drugs highly efficacious.

Curtis (2004) reported that macrocyclic lactones, which include *Ivermectin*, Selamectin and other products of avermectin group are very effective against Sarcoptic mange in pet
animals. He further reported that *Ivermectin* can be administered orally, topically or subcutaneous injection.

Cestari and Martinago (2005) reported *Ivermectin* as a fast acting, safe and well tolerated drug which operates in the whole body and very effective in the treatment of scabies. They also reported that *Ivermectin* is being used both in animals and human beings for the treatment of a variety of internal and external parasites.

Robles (2005) treated the lice infested animals with different herbal plants which were easily accessible. After conducting a detailed comparative study of different herbal plants, he reported that *Nicotiana tobacum* (Tobacco), Tubli (Derris philippinesis), Makebuhay (Tinosphora rumphi) and *Azadirachta indica* (Neem) are very effective against different ectoparasitic infestations when used as a single or as a mixture.

Assen et al. (2005) reported that *Ivermectin* a synthetic derivative of the avermectins is very effective against both endoparasites and ectoparasites such as *Sarcoptes scabies*.

Ghubash (2006) while discussing the parasitic miticidal therapy reported that the *Sarcoptes scabiei* mite is the cause of *Sarcoptic* mange in dogs and the disease is highly contagious with zoonotic importance as it can affect the human beings. He observed that treatment cannot only be a successful tool in its control until and unless the contact material is cleaned, disinfected or disposed of properly. He further reported that beside other so many drugs, Selamectin, a product of avermectin group and *Ivermectin* are the drugs of choice as these are found highly effective in the treatment of *Sarcoptiosis*.

Heukelbach et al. (2006) reported that scabies disease which is strongly associated with poverty and overcrowding is a major public health problem, caused by a neglected small parasite
in many resource deficient and poor regions of the world with a substantial rate of morbidity from and post infective complications due to secondary infections. The delay in early diagnosis and poor treatment facilities and improper use of medicines may also lead to worse conditions of some poor and poverty hit societies. Oral use of *Ivermectin* has been found very successful in community control programs besides the use of some plant derivatives such as turmeric, neem and tea tree oil, which are expected as a promising future treatment.

Walton and Currie (2007) discussed in detail the different issues regarding human and animal scabies and reported that a variety of medicines are available in the market which are selected by the practitioner on the basis of their effectiveness as well as the severity of scabies. *Permethrin* and *Ivermectin* are the most frequent and commonly prescribed for the treatment of scabies. They also reported that due to the development of resistance against such acaricidal medicines, new herbal and terpenoid based drugs, including tea tree oil, lippia oil and a paste of *Azardirachta indica* (Neem), camphor oil and turmeric are also being practiced to treat the scabies successfully.

Fourie et al. (2007) reported that the *Sarcoptic* mange is very common and highly contagious disease of dogs and the use of macrocyclic lactones such as *Ivermectin* when given at the rate of 0.2-0.5mg/kg body weight orally or by injection with 1-2 weeks intervals are very effective in treating and controlling the scabies infestation.

Tabassam et al. (2008) used the Neem (*Azadirachta indica*) seed kernel extracts prepared differently and compared the same with *Ivermectin* for the treatment of *Sarcoptes scabiei* infestation in sheep. They reported that higher concentrations of Neem (*Azadirachta indica*) seed extracts showed very promising results by reducing the mite infestation burden, healing of crusted skin of infected animals and the results of a methanol based extract of neem seed were
equally comparable with the *Ivermectin*. They further reported that neem seed based products were slightly slow in producing the results, but very economical and environmentally friendly.

Parsani et al. (2008) reported that in India, Taramera oil (*Eruca sativa*) after mixing with sulphur, kerosene oil and coal tar is being widely used for the treatment of mange mite infestations and observed it as time & labor consuming with less encouraging results. The other products in use for the treatment of mange are diazinon, amitraz, *deltamethrin* and fenvalerate being very effective after three applications. They also reported that Ivermectin is the latest introduction in the therapeutics which has shown excellent results in the treatment of mange infected camels.

Abdel-Ghaffar and Al-Quraishy (2008) in a study used the Neem seed (*Azadirachta indica*) for the treatment of *Sarcoptic* scabies in dogs and reported that shampooing the mange infested dogs with Neem seed (*Azadirachta indica*) shampoo reduced the *Sarcoptes scabiei* mite infestation resulting in marked improvement in clinical symptoms. They also reported that besides its promising efficacy against mange infestation, it is very safe, both for animals and human beings and also environment friendly.

Omura (2008) while reviewing the use of *Ivermectin* both in humans and livestock reported that some experts believe that *Ivermectin* is one of the greatest health interventions in the last five decades as it has remarkably improved the lives and productivity of millions of people and livestock around the world. He reported that *Ivermectin* is first of its kind medicine, which can be declared as an endectocide being equally effective against endo- and ectoparasites and can easily be used orally, topically and parenterally. The *Ivermectin* carries a unique way of action against nematodes, insects and ticks as it paralyses the pharyngeal and somatic muscles of all such parasites but is exceptionally safe for mammals.
Twomey et al. (2009) while assessing the use of *Ivermectin* in treating and controlling the *Sarcoptes scabiei* mange infestation in alpacas / South American Camelids (Vicugna pacas) reported that its repeated use as a s/c injection at the rate of 0.2mg / kg body weight at fortnightly intervals was very effective as it helped in successfully controlling the disease and the outbreaks of scabies.

Dixit et al. (2009) used an herbal formulation, a mixture of Lemon, Onion, camphor, turmeric and sweet oil for the treatment of camels suffering from *Sarcoptic* mange and reported that this herbal formulation, drug did possess a good miticidal activity which helps in the recovery from symptoms like itching, thickening and wrinkling of skin.

Kataria et al. (2009) while handling an outbreak of *Sarcoptic* mange in a Bucks farm reported that a single dose of subcutaneous injection of *Ivermectin* at the rate of 0.2mg/kg body weight coupled with improved management proved very effective in controlling the disease problem.

Bornstein (2010) reported that the Indian peasants believe fat of condors as a good element of treatment for scabies in South American Camels (SACs). Later on some of the farmers started using motor oil, whereas some used macrocyclic lactones. The use of *Ivermectin* (0.2 mg / kg body weight) also proved a good acaricidal against mites and lice infestations. They further reported that use of such products that contain eprinomectin, doramectin, moxidectin and *Cypermethrin* have also been proved very effective against mange infestation.

Abdally (2010) studied the acaricidal effect of *Ivermectin* and *Doramectin* on *Sarcoptic* mange affected camels in Saudi Arabia and reported that the results pertaining to Doramectin were more promising than *Ivermectin* being stronger and long lasting. The animals treated with
**Doramectin** were quickly recovered showing negative prevalence and remained comfortable because of quick relief, high performance rate and its effectiveness for a longer period as compared to **Ivermectin**. Furthermore the level of glucose, urea, creatinine, GOT and GPT in the serum increased in camels treated with Doramectin than those treated with **Ivermectin**.

Premalatha et al. (2010) conducted treatment trials with **Ivermectin**, of **Sarcoptic** mange affected camels kept under captive conditions. They reported that the animals prior to treatment were showing clinical symptoms of pruritus, itching, biting, rubbing and restless along with very weak and emaciated condition but after the treatment with Ivermectin injection subcutaneously at the rate of 0.2 mg / kg body weight at fortnightly intervals for sixty days showed very effective results by changing the entire texture of skin as the skin lesions were healed and it became smooth, fresh and shiny and the clinical signs disappeared by 56th day of treatment.

Munang’andu et al. (2010) in a study regarding the epidemiology and treatment of **Sarcoptes** mite in African buffalo calves of game ranches reported that **Ivermectin** was 100% effective in eradication and control of **Sarcoptes** mange infestation from the animals with maximum of three doses depending on the severity of disease.

Khan et al. (2013) conducted the therapeutic trials to compare the efficacy of **Ivermectin** with **Tecomella undulate** G. Don an herbal medicine which is in use since long in Ayurvedic system of medicine for the treatment of **Sarcoptes scabiei** in different animals and human beings and monitored the results through symptomatic relief as well as microscopic examination. They reported that **Ivermectin** was found as the most effective for the treatment of scabies.

Deger and Ural (2013) conducted a study by comparing the efficacy of different drugs for the treatment of **Sarcoptic** mange in dogs. The said study was based on clinical signs of scabies.
like pruritus, erytherma, loss of hairs, crusting of the affected area and hyperpigmentation. They reported that *Eprinomectin*, a product containing the *avermectin* compounds, very effective in treating and controlling the scabies originating from *Sarcoptes scabiei*. They also did not experience any adverse effect of the medicine.

Seddiek et al. (2013) studied the acaricidal efficacy of Neem (*Azadirachta indica*) and Ivermectin against *Sarcoptes scabiei* infestation in rabbits and reported that 40% aqueous neem (*Azadirachta indica*) extract was highly efficacious against mite larvae whereas both the medicines were equally effective against adult mites.

### 2.5 STATEMENT OF PROBLEM

In Pakistan, entire camel population exists in the rain fed areas of the country including the province of Punjab. Poor veterinary services, harsh climatic conditions, malnutrition, poor management and unhygienic conditions threaten the camel health. Accordingly camel has a high disease burden, of which scabies, caused by *Sarcoptes* is the commonest one. Animals affected with mange lose their health and production very quickly leading to economic losses. There also exists a skin problem amongst the camel handlers.

The present study was accordingly designed to determine the prevalence of *Sarcoptic* mange infestation in the camel population of Punjab province in Pakistan as well as to investigate the different contributing factors in its occurrence. The change in blood physiology of diseased and treated animals, its comparison with healthy animals, its zoonotic importance as well as its occurrence in human beings was investigated. Furthermore the therapeutic effect with their economic viability of two different allopathic and three indigenous herbal medicines, identified as having the anti-parasitic effect against different types of internal and external
parasites has also been studied under this project. The following objectives were proposed at the start of this study.

1. To determine the factors contributing to the prevalence of scabies in camels due to *Sarcoptic* mange.

2. To identify factors contributing to the occurrence of mange.

3. To study the zoonotic importance of the disease.

4. To study the efficacy of various herbal (Indigenous) and allopathic drugs against *Sarcoptic* mange.

5. Economic viability of drugs used for these trials.

6. To study Haematology and biochemical analysis of mange affected animals before and after treatment.
CHAPTER 3
MATERIALS AND METHODS

3.1 EXPERIMENTAL SITES

The study was carried out in the rain fed field areas of the province of Punjab, Pakistan. The diagnostic facilities of Livestock & Dairy Development Department, Government of the Punjab, available at district level, Barani Livestock Production Research Institute (BLPRI), Kheirimurat, district Attock, and Camel Breeding and Research Center (CBRC), Rakh Mahni, district Bhakhar were used for initial diagnosis on the basis of microscopic findings regarding the different stages of mange available in the skin scrapings. Diagnostic facilities of Department of Parasitology, University of Veterinary & Animal Sciences (UVAS), Lahore were also randomly used for re-confirmation of initial diagnosis from skin scrapings carried out in the diagnostic laboratories of the field. The facilities of Quality Operations laboratory, UVAS, Lahore and Microbiology laboratory of Mayo Hospital, Lahore were used as focal diagnostic stations for Haematological analysis. During the course of study, i.e. from September, 2013 to August, 2014, skin scrapings from 1489 camels, without the discrimination of age and sex were taken from all over the Punjab for diagnosis.

3.2 EPIDEMIOLOGICAL STUDIES

Epidemiological study was carried out to find out factors contributing in the prevalence of Sarcoptic mange infestation in camel population of Punjab, Pakistan. The data was collected on a monthly basis to ascertain the ratio of different body parts involved in the disease as well as to find out the effect of season, age and sex on the prevalence of disease. The meteorological factors, i.e. rainfall, humidity and temperature of the same area were also taken into account to find out their relation towards the epidemiology of the disease.
3.2.1 COLLECTION OF SKIN SCRAPINGS

The skin scrapings of camels, without discrimination of age or sex, from different parts of Punjab, Pakistan, were collected on a monthly basis (approximately 100 plus samples per month). An average of twenty five percent of the camel population of each farmer and ten percent from each village visited for the purpose was included in the study. After selection of animals, each camel was restrained properly and the hairs were clipped from the margins of the lesions with the help of scissors and then the area was cleaned with a 10% solution of KOH. After cleaning and letting the area dry, the lesions were scraped from the margins with the help of a fresh razor blade in such a manner till the blood oozes out of the site. The reason of scraping deeply is that some mange / mite may burrow deeply in skin while some remain on the shallow surface of the skin. The skin scrapings were collected from the edges of skin lesions in clean small size plastic jars separately, each duly marked for identification of the individual animal.

3.2.2 DIAGNOSIS OF MITE INFESTATION

The collected samples were shifted to the nearest field diagnostic laboratory of Livestock & Dairy Development Department on the same day for microscopic examination. Each sample was shifted to clean petri dish containing 10% KOH to allow the release of mites from scabs & crusts before the examination. These Petri dishes containing the skin scraping samples were warmed at 38°C for about two minutes and then examined microscopically for the presence of various stages of mites i.e. egg, larva, nymph and adult (Soulsby, 1982). The skin scrapings found negative were shifted to test tube individually containing 10 ml of 10% KOH and again heated in water up to five minutes. After heating, the test tubes were centrifuged for three minutes at 2000 rpm and the supernatant was discarded. Again 5ml of water was added to the sediment and the tubes were centrifuged for three minutes at 2000 rpm. After discarding the
supernatant a drop of sediment was examined microscopically for the presence of different stages of mites (Soulsby, 1982).

3.3  **Zoonotic Potential**

The study pertaining to the zoonotic potential of *Sarcoptes scabiei var cameli* (*Sarcoptic mange*) was based on two different parameters, i.e. its incidence in farmers handling the animals and its practical demonstration on rabbits.

3.3.1  **Farmers Based Information**

The farmers whose animals were found positive for *Sarcoptic* mange infestation were interviewed in detail about the transfer of disease symptoms to them. A total of 100 farmers of different localities, whose animals found positive, were interviewed and physically checked for any lesions relating to the scabies. For this purpose a Performa was chalked out and a questionnaire was developed to have first-hand information from the farmers. The farmers who showed some lesions of eczema or itching, including redness of skin, papular eruptions and pruritus, were further examined in detail through laboratory tests.

3.3.2  **Practical Demonstration**

Besides having information from the farmers about the transfer of disease to camel handlers, its practical study was carried out by applying the pathogenic material on the experimental rabbits. For this purpose thirty (30) adult rabbits were raised at Sana farm, Mahmood Booti, Lahore. The hairs from the back of all the rabbits (about two square inch) were first removed with the help of a barber’s shearing machine and later on the skin was smoothly shaved with the help of a clean razor to the extent that no hair remained visible on the shaved part of the body. The skin scrapings from the lesions of the scabies positive camels were taken in a petri dish and mixed with 10% of KOH. One to two drops of honey were first applied to the
shaved skin as adhering material, so that infected material adheres to the skin. After applying the honey as adhesive, the mange infected material was applied to the skin of all the experimental rabbits with the help of cotton buds. The rabbits were kept under constant observation for four weeks and examined on a weekly basis for any skin changes.

3.4 HEMATO-BIOCHEMICAL STUDIES

One hundred camels showing typical clinical lesions of *Sarcoptic* mange and confirmed as positive for mange/mites on microscopic examination were identified for treatment under therapeutic trials. Blood from these camels selected for treatment trials was collected for Haematological analysis on day zero, i.e. at the start of each treatment to find out the effect of mange infestation on the blood physiology of animals. Two blood samples with the help of disposable syringe were collected from the jugular vein, one in a tube containing the Na2-salt of EDTA for the hemogram / study of Hemoglobin (Hb), total erythrocyte count (TEC), packed cell volume (PCV), total leukocyte count (TLC), eosinophils and lymphocytes. The second sample of blood was collected in a tube without anticoagulant for the subsequent serum collection for the study of total proteins, serum albumins, urea, electrolytes (Calcium, Magnesium, Sodium & Potassium) and quantitative estimation of enzymes i.e. Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT) & Lactate Dehydrogenase(LDH). The blood samples from ten healthy camels, found negative for *Sarcoptic* mange were also collected in a similar fashion for analysis and comparison with diseased one. The blood samples of one hundred camels treated with different medicines were again taken in a similar manner at the end of treatment (Day-45) to make its comparison with findings of day zero or before treatment.
3.4.1 Collection of Blood Samples

One hundred (100) positive samples for Sarcoptic mange and Ten (10) negative samples were used in the present study. Under septic measures, 6-8 ml of blood was drawn from the jugular vein with the help of a disposable syringe, and then the blood was transferred to a container containing EDTA for hemogram and without EDTA in test tube slowly to avoid haemolysis, for separation of serum (Benjamin, 1985). The blood of 100 diseased camels treated with different medicines was drawn on day zero and day 45 of each treatment whereas the blood from ten healthy camels was collected once only at the start of the study.

3.4.2 Haematological profile

Haemoglobin (Hb), total erythrocyte count (TEC), packed cell volume (PCV), total leukocyte count (TLC), eosinophil and lymphocyte were recorded as per method described (Salakij et al., 2012).

3.4.2.1 Materials and Equipment

Haematology Analyzer: Make-Austria DIATRON; Code WTO/PAT/M/001

3.4.2.2 Impedance Method

The impedance method counts and sizes cells by detecting and measuring changes in electrical impedance when a particle in a conductive liquid passes through a small aperture (Tatsumi et al., 1999).

3.4.2.3 Procedure

- Instrument was turned on and the program was properly set as described in Abacus user manual.
- 3 ml whole blood was taken in anti-coagulant coated vacutainer
Materials and Methods

- Closed sample vacutainer was inverted 11 times to achieve a homogenous sample, without shaking (Shelah-Goraly et al., 2009).
- Cap of vacutainer was put off and aspiration needle of the analyzer was immersed into it.
- Instrument drawn required amount of blood and aspiration needle was retracted.
- During aspiration sample tube (vacutainer) was held in a stable position until the status LED flashed and heard the beep indicating the end of sampling tube (Klainbart et al., 2011).

3.4.3 Separation of Serum

All the blood samples which were supposed to be analyzed on the basis of serum were allowed to clot for about an hour. The clot was separated by a fine loop and the samples were centrifuged at 3500 rpm for 5 minutes. The clear sterile fluid (serum) was aspirated with a Pasteur pipette and put in an air tight screw caped vial and stored at -20°C until analyzed for different parameters. Diagnostic kits were used for quantitative estimation of enzymes and electrolytes (Berger et al., 1984).

3.4.3.1 Material and Equipment

- Chemistry Analyzer: Make-Netherlands; Model-Microlab 300; Code: WTO/PAT/E/002
- Centrifuge machine: Make-Germany capable of 5000 rpm for test tubes and 14000 for microfuges Code: WTO/PAT/E/004
- Test tubes: Make- Borosilicate / Pyrex5 ml capacity glass or plastic round bottom, size 12 x 75 mm
- Microfuges: Eppendorf or equivalent with writing surface
- Micro pipette’s: 1 – 10, 20-100µl and 200 – 1000 µl capacity
- Pipettes tips: white (1-10 µl) yellow (10-100 µl) and blue (100-1000 µl)
- Water bath (Thermostat): Make - USA; Model Shel lab
- Small ice buckets

### 3.4.3.2 Alanine Aminotransferase ALT (SGPT)

**Estimation Reagents:**

ALT (SGPT) liquid UV kit (Human)

**Procedure:**

The protocol to carry out the analysis for the determination of ALT was observed as per instructions of the manufacturer of the equipment and supplier of the chemicals.

**Specimen:**

- Serum: heparinized or EDTA Plasma. Hemolysis was avoided.
- Serum or Plasma SGPT is stable for at least 3 days at 20-25 °C

**Calculation:**

Concentration (U/l) = A / minute x Factor 1745 (at 340 nm)

### 3.4.3.3 Aspartate Aminotransferase AST (SGOT)

**Test Reagents:**

AST (SGOT) liquid UV kit (Human)

**Procedure:**

The protocol to carry out the analysis for the determination of AST was observed as per instructions of the manufacturer of the equipment and supplier of the chemicals.

**Specimen:**

- Serum, heparinized or EDTA Plasma. Hemolysis was avoided.
- Serum or Plasma SGPT is stable for at least 3 days at 20-25 °C
Calculations:

Concentration (U/l) = A / minute x Factor 1745 (at 340 nm)

3.4.3.4 Lactate Dehydrogenase (LDH) Estimation

Reagents:

Serum Crescent Diagnostic kit

Procedure:

The protocol to carry out the analysis for the determination of LDH was observed as per instructions of the manufacturer of the equipment and supplier of the chemicals.

Calculation:

Concentration (U/l) = A / Minutes x factors

3.4.3.5 Urea Estimation

Reagents:

Urea estimation kit (Human)

Procedure:

The protocol to carry out the analysis for the determination of Urea was observed as per instructions of the manufacturer of the equipment and supplier of the chemicals.

Specimen:

Serum heparinized Plasma. Hemolysis was avoided.

Calculations:

Concentration (g/dl) = A sample x 80 / A standard

3.4.3.6 Estimation of Total Protein

Reagents:

Total Protein estimation Kit (Human)
Procedure:

The protocol to carry out the analysis for the determination of Total Protein was observed as per instructions of the manufacturer of the equipment and supplier of the chemicals.

Calculation:

Concentration (g/dl) = 8 x A sample / A STD

3.4.3.7 Estimation of Albumin

Reagents:

Albumin estimation kit (Human)

Procedure:

The protocol to carry out the analysis for the determination of Albumin was observed as per instructions of the manufacturer of the equipment and supplier of the chemicals.

Calculations:

Concentration (g/dl) = 4 x A sample / STD

3.4.3.8 Calcium Estimation

Reagents:

Calcium estimation kit (Human)

Procedure:

The protocol to carry out the analysis for the determination of Calcium was observed as per instructions of the manufacturer of the equipment and supplier of the chemicals.

Calculation:

Concentration (g/dl) = 8 x sample / STD
3.4.3.9 Estimation of potassium

Reagents:

Potassium Estimation Kit (Human)

Procedure:

The protocol to carry out the analysis for the determination of Potassium was observed as per instructions of the manufacturer of the equipment and supplier of the chemicals.

Calculation:

\[
\text{Concentration (g/dl)} = 5 \times \frac{A \text{ sample}}{A \text{ standard}}
\]

3.4.3.10 Estimation of Sodium

Reagents:

Sodium Estimation Kit (Human)

Procedure:

The protocol to carry out the analysis for the determination of Sodium was observed as per instructions of the manufacturer of the equipment and supplier of the chemicals.

Calculation:

\[
\text{Concentration (g/dl)} = \frac{RB - \text{Sample}}{RB - \text{STD}}
\]

3.4.3.11 Estimation of Magnesium

Reagents:

Magnesium Estimation Kit (Human)

Procedure:

The protocol to carry out the analysis for the determination of Magnesium was observed as per instructions of the manufacturer of the equipment and supplier of the chemicals.
Calculation:

\[
\text{Concentration (g/dl) = RB – Sample} / \text{RB - STD}
\]

3.5 THERAPEUTIC TRIALS

One hundred and twenty camels showing typical symptoms of scabies and found positive for *Sarcoptic* mange / mite on microscopic examination were randomly selected for conducting trials of different herbal and allopathic drugs. The animals were randomly divided into six groups, i.e. A, B, C, D, E and F having 20 animals in each group. The animals in group A, B and C were treated with herbal drugs, i.e. *Azadirachta indica* (Neem), *Nicotiana tobacum* (Tobacco) and *Eruca sativa* (Taramera oil), the animals in group D and F were treated with allopathic / patent medicines i.e. *Ivermectin* and *Cypermethrin* respectively whereas no treatment was provided to the animals of group F and this group was treated as a control. The herbal drugs were prepared before the start of treatment on each occasion and the allopathic drugs were purchased from the market. The skin scrapings from the lesions of affected animals of all the groups were obtained on day 0, 15, 30 and 45 of the treatment to ascertain the efficacy of drugs on the basis of counting of live mite per gram of skin scrapings examined microscopically. The persons involved in collection of skin scrapings, collection of blood and applying of different drugs for therapeutic trials were provided with the disposable gloves to avoid any cross infection or transfer of *Sarcoptic* mange to human beings.

**Calculation of live mite prevalence:**

The calculation of live mite prevalence per gram of skin scrapings in a particular group on a specific day of observance was done arithmetically first by summation of the total no. of mites seen in the slides of a group, then multiplying it by 100 and then dividing the same with total no. of animals in that group.
Total No. of live mites seen per slide × 100 / Total No. of animals in the group

3.5.1 Group A – Treatment with Azadirachta indica (Neem)

Azadirachta indica (Neem) is being used as antibacterial, antifungal and anti-parasitic since centuries ago. The uses of Neem in India have been documented since 4000 B.C. and at present different preparations made from its various parts are being marketed in the shape of Neem soap, Neem shampoo, Neem toothpaste and even facial creams. Its leaves and fruits are the main parts which are used in different preparations. Two different concentrations prepared from the leaves of Neem have been used in this study.

3.5.1.1 Preparation of herbal drug solution

The green leaves of Azadirachta indica (Neem) were obtained from the healthy plants and dried under shade. The dried leaves were ground into powder form and two different concentrations, i.e. 20% (w/v) and 40% (w/v) were prepared with the help of water. Both the concentrations were prepared by using 20gm and 40gm powdered Neem leaves by adding the boiled water kept at room temperature so as to make the solutions 100ml in each case. Approximately two liters of solution were used for each animal for the treatment purpose at one time. Collection of leaves and preparation of solution required labor, which was done on self-help basis. The collection and grinding of the leaves was done at home, hence its cost was not calculated.

3.5.1.2 Application of drug on mange infested camels

Both these concentrations, i.e. 20% and 40% solutions were applied by spraying with the help of spray pump as well as with the help of a soaked piece of cotton cloth, on the scabies lesions of two different subgroups of camels comprising of 10 animals each on day zero of treatment and was repeated on day 15 of treatment. The skin scrapings from the lesions were
obtained on day 0, 15, 30 and 45 of the treatment to ascertain the efficacy of drug on the basis of counting of live mite per gram of skin scrapings examined microscopically. Besides microscopic examination for live mite estimation, the gradual disappearance of gross clinical lesions including stopping of itching, smoothness of skin, regrowth of hairs, etc. were also taken into consideration to assess the efficacy of the drug.

3.5.2 Group B – Treatment with *Nicotiana tobacum* (Tobacco)

The use of *Nicotiana tobacum* (Tobacco / Tambaku) by the smokers is in practice since centuries. Nicotine is basic ingredient available in Tobacco, which has an excellent miticidal effect against various health problems. Its use for the treatment of mange infestation with two different concentrations has been studied in this research project.

3.5.2.1 Preparation of herbal drug solution

The dried leaves of *Nicotiana tobacum* (Tobacco) are available in the market for sale for use by smokers. The untreated dried leaves of Tobacco were purchased from the market and ground to powder form. Two different solutions of Tobacco having the concentrations of 20% and 40% were prepared with the help of water. Both the concentrations were prepared by using 20gm and 40gm powdered Tobacco leaves by adding the boiled water kept at room temperature so as to make the solutions 100 ml (w/v) in each case. Approximately two liters of solution were used at one time for each animal for the treatment purpose. One liter of 20% and 40% Tobacco solution cost about Pakistan Rupee (Rs.) 50.00 &100.00 respectively.

3.5.2.2 Application of drug on mange infested camels

Both these concentrations, i.e. 20% and 40% solutions were applied by spraying with the help of spray pump as well as with the help of a soaked piece of cotton cloth on the scabies lesions of two different subgroups of camels comprising of 10 animals each on day zero of treatment and was repeated on day 15 of treatment. The skin scrapings from the lesions were
obtained on day 0, 15, 30 and 45 of the treatment to ascertain the efficacy of drugs on the basis of counting of live mite per gram of skin scrapings examined microscopically. Besides microscopic examination for live mite estimation, the gradual disappearance of gross clinical lesions stopping of itching, smoothness of skin, regrowth of normal hairs, etc. were also taken into consideration to assess the efficacy of the drug.

3.5.3 Group C – Treatment with *Eruca sativa* (Taramera oil)

The seeds of *Eruca sativa* (Taramera), a herbal plant under regular cultivation in the subcontinent are used for extraction of oil. Its oil and cake both are being used as a source of feed for livestock. Its chemical constituents support its use as a traditional medicine in various disorders, both in livestock and man. Two different concentrations of *Eruca sativa* have studied in this project.

3.5.3.1 Preparation of herbal drug paste

The oil extracted from the seeds of *Eruca sativa* (Taramera) is available in the market. The oil was procured directly from the expeller so as to ensure that the same is free from any adulteration. Two different concentrations of Taramera oil paste i.e. 40% and 60% were prepared by adding lemon juice, ground onion, powdered camphor and turmeric powder. Both the concentrations were prepared by using 40ml and 60ml of Taramera oil by adding 15ml & 10ml lemon juice, 15gm & 10gm onion paste, 15gm & 10gm ground camphor and 15gm & 10gm turmeric powder respectively. Approximately 250 grams of paste were used on the affected parts of the each diseased animal at one time for treatment purpose. The approximate cost of the 250 gram paste prepared was Pak. Rs. 350.00 and 300.00 for 40% and 60% respectively.
3.5.3.2 Application of drug on mange infested camels

Both these concentrations, i.e. 40% and 60% pastes were applied with the help of the spatula on the scabies lesions of two different subgroups of camels comprising of 10 animals each on day zero of treatment and was repeated on day 15 of treatment. The skin scrapings from the lesions were obtained on day 0, 15, 30 and 45 of the treatment to ascertain the efficacy of drugs on the basis of counting of live mite per gram of skin scrapings examined microscopically. Besides microscopic examination for live mite estimation, the gradual disappearance of gross clinical lesions stopping of itching, smoothness of skin, regrowth of hairs, etc. were also taken into consideration to assess the efficacy of the drug. At an average about 250 gm of prepared paste per animal was used.

3.5.4 Group D – Treatment with *Ivermectin* 1%

*Ivermectin* is a synthetic derivative of *Avermectins* which is regarded as one of the best antiparasitic medicine invented in the last century.

3.5.4.1 Procurement of Medicine

The medicine *Ivermectin* 1% with different brand names imported as well as locally manufactured is available in the market. *Ivermectin* with its patent name Ivomec (Merial) an imported product was purchased from the local market for use in the trial. The medicine cost was Pak. Rs. 50/= per ml.

3.5.4.2 Use of Medicine

The drug was administered at the rate of 0.2mg/kg body weight as a subcutaneous injection (s/c inj.) on the said group of camels comprising of 20 animals on day zero of treatment and was repeated on day 15 of treatment. The skin scrapings from the lesions were obtained on day 0, 15, 30 and 45 of the treatment to ascertain the efficacy of drugs on the basis of counting of live mite per gram of skin scrapings examined microscopically. Besides microscopic examination for live mite estimation, the gradual disappearance of gross clinical lesions stopping
of itching, smoothness of skin, regrowth of hairs, etc. were also taken into consideration to assess the efficacy of the drug.

3.5.5 Group E – Treatment with Cypermethrin

Cypermethrin is a class II synthetic pyrethroid pesticide, used for controlling insects in houses and agriculture. It damages the nervous system of the insects / parasites. The use of Cypermethrin against mange mite infestation has been studied in this project.

3.5.5.1 Procurement and preparation of medicine

Cypermethrin a product both imported as well as local is available in the market with different brand names. Cypermethrin with the name of Ecoflee (Prix Pharma) was purchased from the local market. One ml of Cypermethrin was added to one liter of clean boiled water kept at room temperature. Approximately two liters of solution were used for each animal for the treatment purpose. The cost of medicine was Pak. Rs. 5.00 per ml.

3.5.5.2 Application of Medicine

The diluted medicine (Cypermethrin) was applied by spraying the same on the scabies lesions with the help of spray pump as well as with the help of a soaked piece of cotton cloth, of a subgroup of camels comprising of 20 animals on day zero of treatment and was repeated on day 15 of treatment. The skin scrapings from the lesions were obtained on day 0, 15, 30 and 45 of the treatment to ascertain the efficacy of drugs on the basis of counting of live mite per gram of skin scrapings examined microscopically. Besides microscopic examination for live mite estimation, the gradual disappearance of gross clinical lesions stopping of itching, smoothness of skin, regrowth of hairs, etc. were also taken into consideration to assess the efficacy of the drug.

3.5.6 Group F – No Treatment (Control group)

This group was not provided with any treatment, as the same served as a control one. The skin scrapings from the lesions of this group were also obtained on day 0, 15, 30 and 45 to ascertain the strength of disease prevailing on different days. At the end of the project all the
Materials and Methods

camels of this group were treated with s/c injections of Ivermectin at a dose rate of 0.2mg / kg body weight. The selection of Ivermectin for this purpose was merely made on the basis its performance during the trials. The non-provision of any treatment to this group during the trial period was done with the consent of farmers.

3.6 Statistical Analysis

The data collected regarding prevalence, hemato-bichemical and therapeutic effects were statistically analyzed by using SPSS version with different techniques / tests as per under.

3.6.1 Prevalence of disease

- The Chi Square test was used to compare the month wise, season wise and age wise prevalence of disease.
- Z-test was used to determine the proportion of disease incidence among different sexes.
- Bi-Serial correlation was used to check the relation between the prevalence of disease and different meteorological parameters.

3.6.2 Hemato-biochemical Profile

- The Paired t-test was used to compare the Haematological parameters before and after treatment.

3.6.3 Therapeutic effect

Two way Analysis of Variance (ANOVA) was used to find out the effect of different medicines on different days regarding treatment of Sarcoptic mange in camels.
CHAPTER 4
RESULTS

4.1. EPIDEMIOLOGY

An epidemiological study was conducted for whole one year period from September, 2013 to August, 2014 in almost all those areas of Punjab, where camel population exists. For this purpose 1489 camels were examined to ascertain the presence of *Sarcoptes scabiei var cameli*. The skin scrapings from 1489 camels were collected and examined microscopically for the presence of mange, of these 168 were found positive. The infestation rate was thus 11.28%. In all positive cases (n = 168) *Sarcoptes scabiei var cameli* was identified as the only mite species from the entire skin scrapings (n = 1489).

Lesions of mange mite infestation were observed most commonly on the face (72.61%), neck region (63.09%), abdominal region (41.66%), inner surface of the thighs (36.90%) and inguinal region (32.14%) of the infected camels. Clinically the disease is characterized by loss of hairs, scab formation, thickening and corrugation of skin and severe itching was also noted in many camels. The detail of mange infestation lesions on different body parts of camels found positive is reflected in Table-1.
### Results

Table No: 1  Lesions of mange/mite infestation on various body areas of camels

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Region</th>
<th>Positive cases</th>
<th>Lesions Present</th>
<th>%age of infestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Face</td>
<td>168</td>
<td>122</td>
<td>72.61%</td>
</tr>
<tr>
<td>2</td>
<td>Neck</td>
<td>168</td>
<td>106</td>
<td>63.09%</td>
</tr>
<tr>
<td>3</td>
<td>Abdominal</td>
<td>168</td>
<td>70</td>
<td>41.66%</td>
</tr>
<tr>
<td>4</td>
<td>Inner surface of thighs</td>
<td>168</td>
<td>62</td>
<td>36.90%</td>
</tr>
<tr>
<td>5</td>
<td>Inguinal region</td>
<td>168</td>
<td>54</td>
<td>32.14%</td>
</tr>
</tbody>
</table>
4.1.1. Monthly prevalence of *Sarcoptic* mange infestation in Camels

Skin scrapings from camels suspected for Sarcoptic mange infestation was collected on a monthly basis (approximately 100 plus per month) to find out the prevalence of disease. The prevalence of the disease was confirmed with the help of microscopic examination, the detail of results is reflected in Table-2 and Figure-1.
Table No: 2  Month wise Prevalence of *Sarcoptic* mange infestation in Camels

<table>
<thead>
<tr>
<th>Month</th>
<th>Total Animals Examined</th>
<th>Animals Found Positive</th>
<th>%age Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep-13</td>
<td>102</td>
<td>5</td>
<td>4.9</td>
</tr>
<tr>
<td>Oct-13</td>
<td>103</td>
<td>8</td>
<td>7.76</td>
</tr>
<tr>
<td>Nov-13</td>
<td>139</td>
<td>23</td>
<td>16.54</td>
</tr>
<tr>
<td>Dec-13</td>
<td>141</td>
<td>24</td>
<td>17.02</td>
</tr>
<tr>
<td>Jan-14</td>
<td>139</td>
<td>31</td>
<td>22.3</td>
</tr>
<tr>
<td>Feb-14</td>
<td>139</td>
<td>36</td>
<td>25.89</td>
</tr>
<tr>
<td>Mar-14</td>
<td>141</td>
<td>26</td>
<td>18.43</td>
</tr>
<tr>
<td>Apr-14</td>
<td>110</td>
<td>8</td>
<td>7.27</td>
</tr>
<tr>
<td>May-14</td>
<td>140</td>
<td>5</td>
<td>3.57</td>
</tr>
<tr>
<td>Jun-14</td>
<td>101</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Jul-14</td>
<td>133</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Aug-14</td>
<td>101</td>
<td>2</td>
<td>1.98</td>
</tr>
<tr>
<td>Total/Ave.</td>
<td>1489</td>
<td>168</td>
<td>11.28%</td>
</tr>
</tbody>
</table>

Figure No: 1  Month wise prevalence of *Sarcoptic* mange in Camels
Samples from 1489 animals were examined in the laboratory for the presence of different stages of Sarcoptic mange. 168 animals (11.28%) were found positive for the mange infestation. The results of monthly prevalence are presented in Table-2 and Figure-1. Results revealed that the intensity of disease was much higher during the months of November to March with its peak during February (25.89%) followed by January (23.30%). The lowest disease incidence (0%) was observed during the months of June and July. Statistical analysis on the basis of Chi Square revealed a significant difference ($p < 0.05$) among the months.

4.1.2. Season wise prevalence of Sarcoptic mange infestation in Camels

Pakistan is blessed with four different seasons, i.e. Autumn (September & October), Winter (November-February), Spring (March & April) and Summer (May- August). The season wise data was collected to find out its effect on the prevalence of disease which is presented in Table-3 and Figure-2.
Table No: 3  Season wise Prevalence of *Sarcoptic* mange infestation in Camels

<table>
<thead>
<tr>
<th>Season</th>
<th>Total</th>
<th>Positive</th>
<th>% Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn</td>
<td>205</td>
<td>13</td>
<td>6.34</td>
</tr>
<tr>
<td>Winter</td>
<td>558</td>
<td>114</td>
<td>20.43</td>
</tr>
<tr>
<td>Spring</td>
<td>251</td>
<td>34</td>
<td>13.55</td>
</tr>
<tr>
<td>Summer</td>
<td>475</td>
<td>7</td>
<td>1.47</td>
</tr>
</tbody>
</table>

Figure No: 2  Season wise prevalence of Sarcoptic mange in Camels
The prevalence of Sarcoptic mange was studied on the basis of different seasons prevailing in the country. The season wise results are presented in Table-3 and Figure-2. The results revealed that the highest disease incidence was observed during winter season (20.43%) followed by spring (13.55%) then the autumn (6.34%), whereas the lowest prevalence of disease was observed in summer (1.47%). The Chi Square test was performed which showed significant difference (p < 0.05) for the prevalence of disease amongst the different seasons.

4.1.3. Sex wise prevalence of Sarcoptic mange infestation in Camels

The detail about the sex of all the animals was recorded at the time of collecting the samples to find out the relation of sex if any on the epidemiology of the disease. The results are presented in Table-4 and Figure-3.
Table No: 4  Sex wise Prevalence of *Sarcoptic* mange infestation in Camels

<table>
<thead>
<tr>
<th>Sex</th>
<th>Total</th>
<th>Positive</th>
<th>% Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>567</td>
<td>74</td>
<td>13.05</td>
</tr>
<tr>
<td>Male</td>
<td>922</td>
<td>94</td>
<td>10.19</td>
</tr>
</tbody>
</table>

Figure No: 3  Sex wise prevalence of *Sarcoptic* mange infestation in Camels
The prevalence of *Sarcoptic* mange infestation, disease was also studied on the basis of sex of animals. Of the total 1489 animals under study, 567 were females and 922 males. 13.05% females (74/567) were found positive for *Sarcoptes* as compared to 10.19% (94/922) males. The results of disease prevalence on the basis of sex are reflected in Table-4 and Figure-3. On the basis of the Z-test (for Population Proportion), there was no significant difference ($p < 0.05$) amongst sexes as far as disease incidence is concerned.

4.1.4. Age wise prevalence of *Sarcoptic* mange infestation in Camels

The detail about the age of all the animals was also recorded at the time of collecting the samples to find out the relation of age on the prevalence of the disease. The results are presented in Table-5 and Figure-4.
Results

Table No: 5  Age wise Prevalence of *Sarcoptic* mange infestation in Camels

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Total</th>
<th>Positive</th>
<th>% Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 2 years</td>
<td>237</td>
<td>31</td>
<td>13.08</td>
</tr>
<tr>
<td>2 to 5 years</td>
<td>506</td>
<td>62</td>
<td>12.25</td>
</tr>
<tr>
<td>above 5 years</td>
<td>746</td>
<td>75</td>
<td>10.05</td>
</tr>
</tbody>
</table>

Figure No: 4  Age wise prevalence of *Sarcoptic* mange infestation
All the animals under study were divided into three groups, i.e. Sucklers (up to 2 years), Young (2-5 years) and Adult (above 5 years). The age wise disease prevalence results are presented in Table-5 and Figure-4. The results reveal that sucklers (13.08%) were more prone to the disease followed by younger (12.25%) and adults (10.05%). The analysis performed on the basis of Chi Square test shows that there was no significant difference (p < 0.05) amongst different age groups.

4.1.5. Prevalence of Sarcoptic mange infestation and its relation to weather

The detail about rainfall, temperature and humidity for the last four years (2010-11 to 2013-14) was obtained from the meteorological department to find out the relation of these environmental factors on the epidemiology of the disease. The mean average for the last four years of all these three environmental factors is reflected in Table-6.
Table No: 6  Average Monthly Meteorological Data

<table>
<thead>
<tr>
<th>Month</th>
<th>Rain Fall</th>
<th>Temperature</th>
<th>Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAN</td>
<td>14.12</td>
<td>11.32</td>
<td>66.95</td>
</tr>
<tr>
<td>FEB</td>
<td>65.50</td>
<td>13.02</td>
<td>66.90</td>
</tr>
<tr>
<td>MAR</td>
<td>38.90</td>
<td>19.95</td>
<td>59.27</td>
</tr>
<tr>
<td>APR</td>
<td>53.65</td>
<td>25.50</td>
<td>51.02</td>
</tr>
<tr>
<td>MAY</td>
<td>15.45</td>
<td>31.67</td>
<td>37.12</td>
</tr>
<tr>
<td>JUN</td>
<td>53.97</td>
<td>34.20</td>
<td>43.15</td>
</tr>
<tr>
<td>JUL</td>
<td>130.75</td>
<td>33.02</td>
<td>58.90</td>
</tr>
<tr>
<td>AUG</td>
<td>138.40</td>
<td>31.47</td>
<td>67.70</td>
</tr>
<tr>
<td>SEP</td>
<td>61.55</td>
<td>29.67</td>
<td>66.82</td>
</tr>
<tr>
<td>OCT</td>
<td>8.32</td>
<td>25.60</td>
<td>61.17</td>
</tr>
<tr>
<td>NOV</td>
<td>7.52</td>
<td>19.22</td>
<td>65.77</td>
</tr>
<tr>
<td>DEC</td>
<td>8.70</td>
<td>13.75</td>
<td>68.55</td>
</tr>
</tbody>
</table>

The camel population is most commonly available in the arid or rain fed areas of Punjab. This study was accordingly conducted in the camel populations of the province of Punjab, Pakistan. The meteorological data in respect of rainfall, temperature and humidity for the last four years of the areas from where the samples were collected was officially obtained from the meteorological department. The monthly mean average of all these three parameters, firstly on an annual basis and then for the last four years was arithmetically calculated which is reflected in Table-6. The monthly prevalence of the disease was then compared with the meteorological data and statistically analyzed using biserial correlation between prevalence and the environmental factors i.e. rainfall, temperature and humidity. Statistical analysis revealed that the rainfall had negative and non-significant relation (p < 0.05) with the prevalence of the disease which means that with the decrease of rainfall, the rate of disease prevalence increased. On the other hand humidity had positive, non-significant relation with the prevalence of disease as it increased with
the increase of humidity. However, the biserial correlation between temperature and the prevalence of disease was observed as negative and significant (p < 0.05), as with the decrease of temperature the rate of disease prevalence increased.

4.2 Zoonotic Potential

The different studies carried out in the world have mentioned the transfer of animal scabies to the human population off and on, creating a health problem for human beings. The present study pertaining to the zoonotic potential of *Sarcoptes scabiei var cameli* (*Sarcoptic mange mite of camels*) was accordingly conducted to find out the situation in the farmers particularly who were involved in camel rearing. The present study was based on two different parameters, i.e. its incidence in farmers handling the animals and its practical demonstration.

4.2.1 Farmers Based Information

A survey of risk of zoonosis for camel riders / handlers was carried out. For this purpose a total of 100 farmers / family members who remain in close contact with their camels either being riders or as handlers, of different localities, whose animals found positive for *Sarcoptic* mange infestation, were interviewed and physically checked for any lesions relating to the scabies. Most of the farmers informed that their family members who handle the camels do develop eczema / irritation in inter digital spaces of hands during winter months. Such lesions sometimes when not attended properly do spread to the forearms. For treatment of this, they mostly apply Taramera oil or sometime sweet oil mixed with sulphur, whereas very few of them who happen to visit the towns / cities nearby to get some treatment from a doctor or Hakeem (Herbal treatment expert). As regards to the cause of such eczema, most of the camel owners replied differently, but their crux was the unhygienic conditions, whereas very few of them told that they get this problem from their diseased animals.
The main causes of the eczematic skin problem which could be attributed to the transfer of mangy scabies disease symptoms to human beings were;

i- A harsh winter season in which people remain mixed up with their animals more often.

ii- People do not take a bath daily.

iii- People do not use carbolic or disinfectant soap while taking bath.

iv- Non-use of disinfectants for animals and their housing.

v- Use of animal clothing as bedding by the human beings.

vi- Non washing of hands with disinfectants by the animal keepers after handling them.

It was noticed that out of these 100 farmers interviewed and examined 13 (13%) camel riders and handlers showed itching, localized skin lesions of 1 to 2 month duration on more than one region of the body, i.e. inter digital spaces of the hands (38.76%), flexor surface of the wrist (38.76%), forearms (30.76%), elbow (30.76%), axillary fold (30.76%) and between thighs (23.07%). The detail / results of lesions percentage wise are given in the Table-7 and Figure-5.

These patients were referred to various local clinics / hospitals for the detection which revealed absence of the fungal elements. Their cutaneous examination showed a well-defined 3 × 2.5 cm sized erythematous plaques with papulo-vesicular eruption and minimal scaling. The material collected from the eczematic lesions from all these persons was further examined microscopically which revealed the presence of different live stages of mange mite of which two were adult one with a size of 300-400 μm. Infection was identified as *Sarcoptes* mange mite on the basis of their morphology. It was also noted that in some camel riders, there were no typical scabietic lesions, but the history of contact with infected camels was positive. The presenting sites of lesions were also helpful in the diagnosis of *Sarcoptic* mange in these camel riders.
Table No: 7  Presence of lesions on various parts of the body of camel riders

<table>
<thead>
<tr>
<th>Part of body</th>
<th>No. of riders examined</th>
<th>Presence of lesions</th>
<th>%age of infestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter digital spaces of hands</td>
<td>13</td>
<td>5</td>
<td>38.46%</td>
</tr>
<tr>
<td>Flexor surface of wrists</td>
<td>13</td>
<td>5</td>
<td>38.46%</td>
</tr>
<tr>
<td>Forearms</td>
<td>13</td>
<td>4</td>
<td>30.76%</td>
</tr>
<tr>
<td>Elbow</td>
<td>13</td>
<td>4</td>
<td>30.76%</td>
</tr>
<tr>
<td>Axillary fold</td>
<td>13</td>
<td>4</td>
<td>30.76%</td>
</tr>
<tr>
<td>Between thighs</td>
<td>13</td>
<td>3</td>
<td>23.07%</td>
</tr>
</tbody>
</table>

Figure No: 5  Percentage wise body parts of camel riders / handlers involved in scabietic lesions
4.2.2 Practical Demonstration

Besides having information from the farmers about the transfer of disease to camel handlers, its practical study was carried out by applying the pathogenic material on the farm rabbits. For this purpose thirty (30) adult rabbits were raised at Sana farm, Mahmood Booti, Lahore. The hairs from the back of all the animals were first removed with the help of a barbers shearing machine and later on the skin was smoothly shaved with the help of a clean razor to the extent that no hair remained visible on the shaved part of the body. The skin scrapings from the lesions of the scabies positive camels was taken in a petri dish and mixed with 10% KOH. Approximately one drop of honey was first applied to the shaved skin so that infected material adheres to the skin. After applying the honey as adhesive, the mange infected / morbid material was applied to the skin of all the experimental rabbits. The rabbits were kept under constant observation for four weeks and examined on a weekly basis. The papules, vesicles and pustules started developing in the third week after application of morbid material on the skin of rabbits. The skin scrapings from the rabbits were taken after four weeks (day 28) of applying the morbid material to induce the disease and microscopically examined. On microscopic examination all the skin scrapings confirmed the presence of different stages of *Sarcoptes scabiei var cameli* on the skin of rabbits.

4.3. Hemato-biochemical Profile of Sarcoptic Mange Infested Camels

The blood of diseased camels treated with different medicines was analyzed before and after the treatment to ascertain the physiological effect of mange infestation on the health status of diseased animals and the scope of recovery after treatment. The blood was analyzed for different Haematological, biochemical and electrolyte based parameters. The blood of ten healthy camels collected similarly was also analyzed for the same parameters to make its comparison with the diseased camels.
4.3.1: Haematological Profile

The results of different Haematological parameters, i.e. Total Erythrocyte Count (TEC), Packed Cell Volume (PCV), Total Leukocyte Count (TLC), Lymphocytes, Eosinophils, and Hemoglobin (Hb) before and after the treatment were studied to ascertain the changes in their values and to find out the effect of mange infestation on the blood physiology of camels and to compare with the healthy ones. The mean averages of these parameters are presented in Table-8 and Figures-6. The results reveal that Hb, TEC, PCV showed a decreasing trend in the diseased animals, whereas TLC, Lymphocytes and Eosinophils were observed with increased concentrations. All these Haematological parameters were found approaching towards normality after treatment and recovery from the mange infestation. Statistical analyses based on paired t-test revealed a significant difference (p<0.05) among all these Haematological values of mangy and recovered from disease camels.
### Results

**Table No: 8  Haematological Profile of Mangy / Treated and Healthy Camels**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre Treatment</th>
<th>Post Treatment</th>
<th>Healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packed Cell Volume (%)</td>
<td>21.71 ± 0.397&lt;sup&gt;b&lt;/sup&gt;</td>
<td>25.71 ± 0.397&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27.24 ± 0.964</td>
</tr>
<tr>
<td>Total Erythrocyte Count (%)</td>
<td>6.31 ± 0.173&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.30 ± 0.158&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.38 ± 0.528</td>
</tr>
<tr>
<td>Total Lymphocyte Count (%)</td>
<td>22.75 ± 0.505&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17.78 ± 0.486&lt;sup&gt;b&lt;/sup&gt;</td>
<td>16.21 ± 1.542</td>
</tr>
<tr>
<td>Lymphocyte (%)</td>
<td>56.55 ± 1.033&lt;sup&gt;a&lt;/sup&gt;</td>
<td>46.79 ± 1.369&lt;sup&gt;b&lt;/sup&gt;</td>
<td>39.60 ± 2.412</td>
</tr>
<tr>
<td>Eosinophil (%)</td>
<td>12.94 ± 0.466&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.00 ± 0.314&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.60 ± 1.074</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td>8.33 ± 0.230&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.15 ± 0.269&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.40 ± 0.627</td>
</tr>
</tbody>
</table>

**Figure No: 6  Haematological Profile of Mangy / Treated and Healthy Camels**
Biochemical Profile

The results of different biochemical parameters including total Proteins, serum Albumins, Urea and different serum enzymes, i.e. Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT) and Lactate Dehydrogenase (LDH) before and after treatment were studied to ascertain the changes in their values and compare with the healthy ones. The mean averages of these parameters are presented in Table-9 and Figures-7. The results revealed that total Proteins and serum albumins showed a decreasing trend in the diseased animals, whereas Urea, AST, ALT and LDH were observed with increased concentrations. All these biochemical parameters were found approaching towards normality after treatment and recovery from the mange infestation. Statistical analyses conducted by using the paired t-test revealed a significant difference (p<0.05) among all the biochemical values of before and after recovery of the mangy camels.
Table No: 9  Biochemical Profile of Mangy / Treated and Healthy Camels

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre Treatment</th>
<th>Post Treatment</th>
<th>Healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (g/dl)</td>
<td>6.01 ± 0.066(^b)</td>
<td>7.02 ± 0.072(^a)</td>
<td>6.94 ± 0.096</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>2.96 ± 0.045(^b)</td>
<td>3.54 ± 0.046(^a)</td>
<td>3.66 ± 0.107</td>
</tr>
<tr>
<td>Urea (g/dl)</td>
<td>59.28 ± 1.073(^a)</td>
<td>51.37 ± 0.980(^b)</td>
<td>50.51 ± 1.860</td>
</tr>
<tr>
<td>Alanine Aminotransferase (U/l)</td>
<td>21.45 ± 0.128(^a)</td>
<td>17.44 ± 0.128(^b)</td>
<td>17.75 ± 0.488</td>
</tr>
<tr>
<td>Aspartate Aminotransferase (U/l)</td>
<td>220.51 ± 1.289(^a)</td>
<td>172.77 ± 4.397(^b)</td>
<td>185.30 ± 9.522</td>
</tr>
<tr>
<td>Lactate Dehydrogenase (U/l)</td>
<td>544.56 ± 0.984(^a)</td>
<td>444.76 ± 1.230(^b)</td>
<td>456.20 ± 12.514</td>
</tr>
</tbody>
</table>

Figure No. 7  Biochemical Profile of Mangy / Treated and Healthy Camels
4.3.3: Electrolyte Profile

The blood serum was also analyzed to know the unbalancing of different electrolytes due to mange infestation. The levels of Potassium (K), Calcium (Ca), Magnesium (Mg) and Sodium (Na) were checked from the blood serum of diseased and treated animals. The results showed that the levels of all these minerals were on the lower side of the normal range in the diseased camels, but the picture reversed with the recovery of animals from the disease as the level of all these electrolytes was found close to the normal range in the treated animals. The results of electrolytes are presented in Table-10 and Figure 8. Statistical analyses using the paired t-test was conducted to find out the effect of mange infestation on the health of camels which revealed a significant difference (p<0.05) among all the electrolyte values meaning that the mange infestation effected the electrolyte based blood physiology of the diseased camels.
Table No: 10  Electrolytes Profiles of Mangy / Treated and Healthy Camels

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre Treatment</th>
<th>Post Treatment</th>
<th>Healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium (g/dl)</td>
<td>3.30 ± 0.068&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.07 ± 0.046&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.92 ± 0.113</td>
</tr>
<tr>
<td>Calcium (g/dl)</td>
<td>8.10 ± 0.090&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9.01 ± 0.036&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.93 ± 0.105</td>
</tr>
<tr>
<td>Magnesium (g/dl)</td>
<td>1.92 ± 0.014&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.13 ± 0.036&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.13 ± 0.033</td>
</tr>
<tr>
<td>Sodium (g/dl)</td>
<td>149.04 ± 2.972&lt;sup&gt;b&lt;/sup&gt;</td>
<td>167.81 ± 0.346&lt;sup&gt;a&lt;/sup&gt;</td>
<td>167.90 ± 0.737</td>
</tr>
</tbody>
</table>

Figure No. 8  Electrolytes Profiles of Mangy / Treated and Healthy Camels
4.4 Therapeutic Effect of different herbal and allopathic drugs against *Sarcoptic* mange in camels

The effect of three different herbal preparations (each having two concentrations), made from *Azadirachta indica* (Neem), *Nicotiana tobacum* (Tobacco / Tambaku) and *Eruca sativa* (Taramera oil) along with two allopathic medicines presently being used as anti-parasitic drugs were studied. Two different concentrations of each herbal preparation were used in the trials and compared with *Ivermectin* and *Cypermethrin*. A control group without treatment was also retained to compare the effect of all these medicines. The results of different treatments are reflected in Table 22, 23 & 24 and Figure-14.

The results obtained were statistically analyzed by using two way ANOVA to ascertain the effect of all these drugs. The ANOVA table shows that all the treatments had a significant effect ($p < 0.05$) in combating the disease as compared to the control group. Furthermore, it was also revealed that there was a significant effect ($p < 0.05$) at different days amongst treatments. After applying the post hoc test to compare the multiple comparisons using Dunkan multiple range test (DMR), it was observed that all treatments are significantly different from the control group, however Ivermectin has most significant effect as compared to other treatments.

4.4.1 Efficacy of *Azadirachta indica* (Neem) against *Sarcoptic* mange

*Azadirachta indica* (Neem) was applied to the camels of group A. This group was further divided randomly into two subgroups having ten (10) animals and each subgroup was applied with different concentrations, i.e. 20% and 40%. Application of different concentration of solutions was made to separate subgroups on day zero and day fifteen. The subgroup which was treated with 20% concentration showed 26.66% efficacy on 15th day post treatment. Whereas after the second application of medicine there was a marked improvement as 53.33% and 66.66% efficacy of the drug was observed on the 30th day 45th day of post-treatment. The second
subgroup which was treated with 40% concentration of *Azadirachta indica* (Neem) showed 34.48% efficacy on day 15th with marked improvement in its efficacy, especially after the second application of medicine on day 30th and 45th of post-treatment with 62.06% and 75.86% recovery rate. The results of skin scrapings observed microscopically at different days of interval, i.e. zero, 15, 30 and 45 are presented in Table-11 & 12 and Figure-9.

On the 45th day of treatment, three animals of subgroup treated with a 20% solution and five animals of subgroup treated with a 40% solution showed complete recovery as observed from the skin scrapings. It was noted that the camels after recovery and approaching a state of clinical normality, also gained weight. No side effects were observed in any case treated with different concentrations of *Azadirachta indica* (Neem) solutions.

The camels kept in the control group did not improve clinically and remained positive for mange as these animals consistently harbored the *Sarcoptes scabiei*. These animals had a weight loss and the symptoms of itching, irritation and alopecia remained positive in all untreated camels and clinically worsened condition was also observed in all these animals.
Results

Table No: 11  Effect of *Azadirachta indica* (Neem) against *Sarcoptic* mange in camels

<table>
<thead>
<tr>
<th>Solution %age</th>
<th>Average No. of live <em>S. scabiei var cameli</em> per gram of skin scrapings recorded by <em>Azadirachta indica</em> (Neem) treatment on different days</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>0-Day: 300  15-Day: 220  30-Day: 140  45-Day: 100</td>
</tr>
<tr>
<td>40%</td>
<td>0-Day: 290  15-Day: 190  30-Day: 110  45-Day: 70</td>
</tr>
</tbody>
</table>

Table No: 12  Effect of *Azadirachta indica* (Neem) against *Sarcoptic* mange in camels (recovery percentage)

<table>
<thead>
<tr>
<th>Solution %age</th>
<th>The recovery percentage recorded by <em>Azadirachta indica</em> (Neem) treatment on different days</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>0-Day: 0%  15-Day: 26.66%  30-Day: 53.33%  45-Day: 66.66%</td>
</tr>
<tr>
<td>40%</td>
<td>0-Day: 0%  15-Day: 34.48%  30-Day: 62.06%  45-Day: 75.86%</td>
</tr>
</tbody>
</table>

Figure No: 9  Effect of *Azadirachta indica* (Neem) against *Sarcoptic* mange in camels
4.4.2 Efficacy of *Nicotiana tobacum* (Tobacco / Tambaku) against *Sarcoptic* mange

*Nicotiana tobacum* (Tobacco / Tambaku) mixed with water was applied topically to 20 camels of group B. Two different concentrations of 20% and 40% solutions were prepared and applied to different subgroups comprising of 10 animals each on day zero and 15. The efficacy of both the concentrations was observed on day zero, 15, 30 and 45 of post-treatment on the basis of microscopic examination of skin scrapings made on these days. The microscopic examination of skin scrapings revealed 28.57%, 57.14% and 71.42% efficacy of 20% solution for day 15, 30 and 45 respectively. The 40% solution of *Nicotiana tobacum* (tobacco / tambaku) showed efficacy as 32.25%, 61.29% and 77.41% for the same period. On the 45\textsuperscript{th} day of treatment, three animals of subgroup treated with a 20% solution and six animals of subgroup treated with a 40% solution showed complete recovery as observed from the skin scrapings. The results, based on skin scrapings are presented in Table-13 & 14 and Figure-10. With the disappearance of mange mite infestation, the animals showed physical improvement as their skin condition, i.e. itching, alopecia and restlessness was not observed in negative cases.
Results

Table No: 13 Effect of *Nicotiana tobacum* (Tobacco) against *Sarcoptic* mange in camels

<table>
<thead>
<tr>
<th>Solution %age</th>
<th>0-Day</th>
<th>15-Day</th>
<th>30-Day</th>
<th>45-day</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>280</td>
<td>200</td>
<td>120</td>
<td>80</td>
</tr>
<tr>
<td>40%</td>
<td>310</td>
<td>210</td>
<td>120</td>
<td>70</td>
</tr>
</tbody>
</table>

Table No: 14 Effect of *Nicotiana tobacum* (Tobacco) against *Sarcoptic* mange in camels (recovery percentage)

<table>
<thead>
<tr>
<th>Solution %age</th>
<th>0-Day</th>
<th>15-Day</th>
<th>30-Day</th>
<th>45-day</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>0%</td>
<td>28.57%</td>
<td>57.14%</td>
<td>71.42%</td>
</tr>
<tr>
<td>40%</td>
<td>0%</td>
<td>32.25%</td>
<td>61.29%</td>
<td>77.41%</td>
</tr>
</tbody>
</table>

Figure No: 10 Effect of *Nicotiana tobacum* (Tobacco) against *Sarcoptic* mange in camels
4.4.3 **Efficacy of *Eruca sativa* (Taramera oil) mixture against *Sarcoptic* mange in camels.**

Prior to treatment, viable *Sarcoptes scabiei* were observed in the skin scrapings of 20 camels of this group. The group was randomly divided into two subgroups i.e. C1 and C2, each having 10 camels. Subgroup C1 was treated with a mixture having 40% concentration of taramera oil mixed with other ingredients, whereas the other subgroup (C2) was treated with a mixture with 60% concentration of *Eruca sativa* (taramera oil). The treatment was repeated after fifteen (15) days. The effect of both the concentrations of this drug was observed by examining the skin scrapings for Sarcoptes scabiei, on day zero, 15, 30 and 45. One animal of subgroup C1, which were treated with 40% concentration, showed complete recovery on day 15 and the overall efficacy of the drug in this subgroup was observed at 31%. The two animals of subgroup C2, treated with 60% *Eruca sativa* (taramera oil) concentration showed negative skin scrapings on day 15 with 35.71% efficacy of the *Eruca sativa* (Taramera oil) in this subgroup. The effectiveness of this herbal preparation on day 30 and 45 was observed at 58.63% & 67.85% for 40% and 72.41% & 78.57% for 60% concentration. Four animals from subgroup C1 treated with 40% and six animals of subgroup C2 treated with 60% concentration of taramera oil showed negative skin scrapings on day 45 and were found completely recovered from the *Sarcoptes scabiei* problem. There was also a marked reduction in clinical lesions of all the animals treated with *Eruca sativa* (taramera oil). All the treated animals showed general improvement and no ill effects were observed in any of the treated cases. The results of treatment of *Eruca sativa* (Taramera oil) mixture are reflected in Table-15 & 16 and Figure-11.
Table No: 15 Effect of *Eruca sativa* (Taramera oil) mixture against *Sarcoptic* mange in camels

<table>
<thead>
<tr>
<th>Solution %</th>
<th>0-Day</th>
<th>15-Day</th>
<th>30-Day</th>
<th>45-Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>40%</td>
<td>290</td>
<td>200</td>
<td>120</td>
<td>80</td>
</tr>
<tr>
<td>60%</td>
<td>280</td>
<td>180</td>
<td>90</td>
<td>60</td>
</tr>
</tbody>
</table>

Table No: 16 Effect of *Eruca sativa* (Taramera oil) mixture against *Sarcoptic* mange in camels (recovery percentage)

<table>
<thead>
<tr>
<th>Solution %</th>
<th>0-Day</th>
<th>15-Day</th>
<th>30-Day</th>
<th>45-Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>40%</td>
<td>0%</td>
<td>31%</td>
<td>58.62%</td>
<td>72.41%</td>
</tr>
<tr>
<td>60%</td>
<td>0%</td>
<td>35.71%</td>
<td>67.85%</td>
<td>78.57%</td>
</tr>
</tbody>
</table>

Figure No: 11 Effect of *Eruca sativa* (Taramera oil) mixture against *Sarcoptic* mange in camels
4.4.4 Efficacy of Ivermectin against Sarcoptic mange in camels

Ivermectin (Ivomec) was injected to 20 camels of group D at the dose rate of 0.2mg/kg body weight by subcutaneous route on day zero and the treatment was repeated on day 15. Out of these 20 camels, five camels were completely recovered on day 15, as the skin scrapings of these camels were found negative for mange examined microscopically and the overall recovery percentage of this group treated with Ivermectin was observed as 43.33%. After the administration of a second dose on the 15th day, thirteen camels showed complete recovery based on negative skin scrapings collected on day 30 and examined microscopically. Ivermectin at a dose rate of 0.2mg/kg body weight showed 96.66% therapeutic efficacy by day 45 of treatment with 18 camels showing a complete recovery from the Sarcoptes scabiei infestation. The results of skin scrapings observed microscopically at various intervals before and after treatment with Ivermectin are presented in Table-17 & 18 and Figure-12. It was also noted that camels treated with Ivermectin improved clinically and gained more weight than untreated camels. There was no apparent adverse reaction to treatment in the current study.
Table No: 17 Effect of *Ivermectin* (Ivomec) against *Sarcoptic* mange in camels

<table>
<thead>
<tr>
<th>Dose</th>
<th>Average No. of live <em>S. scabiei var cameli</em> per gram of skin scrapings recorded by <em>Ivermectin</em> (Ivomec) treatment on different days</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.02mg/kg (bw) s/c inj.</td>
<td>0-Day</td>
</tr>
<tr>
<td></td>
<td>300</td>
</tr>
</tbody>
</table>

Table No: 18 Effect of *Ivermectin* (Ivomec) against *Sarcoptic* mange in camels (recovery percentage)

<table>
<thead>
<tr>
<th>Dose</th>
<th>Recovery percentage recorded by <em>Ivermectin</em> (Ivomec) treatment on different days</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.02mg/kg (bw) s/c inj.</td>
<td>0-Day</td>
</tr>
<tr>
<td></td>
<td>0%</td>
</tr>
</tbody>
</table>

Figure No: 12 Effect of *Ivermectin* (Ivomec) against *Sarcoptic* mange in camels
4.4.5 Efficacy of Cypermethrin against Sarcoptic mange in camels

The results of Cypermethrin against Sarcoptic mange in camels are presented in Table-19 & 20 and Figure-13.

In the present study, Cypermethrin (Ecoflee) was used topically in 20 camels at the rate of 1ml / liter of water. The Cypermethrin was applied to the animals, especially the mange affected parts of camels with the help of a spray pump as well as with a clean piece of cloth soaked with 0.1% solution drug. This drug caused 35.48% efficacy on day 15 of post-treatment. No mite or their larval stages were seen in the skin scrapings of four camels by the 15th day of treatment and these animals also showed improvement with respect to the clinical lesions. The remaining camels were applied with the second dose on day 15th with Cypermethrin which resulted in complete recovery of 16 animals by day 45 with efficacy of 90.32%. The health of all the 16 camels recovered from Sarcoptic mange also improved significantly; therefore this dermatotherapy having an excellent efficacy as acaricidal, also may be useful to treat the disease differently, as all the animals were seen approaching the state of clinical normality within 45 days after treatment. The camels treated with this miticide gained weight with improved health and clinically there were no adverse effects associated with this therapy.
Table No: 19 Effect of *Cypermethrin* (Ecoflee) against *Sarcoptic* mange in camels

<table>
<thead>
<tr>
<th>Solution rate</th>
<th>Average No. of live <em>S. scabiei var cameli</em> per gram of skin scrapings recorded by <em>Cypermethrin</em> (Ecoflee) treatment on different days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1ml/liter of water</td>
<td>0-Day 15-Day 30-Day 45-Day</td>
</tr>
<tr>
<td></td>
<td>310 200 80 30</td>
</tr>
</tbody>
</table>

Table No: 20 Effect of *Cypermethrin* (Ecoflee) against *Sarcoptic* mange in camels (recovery percentage)

<table>
<thead>
<tr>
<th>Solution rate</th>
<th>Recovery percentage recorded by <em>Cypermethrin</em> (Ecoflee) treatment on different days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1ml/liter of water</td>
<td>0-Day 15-Day 30-Day 45-Day</td>
</tr>
<tr>
<td></td>
<td>0% 35.48% 74.19% 90.32%</td>
</tr>
</tbody>
</table>

Figure No: 13 Effect of *Cypermethrin* (Ecoflee) against *Sarcoptic* mange in camels
4.4.6. Control Group (F)

No treatment was provided to the control group, i.e. group F till the completion of this study. The skin scrapings from this group were also collected on day zero, 15, 30 & 45 and examined microscopically to compare the results of the treated groups. The results of this untreated control group are reflected in Table-21. The results showed that there was no change in the state of mange infestation in this in all the skin scraping examinations.
### Results

Table No: 21 Untreated (Control Group) details about live *Sarcoptic* mange

<table>
<thead>
<tr>
<th>Days</th>
<th>0-Day</th>
<th>15-Day</th>
<th>30-Day</th>
<th>45-Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300</td>
<td>290</td>
<td>300</td>
<td>300</td>
</tr>
</tbody>
</table>

Table No: 22 Comparison of different medicines on the basis of live mite/gm of skin scrapings recorded on different days of treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>0-Day</th>
<th>15-Day</th>
<th>30-Day</th>
<th>45-Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azadirachta indica (Neem) 20%</td>
<td>300</td>
<td>220</td>
<td>140</td>
<td>100</td>
</tr>
<tr>
<td>Azadirachta indica (Neem) 40%</td>
<td>290</td>
<td>190</td>
<td>110</td>
<td>70</td>
</tr>
<tr>
<td>Nicotiana tobacum (Tobacco) 20%</td>
<td>280</td>
<td>200</td>
<td>120</td>
<td>80</td>
</tr>
<tr>
<td>Nicotiana tobacum (Tobacco) 40%</td>
<td>310</td>
<td>210</td>
<td>120</td>
<td>70</td>
</tr>
<tr>
<td>Eruca sativa (Taramera Oil) 40%</td>
<td>290</td>
<td>200</td>
<td>120</td>
<td>80</td>
</tr>
<tr>
<td>Eruca sativa (Taramera Oil) 60%</td>
<td>280</td>
<td>180</td>
<td>90</td>
<td>60</td>
</tr>
<tr>
<td>Ivermectin (Ivomec)</td>
<td>300</td>
<td>170</td>
<td>60</td>
<td>10</td>
</tr>
<tr>
<td>Cypermethrin (Ecoflee)</td>
<td>310</td>
<td>200</td>
<td>80</td>
<td>30</td>
</tr>
<tr>
<td>Control</td>
<td>300</td>
<td>290</td>
<td>300</td>
<td>300</td>
</tr>
</tbody>
</table>
Table No: 23  Comparison of different medicines based on reduction in live mite/gm of skin scrapings on different days of treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average No. of Mites on Day-0</th>
<th>No. of Mites Reduced Day-15</th>
<th>No. of Mites Reduced Day-30</th>
<th>No. of Mites Reduced Day-45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azadirachta indica (Neem) 20%</td>
<td>300</td>
<td>80</td>
<td>160</td>
<td>200</td>
</tr>
<tr>
<td>Azadirachta indica (Neem) 40%</td>
<td>290</td>
<td>100</td>
<td>180</td>
<td>220</td>
</tr>
<tr>
<td>Nicotiana tobacum (Tobacco) 20%</td>
<td>280</td>
<td>80</td>
<td>160</td>
<td>200</td>
</tr>
<tr>
<td>Nicotiana tobacum (Tobacco) 40%</td>
<td>310</td>
<td>100</td>
<td>190</td>
<td>240</td>
</tr>
<tr>
<td>Eruca sativa (Taramera Oil) 40%</td>
<td>290</td>
<td>90</td>
<td>170</td>
<td>210</td>
</tr>
<tr>
<td>Eruca sativa (Taramera Oil) 60%</td>
<td>280</td>
<td>100</td>
<td>190</td>
<td>220</td>
</tr>
<tr>
<td>Ivermectin (Ivomec)</td>
<td>300</td>
<td>130</td>
<td>240</td>
<td>290</td>
</tr>
<tr>
<td>Cypermethrin (Ecoffee)</td>
<td>310</td>
<td>110</td>
<td>230</td>
<td>280</td>
</tr>
<tr>
<td>Control</td>
<td>300</td>
<td>290</td>
<td>300</td>
<td>300</td>
</tr>
</tbody>
</table>
**Results**

Table No: 24 Comparison of different medicines on the basis of recovery percentage recorded on different days of treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>0-Day</th>
<th>15-Day</th>
<th>30-Day</th>
<th>45-Day</th>
<th>Animals showing complete recovery on Day-45</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Azadirachta indica</em> (Neem) 20%</td>
<td>0%</td>
<td>26.66%</td>
<td>53.33%</td>
<td>66.66%</td>
<td>3(10)</td>
</tr>
<tr>
<td><em>Azadirachta indica</em> (Neem) 40%</td>
<td>0%</td>
<td>34.48%</td>
<td>62.06%</td>
<td>75.86%</td>
<td>5(10)</td>
</tr>
<tr>
<td><em>Nicotiana tabacum</em> (Tobacco) 20%</td>
<td>0%</td>
<td>28.57%</td>
<td>57.14%</td>
<td>71.42%</td>
<td>3(10)</td>
</tr>
<tr>
<td><em>Nicotiana tabacum</em> (Tobacco) 40%</td>
<td>0%</td>
<td>32.25%</td>
<td>61.29%</td>
<td>77.41%</td>
<td>6(10)</td>
</tr>
<tr>
<td><em>Eruca sativa</em> (Taramera Oil) 40%</td>
<td>0%</td>
<td>31.00%</td>
<td>58.62%</td>
<td>72.41%</td>
<td>4(10)</td>
</tr>
<tr>
<td><em>Eruca sativa</em> (Taramera Oil) 60%</td>
<td>0%</td>
<td>35.71%</td>
<td>67.85%</td>
<td>78.57%</td>
<td>6(10)</td>
</tr>
<tr>
<td><em>Ivermectin</em> (Ivomec)</td>
<td>0%</td>
<td>43.33%</td>
<td>80%</td>
<td>96.66%</td>
<td>18(20) or 9(10)</td>
</tr>
<tr>
<td><em>Cypermethrin</em> (Ecoflee)</td>
<td>0%</td>
<td>35.48%</td>
<td>74.19%</td>
<td>90.32%</td>
<td>16(20) or 8(10)</td>
</tr>
<tr>
<td>Control</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>Nil</td>
</tr>
</tbody>
</table>
Figure No: 14 Effect of different medicines for treatments of Sarcoptic mange
4.4.7 Economic Viability of Medicines Used

Three different herbal preparations, each having two concentrations and two allopathic medicines were used in this study. The herbal products available in the market were purchased and the preparations were made at home level, hence labor cost has not been calculated. The patent or allopathic medicines were also purchased from the market. Approximately two liters of solution of Neem, Tobacco and Cypermethrin were used as a single dose, whereas about 250 mg of Taramera oil paste and 15 ml of Ivomec was applied as one treatment. The detail of cost per treatment is reflected in table-25. Treatment cost of mange infested camels with two dose levels of Ivermectin was found at the highest and that of Neem as the lowest.
### Table No: 25. Economic Viability of Medicines Used

<table>
<thead>
<tr>
<th>Sr. #</th>
<th>Name of Medicine / Preparation</th>
<th>Cost per Dose</th>
<th>Treatment Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Azadirachta indica</em> (Neem, Solution) 20%</td>
<td>Home-made / Nil</td>
<td>Home-made / Nil</td>
</tr>
<tr>
<td>2</td>
<td><em>Azadirachta indica</em> (Neem, Solution) 40%</td>
<td>Home-made / Nil</td>
<td>Home-made / Nil</td>
</tr>
<tr>
<td>3</td>
<td><em>Nicotiana tobacum</em> (Tobacco, Solution) 20%</td>
<td>*Rs. 100.00</td>
<td>Rs. 200.00</td>
</tr>
<tr>
<td>4</td>
<td><em>Nicotiana tobacum</em> (Tobacco, Solution) 40%</td>
<td>Rs. 200.00</td>
<td>Rs. 400.00</td>
</tr>
<tr>
<td>5</td>
<td><em>Eruca sativa</em> (Taramera oil, Paste) 40%</td>
<td>Rs. 350.00</td>
<td>Rs. 700.00</td>
</tr>
<tr>
<td>6</td>
<td><em>Eruca sativa</em> (Taramera oil, Paste) 60%</td>
<td>Rs. 300.00</td>
<td>Rs. 600.00</td>
</tr>
<tr>
<td>7</td>
<td><em>Ivermectin</em> (Ivomec 1%) 0.2mg/kg bw</td>
<td>Rs. 750.00</td>
<td>Rs. 1500.00</td>
</tr>
<tr>
<td>8</td>
<td><em>Cypermethrin</em> (Ecoflee) 1ml/liter of water</td>
<td>Rs. 10.00</td>
<td>Rs. 20.00</td>
</tr>
</tbody>
</table>

*One US $ = About 100 Pakistan Rupee (Rs.)*
CHAPTER 5
DISCUSSION

5.1 Prevalence

The camels in Pakistan are raised by the livestock farmers under harsh climatic and hard living conditions due to which they always remain subjected to a large variety of internal and external parasites. Amongst these parasitic infestations, *Sarcoptic* mange is considered as one of the potential threat to the camel population in the world. The occurrence of *Sarcoptic* mange is influenced by multifactorial systems, i.e. poor health condition, temperature, humidity, overcrowding, unhygienic conditions, lack of acaricidal treatment and poor veterinary services. In the present study, epidemiological data on *Sarcoptic* mange in camels due to *Sarcoptes scabiei var cameli* was collected from various rain fed and arid areas of Punjab province of Pakistan i.e. Pothohar, Thal and Cholistan. In this study *Sarcoptes scabiei var cameli* was identified as the only mite species from all collected samples of skin scrapings. This observation is in a general agreement with various research workers (Higgins 1983 & 1985, Basu et al 1995, Anwar and Khan 1998, Al-Rawashdeh et al 2000, Bebe 2001, Workneh 2002, Delafosse and Doultoum 2004, CSA 2007-2008, Dinka et al. 2010). Even though both the *Sarcoptic* and *Chorioptic* mange mites *Sarcoptic* mange scabies caused by *Sarcoptes scabiei var cameli* is the most common, extremely contagious and serious problem seen in camels (Pegram and Higgins 1992, Nayel and Abu-Samra 1986, Parsani et al. 2008.).

Lesions of mange mite infestation were observed most commonly on the head, neck, abdomen, inner surface of the thighs and the inguinal region with the ratio of 72.61%, 63.09%, 41.66%, 36.90% and 32.14% of infested camels respectively. Camel mange mite infestation usually starts from the head and neck area to lower parts and then extending to other areas of the
body with thin skin such as penile sheath and the udder. The entire body may be involved in disease within a four week time (Mukassa – Mugerwa 1981). Richard (1987) also indicated that camel mange infestation commences at areas of thin skin, the head, and base of the neck, udder, prepuce and flank. The head becomes affected rapidly in every case because the animal uses its teeth to scratch the affected areas. These findings are in general agreement with the findings of Foster 2008, Moallin 2009, Towmey 2009, Biu & Kyari 2012 and Awol et al 2014, who all reported almost similar pattern of lesion in different studies.

In the present study, the overall results obtained from different areas of the Punjab province indicated a total of 1489 camels were examined for *Sarcoptes scabiei var cameli*. Of these, 168 (11.28%) were found positive. The prevalence rate of infestation is comparable to the 13.40% by Anwar & Khan (1998) in Pakistan, 12.1% by Gebrehiwet (1998) in Eritrea and 10.68% infected camels found by Dinka et al. (2007) in Ethiopia. It appears that the infestation rate in the present study is almost similar to the workers mentioned above. However, Agab and Abbas (1999), Bebe (2001), Muhammad et al. (2006) Awol et al. (2014) respectively observed, 31.6, 27.8, 35 and 16.7 percent prevalence in different countries of the world. These findings are also in partial agreement with the present study. The difference in the prevalence of camel mange/mite might be attributed to the different management systems and the environmental conditions that exist among those areas. However, the results of the present study are not in agreement with the findings of Al-Ani et al. (1998) who recorded 83 percent prevalence of camel mange in different areas. This variation in the rate of mangy scabies prevalence in camels can be attributed to different environmental conditions, management practices and use of insecticides.

In the present study it was observed that the prevalence of mange/mite was the highest during winter season (20.43%), followed by spring (13.55%), then autumn (6.34%) and the
Discussion

lowest (1.47%) during summer. Awol et al. (2014) reported that the prevalence of the camel mange mite may be attributed to environmental conditions that exist in those areas. They also emphasized that low temperature and overcrowding during winter months are favorable for the rapid propagation of the mite life cycle as was also reported by Richard (1987). The present study is also in agreement with the findings of Fassi-Fehri (1987), Grigoryan (1987), Banaja & Ghandour (1994) and Basu et al. (1995) who all reported higher rate of scabietic mange disease in camels during winter season. However, these results are not supported by the findings of Higgins et al. (1984) and Gebrehiwet (1998) as they reported the higher rate of disease prevalence during summer months.

In the present study the prevalence of mange/mite was slightly higher in females (13.05%) than the males (10.19%), however, no significant difference was observed (p < 0.05). This may be associated with some hormonal influences. The higher level of Prolactin and Progesterone hormones could make the females more susceptible to any infection (Lloyd, 1983). Additionally, pregnancy and lactation stress could also aggravate the susceptibility of the female camels to infections. Furthermore the breeding behavior of mange infected males could also be attributed to the transfer of disease to a number of females. The results of the present study are in agreement with the findings of Tefera & Gebreah (2001) and Gakuya et al. (2012) who also reported a higher disease incidence rate in females. The present results are not supported by the findings of Dinka et al. (2010) and Biu & Kyari (2012) as they reported higher incidence in males than the females. However Megersa et al. (2012) and Awol et al. (2014) did not observe any effect of sex on the prevalence of Sarcoptic mange infestation.

In the present study prevalence of mange/mite infestation was highest in the age group of sucklers (up to 2 years age) than the rest of the age groups. This could be due to the
underdeveloped acquired immunity of young animals (Dinka et al, 2010). Furthermore, close interaction of the sucklers group with the lactating females could also be another factor leading to a higher prevalence in this age group. The results of the present study are in agreement with the findings of Tefera & Gabereah (2001), Khan et al. (2003), Brown (2004), Dinka et al. (2010) and Gakuya et al. (2012) as they also reported higher rates of disease incidence in young animals than the adult and older ones. However Megerasa et al. (2012) and Awol et al. (2014) did not observe any role of age in the disease prevalence.

5.2 Zoonotic Potential

Sarcoptes scabiei mange/mite gets transmitted to humans in close contact with infected camels, leading to intense pruritus and irritation due to a hypersensitivity reaction to the mites and their products (Vaila and Vaila, 1996). It was noted that human scabies infection is not rare in our setup, the predisposing factors being low socioeconomic conditions, overcrowding and poor hygiene (Wong et al. 2001). The animal scabies in humans should be considered as a differential diagnosis for itching dermal lesions in those who have a direct contact with animals. The lesions of the animal scabies in humans can mimic various dermatological skin diseases such as dermatitis, eczema, contact dermatitis, fungal infections and insect bites. It has been estimated that more than 300 million peoples suffer from animal scabies infestation at any one time (Taplin et al. 1991).

It was noted that due to intimate and continuous close contact of the camel riders and handlers with their camels, direct transmission from camel to man is common, resulting in the condition in man termed pseudo scabies (Schilinger, 1987). Schilinger (1987) reported that the transmission from camel to camel riders and handlers usually occur during milking, riding and coming in contact with infected fomites. Pseudo scabies is therefore seen mainly in inter digital
spaces of the hands, flexor surface of the wrists, the forearms, the elbows and axillary folds. In the case of camel riders, the lesions are mostly seen between the thighs. Once a herd has been infected, continuous reinfection occurs and this makes it difficult to assess whether the disease in man is self-limiting as for *Sarcoptic* mange transmitted from other animals to man. It is essential to treat both camel and men at the same time for the proper control of the *Sarcoptic* mange infestation.

In the present study 13% of the farmers who remained in close contact with the camels had the scabies lesions on their different body parts. The results of the present study are in close agreement with the findings of Schillinger (1987), Bornstein et al. (2002) and Al-Saad et al. (2013) who observed the development of scabies lesions in camel handlers due to *Sarcoptes* mange mite infestation. These findings are also supported by the reports of Mitra et al (1993), Walton et al. (2004), Hengge et al. (2006), Parsani et al. (2008), Al-Saad et al. (2011), Torgerson & Macpherson (2011) and Jackson & Villarroel (2012). They all reported the transmission of animal origin *Sarcoptes scabiei* mange/mites in humans, causing scabies lesions in them.

In the present study it was also noticed that the *Sarcoptes scabiei var cameli* produced the scabies lesions in the experimental rabbits when *Sarcoptes* infected morbid material was applied to them. These rabbits started developing signs of scabies which include the redness of skin and development of papules, in the third week after application of camel origin infected material. These findings are in close agreement with the findings of Baker (1956), who reported that Sarcoptes scabiei var cameli can create scabietic lesions in other animals. Flannery et al (2008), also reported that *Sarcoptes* from different origins of old world camels, Andean camels, rabbits and horses can attack mammals other than their specific hosts. Arlian et al (1984), in a study concluded that different varieties of *Sarcoptes scabiei* do have the host preference rather being
host specific. These findings are also in agreement with Zahler et al (1999), who observed that different variants of *Sarcoptes* are phenotypically different, but genotypically there exist no delimitation between the groups and no correlation with host species.

### 5.3 Haematological Profile

The camels suffering with Sarcoptic mange, *Sarcoptes scabiei var cameli* are accompanied by such activity of the body which lead to changes in the blood known as oxidative stress process. This oxidative stress further helps in the production of free radicals. The excessive production of these free radicals lead to anti-oxidative process known as oxidative stress or damage which does take place in the animals suffering from scabies resulting in molecular disruption and tissue damage (Nikki, 2009 and Mostafa et al. 2011). Different studies have shown a strong relationship between *Sarcoptic* mange infestation in different animals and oxidative stress, such as buffaloes, sheep (Dimri et al. 2008 & 2010) and dogs (Camkerton et al. 2009). Valko et al. (2007) studied the effects of mange infestation and its relation to the production of free radicals and reported that increased generation of these free radicals can result in metabolic dysfunction and bio molecular oxidative damage in the body, which can lead to certain pathological changes in the body tissues. Bickers and Athar (2006) studied the effects of cytokine and reported that cytokine production can help to excessive generation of the reactive oxidants and free radicals in the biological system leading to the physiological change process of the body known as Oxidative stress. They further reported that this Oxidative stress is not only believed as an integral part, but also a major component in the pathogenesis of skin diseases and abnormalities.

In the present study regarding haemato-biochemical profile revealed a decrease in hemoglobin, total erythrocyte count, packed cell volume, total proteins, albumins and
Discussion

Such findings showing the lower values of total proteins, albumins, Hb, TEC and PCV have already been recorded by Parmar et al. (2005), Badawy et al. (2008), Dixit et al (2009) and Premalatha et al. (2010). An increase in total leukocyte count, mixed cells, urea and different enzymes have also been revealed from this study. The observations of this study are supported by the findings of Gorakh Mal et al. (2006) and Premalatha et al. (2010) they observed similar changes in blood chemistry of mange infected camels. The post treatment Haematological and biochemical values were within the normal reference ranges to those reported elsewhere for camels by Schalm et al. (1975), Parmar et al. (2005), Al-Basudah (2007) and Premalatha et al. (2010). These Haematological changes are also in partial agreement with the findings of Dimri et al. (2007), Vishe et al. (2012) and Ogundiyi et al. (2012) they reported similar changes in the blood of buffaloes, buffalo calves and sheep & goat respectively.

5.4 Chemotherapy / Treatment of camel mange

The proliferation of opportunistic pathogens on the skin resulting in parasitic, fungal, bacterial, viral and other non-specific dermatitis, which occurs mainly due to changes in local resistance. The dermatological concerns develop when the dermatitis produced by these organisms living in or on the skin produce irritation and sensitization. External skin diseases may comprise of different types of parasites viz. ticks, mites and lice. The genus *Sarcoptes* is a group of mites, which live on the skin and causes Sarcoptic mange. This condition not only compromises the health of the animal, but also is of zoonotic importance. These diseased skin conditions remained a challenge for the healers or practitioners for centuries and in the development of independent pharmaceutical industry with a lot of research work is a continuous process to handle such diseases. Amongst the drugs which are being tried for treatment and control of mange, some have indicated drug resistance, but still a large number of new and old
drugs are being used as acaricidal medicines. Also in spite of the fact that a large number of
effective drugs against *Sarcoptic* mange, coming on the market, the possibility of getting
treatment of mange with cost effective drug preparation, which an average Pakistani farmer can
afford is yet to be explored. From a large range of the allopathic drugs being used nowadays are
mostly are advocated to be costly, one, have problems of drug resistance, many are toxic at
certain concentrations, long residual effects, some harmful to humans handling those medicines
and some of these may even contaminate the environment as well.

As against the scenario with allopathic drugs, the other side with herbal medicines, which
were traditionally under use by the local healers are again gaining significance due to their
reduced costs, ease of use and are proposed to be free from risk of harming humans handling
them as well as the hardly contaminate the environment.

The present study was designed to treat the camels affected with *Sarcoptic* mange with
herbal preparations, i.e. *Azadirachta indica* (Neem), *Nicotiana tobacum* (Tobacco / Tambaku),
*Eruca sativa* (Taramera oil) and their comparison with allopathic drugs i.e. *Ivermectin* and
*Cypermethrin*.

5.4.1 **Treatment of camel mange with Azadirachta indica (Neem)**

*Azadirachta indica* (Neem) is a plant which is in use of human beings for centuries. Its
sticks are used as tooth brush by the people with the idea that it controls different infections of
teeth and mouth. Its leaves and seeds contain Nimbinin, Nimbandiol and large quantities of
Azadirachtin. Azadirachtin is a complex tetranortriterpenoid limonoid, which has the toxic
effects for insects and parasites. It affects the neurosecretory system of the brain, which further
blocks the release of morphogenetic peptide hormones. Furthermore the Azadirachtin is taken up
into the cells, which cause inhibition of both cell division & protein synthesis. It leads to
Discussion

paralysis of muscles, mid gut cells necrosis and loss of regenerative cells of the gut and stoppage in mid gut enzyme production of the parasites or insects (Mordue & Nisbet, 2000). This unique way of action of *Azadirachta indica* makes it a plant of choice for scientists as acaricidal or anti-parasitic one for formulation of different preparations.

*Azadirachta indica* (Neem) was applied topically to a group of camels comprising of 20 animals. The said group was further divided into two subgroups with 10 animals in each and two different concentrations, i.e. 20% and 40% solutions were used independently for each subgroup, so as to study the effect of different concentration levels. The treatment to the diseased camels was provided on day zero and 15, whereas skin scrapings were examined on day zero, 15, 30 and 45. The efficacy of 20% concentration based on the results of skin scrapings revealed 26.66%, 53.33% and 66.66% recovery on day 15, 30 and 45 respectively, whereas the efficacy of 40% *Azadirachta indica* (Neem) solution was observed at 34.48%, 62.06% and 75.86% for the same period / days of study, respectively. The results of the present study are nearly similar to those of Chopra & Chopra (1955), Chopra et al. (1955), Koul et al. (1990), Mordue & Blackwell (1993), Sivarajan & Balachandran (1994), Gillar & Mathews (1995), Dakshinkar & Sarode (1997), Nadkarni (2000), Sharma & Joshi (2004) and Tabassum et al. (2008). They reported that *Azadirachta indica* (Neem) seed & leaf oil possess insecticidal and anti-parasitic properties. It is being used for the treatment of foul ulcers, eczema and skin diseases like scabies, ringworm and mange in animals. The present results regarding effect of *Azadirachta indica* (Neem) against mangy scabies are also in agreement with the findings of Charles & Charles (1992), Walton & Currie (2007), Abdel-Ghaffar & Al-Quraishy (2008) and Seddiek et al. (2013) who reported similar anti-parasitic effect of *Azadirachta indica* (Neem) against *Sarcoptes scabiei* infestations in different animals and human beings.
5.4.2 Treatment of camel mange with *Nicotiana tobacum* (Tobacco / Tambaku)

*Nicotiana tobacum* (Tobacco / Tambaku) is a small leafy plant grown in almost all the continents of the world. The maximum quantity of Tobacco is used by the people being smokers either as raw or in processed form. Tobacco plant contains a large number of phytochemicals, which include nicotine, anatabine, anabasine and propionic acid. Nicotine is a major content which is mainly found in the leaves followed by stem, roots and flowers. Tobacco is traditionally in use by the people for different purposes in different parts of the world. Its main uses are, to induce vomiting, to treat the infected wounds, to destroy the worms in sores, to treat the different skin diseases and as insecticide & pesticide (Lans & Turner, 2011). In addition to above, the use of tobacco as antiparasitic especially against scabies has also been documented in different countries (Bullitta et al. 2007 and Babar et al. 2011). In the present study two different concentrations (20% & 40% w/v) from tobacco leaves were prepared and used in camels for the treatment of scabies.

*Nicotiana tobacum* (Tobacco / Tambaku) mixed in water was applied topically to a group of 20 camels at two different concentrations, i.e. 20% & 40% by dividing them into equal subgroups of 10 animals in each. Both the subgroups were provided with the treatment on day zero and 15 with the respective concentrations. The efficacy of 20% concentration of *Nicotiana tobacum* (Tobacco / Tambaku) was observed as 28.48% on day 15, 57.14% on day 30 and 71.42% on day 45 of post treatment. The efficacy of 40% solution of *Nicotiana tobacum* (Tobacco / Tambaku) was found as 32.25% on day 15, 61.29% on day 30 and 77.41% on day 45 of the treatment. The results of the present study are closely related to Sharma & Dwivedi (1990), Nadkarni (2000) and Sharma & Joshi (2004). They reported that *Nicotiana tobacum* contain Nicotine Salycylate which is very effective for certain skin diseases. Decoration of
tambaku / tobacco is applied locally to relieve pain, irritation in swellings, syphilitic nodes and other skin diseases and to reduce orchitis problem in certain cases. These results are also in close similarity with Habib et al. (2006) who observed similar findings while Sarcoptic mange infested dogs.

5.4.3 Treatment of camel mange with *Eruca sativa* (Taramera oil)

*Eruca sativa (Taramera oil)* has been in use since centuries as an insecticide for the destruction of lice infestation. Its dry seeds are used for killing pediculi and powdered kernel for washing of hairs. The leaves of *Eruca sativa* (Taramera oil) are boiled in water for hours to form a paste, which is also used after mixing with honey to treat the pustules, boils, ulcers and other skin diseases. Phytochemical analysis with the help of gas chromatography revealed the presence of Erucic acid (51.2%), Oleic acid (15.1%), Cis-II-eicosenoic acid (12.5%) and low quantities of essential and non-essential fatty acids. Furthermore, it also contains higher contents of antibacterial (MIC Values) as compared with gentamycin. The specific chemical composition of *Eruca sativa* (Taramera oil) or seeds supports its use as a traditional medicine in various disorders in human or animal health (Gulfraz et al. 2011). Its oil and cake are used in the feed of animals to keep them healthy and is cultivated in the subcontinent, Far East and Arab countries. In the present study, the paste with two different concentrations of taramera oil was prepared by mixing it with other herbs and chemicals for treatment of Sarcoptic mange in camels.

The Taramera oil mixture as a paste was applied topically to 20 camels at two different concentrations, i.e. 40% and 60% on day zero and 15 of the treatment studies, by using one level of concentration to a subgroup of 10 animals. The efficacy of both the levels of concentrations was evaluated at day 15th, 30th and 45th from the first treatment. The efficacy of 40% taramera oil mixture was observed at 31%, 58.62% and 72.41% for day 15, 30 and 45 respectively, whereas
the performance of 60% concentration for the same tenure of days showed 35.71%, 67.85% and 78.57% efficacy respectively. These efficacy findings are similar to the results which were reported by Kirtikar & Basu (1933), Chopra & Chopra (1955) Rathore (1971), Giller & Mathews (1995), Nadkarni (2000), and Dixit et al. (2009). However, these results are not in agreement with the findings of Parsani et al. (2008), who observed its use not only as less encouraging, but also time and labor consuming one for the treatment of mange infestations.

5.4.4 Treatment of camel mange with *Ivermectin* (Ivomec)

*Ivermectin* is a synthetic product of Avermectins which are in use as antiparasitic drug since 1981. The parasites, especially the arthropods do have Gamma-amino-butyric acid (GABA) a neurotransmitter substance for transmission of inhibitory signals from interneurons to motor neurons in their nerve cord. *Ivermectin* acts as a GABA enhancer so as more GABA substance is released. *Ivermectin* is also known for its long stay in body fat and reducing the nervous functions of cells. Arthropods utilize the GABA, resulting in neuromuscular blockade, leading to the paralysis and death of the parasite. Besides its action of causing paralysis in parasites, it also suppresses the reproductive functions of the affected parasites. Accordingly, it is reported as highly effective against different parasites, especially the *Sarcoptes*. In the present study 1% *Ivermectin* was used at dose rate of 0.2mg/kg bw.

*Ivermectin* (Ivomec) was injected subcutaneously to 20 camels of group D at the rate of 0.2mg/kg body weight. Out of these 20 camels, five were found completely recovered from the disease by day 15 with a just single dose of medicine as the skin scrapings of these five animals were negative and the overall efficacy of the drug was observed as 43.33%. The second dose of *Ivermectin* was injected on day 15 and the efficacy of *Ivermectin* recorded on day 30 and 45 which was found to be 80% and 96.66% respectively. Thirteen (13) camels became negative for
disease by day 30 and eighteen (18) by day 45 as no mites or their larval stages were seen in the
skin scrapings examined microscopically. It was also noted that with the disappearance of
mange/mites, the animal’s health improved, their skin conditions, i.e. itching, irritation reduced
and restlessness was not observed in any of the treated cases. Similar efficacy of Ivermectin
against Sarcoptic mange has been observed by Hashim & Wasfi (1986), Hassan et al. (1989),
Njanja (1991), Paradis (1998), Abu-Samra (1999), Geurden et al. (2003), Kumar et al. (2005),
(2009) and Bornstein (2010) also observed similar effects of Ivermectin against Sarcoptic mange
in South American Camels (SAC). Similar results have also been observed by Chosidow (2000),
Cestari & Martignago (2005), Assen et al. (2005) and Khan et al. (2013) they found Ivermectin
as the most effective treatment of Sarcoptic scabies in humans and other animals. In addition to
effective efficacy, this drug did not show any adverse effect on the treated camels. This is in
agreement with Hashim & Wasfi (1986) and Njanja et al. (1991) who also did not observe any
adverse action as its side effect. Jasmer & Gill (1987), Maqbool et al. (1992), Bates (1994), Irfan
et al. (2003), Omura (2008) and Deger & Ural (2013) also did not observe any adverse action of
Ivermectin while treating different animals including dogs and sheep.

Ivermectin therapy, although expensive, has distinct advantages over topical therapy with
acaricides. First, it is easy to administer as an injection or oral paste and secondly, it is a
thorough treatment because the drug penetrates all layers of the skin affecting the mites and the
eggs laid in the tunnels. Hashim & Wasfi (1986) did not observe any adverse effect of Ivermectin
in pregnant and lactating camels. In some cases pruritus subsided within one to two weeks and
live mites were not found by three weeks after the second treatment. In some cases the skin may
be profoundly damaged by mites compounded by secondary infection and many weeks may be needed for full recovery even in the absence of mites.

5.4.5 Treatment of camel mange with *Cypermethrin* (Ecoflee)

*Cypermethrin* is a synthetic class II pyrethroid pesticide used for control of insects. It crosses the blood brain barriers and induces neurotoxicity & motor deficits, which lead to hyper-excitation of central nervous system (CNS). The involvement of central nervous system helps DNA damage and oxidative stress in neuronal cells of parasites. The oxidative stress and DNA damage lead to Neuro degeneration or neuro muscular paralysis and death of insects or parasites.

*Cypermethrin* (Ecoflee) was applied topically to 20 camels of group E at the rate of 1ml / liters of water on day zero and repeated on day 15. Four animals showed complete recovery by day 15, whereas 16 camels were found completely recovered from the disease on the basis of negative skin scrapings for live mites or their larval stages, by day 45 of the treatment. The efficacy of *Cypermethrin* was recorded as 35.48% on day 15 and 74.19% on day 30 of post treatment. At the end of study by day 45, the drug exhibited 90.32 percent efficacy. The results of the present study were in close agreement with the findings of Rahbari et al (2009) who reported similar results while treating *Sarcoptic* mange. The findings of this study do also have the similarity with the findings of Mitra et al. (1995), Habib et al. (2006), Irfan et al. (2003) who observed similar findings by using the *Cypermethrin* with the same concentration while treating the *Sarcoptic* mange in dogs and other animals. These results are also in agreement with the reports of Kumar & Suryanarayana (2004) and Basheir et al. (2012) they have reported that *Cypermethrin* in combination *Ivermectin* produced the best results in treating the *Sarcoptic* mange infested donkeys and buffaloes respectively. However, these findings are not in agreement with Al-Saad et al. (2000) who reported that the performance of *Cypermethrin* was
lower than Diazinon and Lindane in treating the *Sarcoptic* mange in camels. There was no apparent adverse reaction to treatment in the current study. This confirms that the product would be safe even when used at an interval of 15 days.

It was noted that all the camels treated with different anti scabies drugs improved both clinically as well as health wise, whereas the camels of the control group did not show any improvement. The difference in clinical improvement was highly significant (p < 0.001). The camels in the miticides groups gained more weight than the control and also showed healthy and shiny look. All treated camels were returned to clinical normality and did not require additional therapy. However the camels of control group (Positive for mange) were treated at the end of trials.
CHAPTER 6
SUMMARY

Camel is an important animal of large ruminants group being hard in nature as it can survive in extreme harsh climatic conditions, especially those of deserts, rain fed and arid zones of the world. These extreme and adverse climatic conditions expose the camels to different parasitic infestations of which mange has its significance as it affects the health and production of animals. Keeping in view the importance of the problem, the present study was designed to ascertain prevalence of mange in camel population of Punjab (Pakistan), its zoonotic potential, effect on animal health and to evaluate different allopathic and herbal drugs for its treatment. This study consists of four parts.

First part of the study deals with the epidemiology of *Sarcoptic* mange in camels of Punjab, a province of Pakistan. Epidemiological study was undertaken for whole one year in the camel populations of the province of Punjab. The overall infestation rate was 11.28%. The highest (25.89%) month wise prevalence was noted in the month of February, while the lowest (0%) was reported during June and July. The highest (20.43%) prevalence was noticed during winter, followed by spring (13.55%), then autumn (6.34%) and the lowest (1.47%) during summer. It was also observed that mange infestation was highest in camels under 2 years of age (13.08%), followed by camels from 2-5 years of age (12.25%), whereas the lowest (10.05%) in camels above five years of age. As regard the sex wise prevalence of mange infestation, it was higher (13.05%) in females than males (10.19%). The role of different meteorological factors on the occurrence of disease was also analyzed which showed that the disease had an increasing trend with the increase of humidity and with the decrease of rain fall and temperature.
Part-II deals with the zoonotic potential of the disease. It was noticed that camel mange “*Sarcoptes scabiei var cameli***” has the ability of cross infectivity as it infected the rabbits when morbid material was applied to them. Furthermore scabietic lesions with identification of camel mange were also observed with the human beings, the camel handlers.

Third part of the study pertains to the effects of mange infestation on the Hematobiochemical parameters of camels. Lower values of hemoglobin, total erythrocyte count, packed cell volume, total proteins, serum albumins and electrolytes i.e. Potassium, Calcium, Magnesium & Sodium were observed in the camels suffering from mange infestation. However, total leukocyte count, lymphocytes, eosinophils, urea and the levels of AST, ALT and LDH were found on the higher side in the diseased camels. After treatment of mange infected camels with different drugs the values of all these blood parameters returned close to normality or healthy camels.

Part-IV deals with the therapeutic trials against *Sarcoptic* mange in camels. For this purpose a total of 120 camels were used in 9 controlled experiments to compare the efficacy of certain indigenous drugs including *Azadirachta indica* (Neem), *Nicotiana tobacum* (Tobacco), *Eruca sativa* (Taramera oil) and allopathic drugs which includes *Ivermectin* (Ivomec) and *Cypermethrin* (Ecoflee). Efficacy was quantified by the absence of different stages of mites or eggs in skin scrapings along with disappearance of lesions including smoothness of skin. Efficacy of 20% *Azadirachta indica* (Neem) on 45th day was 66.66% and 40% was 75.86% respectively. The efficacy of *Nicotiana tobacum* (Tobacco) at concentration of 20% and 40% was 71.42 and 77.41 percent respectively. The efficacy of *Eruca sativa* (Taramera oil) at concentration of 40% & 60% was 72.41 and 78.57 percent respectively. Efficacy of *Ivermectin* at 0.2mg/kg body weight was 96.66%, whereas the efficacy of *Cypermethrin* was 90.32 percent.
RECOMMENDATIONS

- Campaign for farmer’s awareness through a continuous education program about the importance of the disease with special reference to production & economic loss due to disease, its treatment, control, management practices, human health hazards and way forward for the betterment should be launched at a government as well as non-government organizations (NGO’s) level so as to improve the life of poverty ridden livestock farmers raising the camels in harsh climatic conditions.

- The disease control program activities at the farmer’s level should be a regular feature of concerned organizations, to save the poor livestock farmers from the socioeconomic losses due to such diseases which are of great importance but neglected one.
CHAPTER 7
LITERATURE CITED


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