I. INTRODUCTION

Pigeons are unique birds found everywhere in and around the human settlements throughout the world. They are very social creatures which have a hierarchical system of social structure in the colony and an association with man who has been rearing them as pets or messengers or as the source of meat and eggs. Since pigeons are beautiful to look in their clear white colour with attractive markings, many people have kept these birds in confines in the houses or gardens as a hobby to enhance the esthetic values of their sites, which of course urges the people to engage in pigeon keeping to spend their spare times and in the meantime to earn some money in their residences themselves. Besides this, the domestic pigeons have also been used in bird racing as a mode of public entertainment, in sending messages to known persons in remote areas as mail-delivery boys do and in meat production as in poultry keeping for several centuries. Because of these utilities, many commercial enterprises have come forward to support the pigeon keepers, especially for providing breeding stocks, assisting in pigeon breeding, feeding the pigeons with healthy feeds and tonics, prevention and control of diseases to maintain healthy birds and for selling the birds either as young ones or adult couples or as meat.

Fancy pigeons are domesticated varieties of *Columba livia* that have desired size, shape, attractive colours, markings and plumages attracting the pigeon fanciers. There are over 300 varieties of fancy pigeons that occupy a great place in pigeon shows aiming at bringing all the pigeon fanciers together for the show and at exhibiting all the varieties to fanciers who can buy and sell their breeds to other. Researchers have felt that if a pair of eggs from the nest of a pigeon are placed under
a domestic pigeon that has been sitting the same length of time as the birds from which the eggs were taken, the latter will produce a pair of domestic pigeons since the young ones are being well attached to their home (Lyell, 1981). Unlike the gallinaceous birds which are hatching at very perfect state that allows the young ones to follow the parents within a few hours after hatching, young ones of pigeons are born in an immature and helpless condition, so that they need to be fed with a curdy secretion, produced in the crops of the parents, as the "baby food" (Davies, 1939).

It is believed that all the fancy pigeons had originated from the Rock pigeon (Columba livia Gmelin.) which is a slaty-grey bird somewhat smaller than the house crow (Salim Ali, 1941) and is widely distributed in Europe, Asia and North America, India, Pakistan, Sri Lanka and Burma (Baker and Inglish, 1928). The fancy breed “Tailor” was first introduced as a new pigeon breed in a Canadian Pigeon Show conducted in 1655 and then the name “Lahore pigeon” was substituted for Tailor in 1858 by Eaton since there were many wild relatives in Lahore region of Pakistan (Lyell, 1981). Now that Lahore pigeons include several subtypes that have been popular fancy pigeons in India and other countries.

1.1. Risks of Commercial Pigeon Keeping

Success of pigeon keeping depends on the maintenance of proper health and immunity of pigeons by providing suitable feeds, supplements and vaccines in time and by providing required hygienic conditions to the lofts. Commercial pigeon keeping is in fact not at all a simple and easy task to the people and even to the commercial enterprises because of the frequent outbreaks of infections which weaken the health and productivity of birds to a considerable extent and which most often lead to heavy mortality in lofts. Healthy birds grow fast and produce more number of
squabs in a year compared to weak birds. Therefore, maintenance of good heath of pigeons is the matter of primary importance in pigeon keeping and it can only be achieved by providing nutritious feeds and suitable feed supplements to the pigeons.

Summer (1899) in his manual on “Diseases of Pigeons” described that pigeons have been affected by roup, scrofula, blight, vertigo, swelling of neck (Empysema), gout, fungoid (smallpox), bronchitis, pneumonia, apoplexy, suppression of feathers, spouts, rheumatism, enteritis, influenza, egg-bound, congestion of liver, enlargement of liver, inflammation of liver, inflammation of egg passage, gorging, shivering, anaemia, gastritis, congestion of lungs, crop diseases, moping, canker in throat, cholera, intestinal worms, diphtheria, wing paralysis, going light, canker in ear, sour crop, crop bound, leg weakness, prolapsus anal, tumours, broken bones and wounds. Later on Coccidiosis, ornithosis, Mycoplasmosis, paratyphoid fever and Newcastle disease were discovered in pigeons in the second half of the 20th century. Incidence of these diseases would be very low in lofts if the pigeons are provided with suitable organic supplements that serve as dietetic components as well as immunomodulatory compounds. The immune modulatory compound/s in the supplement tones up the innate immunity of pigeons by stimulating the production and maturation of lymphocytes taking part in the formation of immune cells, antibodies and immune regulatory proteins (Jacquin et al., 2012).

Antibiotic therapy in fact gives much protection to pigeons against germs, but it has been proved in poultry and veterinary animals that several pathogens have developed resistance against the target antibiotic being preferred to cure the disease. Therefore, several attempts have been taken to make use of certain organic products
as dietary supplements for animals to enhance their growth and reproductive performances, and to enhance the innate immunity of the animals that gives first hand protection to the animals against the invading pathogens.

Proper nutritional management is therefore very important for keeping quality pigeons in the lofts to increase their growth and reproductive performances. In this line of investigations, the effect of yeast supplements, *Lactobacillus fermentum* and neem leaf powder on growth and reproduction of pigeons was already investigated. This dissertation attempts to analyze the dietary effects of a probiotic, herbal powder and powder of a marine brown alga on the growth and reproductive characteristics of Lahore pigeons.

1.2. Probiotics

Probiotics are health-promoting bacteria which make up a balance in the microcosm of intestinal microflora by selectively suppressing the harmful bacteria whose abundance most often cause intestinal problems and even serious diseases too (Jin *et al.*, 1997; Kabir, 2009). It is also established that probiotics prevent the colonization of the harmful-bacteria by competing with the disease causing germs for their attachment on the intestinal wall, and that they detoxify compounds in the diet, improve digestion, supply vitamins, improve the microenvironment inside the intestine and improve the immunity of birds against the infectious diseases. At present vinegar and fermenting foods containing various bacterial species, dried bacterial preparations and yeast biomass are used as probiotics for birds and veterinary animals. In Canada, veterinarians are of the opinion that if probiotics are given to pigeon, the birds would be resistant to some diseases and they would be healthy for
racing and breeding. No available report reveals the dietary use of *Lactobacillus acidophilus* to pigeons, so that it is chosen as a probiotic for this study.

### 1.3. Herbal Powders

Administration of herbal powders or extracts at various concentrations through food enhances the growth and reproductive performances of fishes, birds and animals (Pandey Govind *et al.*, 2012; Evans *et al.*, 2000) and at the same time enhances their innate and adaptive immune responses which have been supplementary preventive measures for the currently available sanitary prophylaxis, disinfection, vaccines, and chemotherapy being used in fishes, shrimps, birds and veterinary animals (ADB/NACA 1991; Dechamag, 2006). The Poland based pharmaceutical company HapLabs has been marketing some herbal products manufactured from medicinal herbs available in the country to boost up the growth and other attributes of pigeon (www.haplabs.com). Although there are about 760 medicinal plants in India, only about 100 plants have been put in common use for their medicinal properties and their roles in immune modulation have not been described in books on Indian medicines. In the Indian systems of medicine, about 37 species of plants are experimentally proved for their immunostimulatory properties in aquatic fishes, animals, birds and man (Sunil Kumar *et al.*, 2011; Mukesh Kumar Bairwa *et al.*, 2012). These plants and their by-products are preferred since they contain several phenolic, polyphenolic, alkaloid, quinone, terpenoid, lectine, and polypeptide compounds, some of which have been shown to be very effective alternatives to antibiotics, chemicals, vaccines, and other synthetic compounds for inducing non-specific immune response and the growth and reproductive attributes of the aquatic animals (Sajid Maqsood *et al.*, 2011). Although there have been many works investigating the active principles in
plants and their medicinal properties to treat the diseases of rat, mice, goat, sheep, cattle, pigs, aquaculture animals, poultry and humans, there is little work on the effectiveness of Indian herbals as dietary supplements to pigeons. The Indian medicinal herb *Andrographis paniculata* is chosen to test its suitability for using as a feed supplement to pigeon.

**1.4. Powder of Marine Algae**

Marine algae such as *Laminaria, Gracillaria, Ulva, Endarachne, Gelliodes, Sargassum, Phaeodactylum*, etc contain the oligosaccharide beta-glucans and various secondary metabolites like cyclic depsipeptide, terpenes, polysaccharides (uronic acids, sulphates), polyhydroxylated lactone, bioglycan, cyclic tripeptide, macrocyclic lactones *etc.*, which have growth promoting effects in birds, fishes, animals, and humans (El-Deck *et al.*, 1987 & 2009). It is believed that they have been exerting a wide range of immunomodulating activity to protect the host animal from the invading pathogens by macrophages which engulf the bacteria and viruses to destroy them in the blood and lymph nodes (Klasing and Leshchinsky, 1999). There has hardly been any research work on the growth and reproductive response of pigeons due to the dietary effect of marine algae. *Sargassum wightii* is a marine brown alga that improves the growth and reproductive attributes of fowls, ducks, shrimps and fishes, and elicits the immune response of the birds and animals. There has hardly been any work on the dietary effects of *Sargassum wightii* on pigeons, and hence it is chosen as a supplement to pigeons.
1.5. Research Problem

Pigeon growers have experienced a heavy loss every year due to high mortality of nestlings and adult pigeons in the lofts because of the sudden outbreak of infectious diseases and due to low productive performance of pigeons because of insufficient nutrients in the food stuffs. It is proved that nutritious foods, vitamins and salt mix and vaccines would possibly improve the health and productive performance of pigeon. For pigeons, several food grains and pulse types have been used, either singly or in combinations, as basic feeds, but the productive performance is poor because of inadequate amount of some minerals and essential amino acids in the feed mixture. The growth and productive efficiencies of pigeons can be improved successfully by providing suitable supplements that can supply the required minerals, methionine, cystine and lysine to the birds. Further, while enhancing the productive performance of animals, the feed supplements modulate their immune system to activate the innate immunity to prevent infectious diseases. Yeast supplementation was already proved to be successful in improving the growth and reproductive performance of pigeons. From the perusal of literatures, it is obvious that the dietary effects of *Lactobacillus acidophilus*, *Andrographis paniculata* and *Sargassum wightii* supplementation on pigeons have hardly been investigated scientifically. Hence, the present study was undertaken to know the effects of *L. acidophilus*, *A. paniculata* and *S. wightii* on the growth and reproductive performances of domestic pigeons and associated immunomodulations.
1.6. Objectives of this Research

The various objectives contemplated to the present investigation include the following:-

(1) To study the growth performance of pigeons in response to different dosages of *L. acidophilus, A. paniculata* and *S. wightii*.

(2) To find out the feed intake and feed conversion rate of pigeons in response to different dosages of *L. acidophilus, A. paniculata* and *S. wightii*.

(3) To understand the effects of the long-term feeding of different doses of *L. acidophilus, A. paniculata* and *S. wightii* on the reproductive characteristics of pigeons.

(4) To know the changes in the proteins and lipid levels in the serum of pigeons fed with *L. acidophilus, A. paniculata* and *S. wightii*.

(5) To find out the modulation in the production of blood cells while feeding the pigeons with *L. acidophilus, A. paniculata* and *S. wightii*.

(6) To determine the most suitable feed supplement among the three that can be recommended as the best feed supplement for pigeons.