Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

**E-ISSN:** 2278-4136
**P-ISSN:** 2349-8234
www.phytojournal.com
JPP 2022; 11(1): 204-207
Received: 25-11-2021
Accepted: 27-12-2021

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# Comparative susceptibility of commercial broiler and Vanraja chicken to *Salmonella enterica* subsp. *enterica serovars Gallinarum* infection with ameliorative effect of *Allium sativum* (Garlic)

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## Abstract
The present experiment was conducted for 35 days, aimed to investigate the susceptibility of commercial Broiler and Vanraja chicken to Salmonella enterica subsp. enterica serovars Gallinarum infection with supplementation garlic. A total of 160 (80 vanraja and 80 broiler), day old chicks were procured from private local hatcheries (Srinagar). 20 birds each of both vanaraja and broiler were put into four cages and labelled as Control, Control Garlic, Infected and Infected Supplemented with Garlic. Infection was given to infected and infected supplemented with garlic given I/P with 0.2 ml suspension *Salmonella gallinarum* containing $2.08\times10^9$ CFU. Clinical signs along with the mortality pattern was recorded in both vanraja and broiler chickens in all the four groups. Daily observations were made in all the four groups in both vanraja and broiler chickens. There was no clinical signs and mortality observed in both control and garlic control group. There was significant increase in mortality in broiler infected with *S. gallinarum* than in vanraja infected group, while as mortality was more in infection supplemented with garlic in broiler birds than in vanraja supplemented with garlic. The study concluded that garlic could be effectively used in both broilers and vanraja feeding to replace antibiotic as a growth promoter.

**Keywords:** broiler, vanraja, *Allium sativum*

## Introduction
Salmonellosis is a big socioeconomic threat worldwide that causes considerable mortality and morbidity in both humans and animals (Smith *et al*, 2016) [29] The gastrointestinal (GI) tract of newly hatched chickens is usually sterile and presents an empty ecological niche that provides easy access for the pathogen to colonize with limited restriction making them highly susceptible to enteric bacterial infections, such as Salmonella (Crhanova M. *et al* 2011) [4]. Among poultry diseases *Salmonella* is a leading cause of food borne illness worldwide with an estimated annual economic loss of 3.7 billion dollar (Hafiz *et al*. 2017) [13]. Although diseases due to this pathogen have been associated with a wide variety of food sources, poultry, in particular, have been regarded as the single largest cause of human salmonellosis (Gould *et al* 2013) [10]. Salmonellae infecting poultry are *S. Gallinarum*: *major avian serotype* in india (Prakash *et al*., 2005) [25], *S. pullorum, S. typhimurium, S. entertitidis.* Fowl typhoid a septicemic disease caused by *Salmonella enterica* subsp. *enterica serovar Gallinarum* is widely distributed throughout the world, affects all age groups of chicken (Priyantha 2012) [26] It is a major avian serotype responsible for immense economic losses due to morbidity and mortality. Many synthetic drugs and growth promoters are supplemented to the broilers to effect rapid growth, but their use have shown many disadvantages like high cost, adverse side effect on health of birds and long residual properties etc. So, scientists are again concentrating on the use of our ancient medicinal system to find beneficial herbs and plants, which can be safely used to increase the production and control various disease. Herbal medicines have always been a form of therapy for livestock among poor small holder farmers. There is, however, little documentation of the use of ethno veterinary medicines, as many researchers and health practitioners view these practices as backward Documentation of herbal plants is necessary because they are likely to be more important in the future, especially given the escalating costs of drugs and the focus on organic products in most developing countries. One of the very important herbs used Spices like Garlic (*Allium sativum*) are well known for their dietary and medicinal value. The precursor of allicin, which is hydrolysed by enzyme allinase after crushing to its active form, the allicin (S-allyl-2-propenthiosulphinate).

Allicin the most potentially active component of garlic is responsible for its biological properties (Heinrich *et al*., 2004) [14]. Freshly crushed garlic contains allicin, alliin, ajoene, diallylsulfide, dithiin, S-allylcysteine. Garlic (*Allium sativum*) has been reported to possess useful pharmacological substances (Akhtar *et al* 1984) [1]. Garlic as natural feed additive in poultry nutrition may be of great benefit and value especially for broiler growers. This is due to its antibacterial, anti-inflammatory, antiseptic, anti-parasitic and immunomodulatory properties of garlic. The flavonoids present in *Allium sativum exhibits* bacteriostatic and bacteriocidal effects on some strains of bacteria by inhibiting the reverse transcriptase and proteases activity in bacteria. (Gazuwa *et al*; 2003) [9].

**Materials and Methods**

A total, 120 (80 commercial broilers and 80 vanraja birds were equally divided ie 20 birds each into four groups, control, garlic control, Infection and Infection supplemeted with garlic @ 176 mg /Kg b/w in their feed. The chicks were reared on cage system under standard management practice though out the experimental period of 35 days. Starter feed was given upto two weeks and finisher ration was fed ad libtum from third to fifth week to both control and treatment groups. Birds were checked for clinical signs and mortality from 0 days post infection during 5 weeks of experimental period. The collected data was stastically analyzed as per procedure given by Snedecor and Cochran (1967).

**Results and Discussion**

The observations for clinical signs in both vanraja and broiler birds in all four groups, Control, Garlic, Infection and infection supplemented with garlic were noted. No clinical signs were observed in the Vanraja or Broiler chickens from control and garlic throughout the course of study.

In Vanraja birds, clinical signs in both infection and garlic supplemented infection groups appeared from day-1 PI. The birds appeared dull and depressed, and huddled along the front wall of the cage. In the infection group, 13 (65%) birds reluctant to move and stood with sunken head with ruffled feathers. The severity appeared to increase on day-2 and 3 PI. Loss of appetite was evident in all the birds but majority started feeding from day-5PI. However, from day-5 PI and during 2nd week PI majority of the birds exhibited increased thirst, and typical loose greenish- yellow diarrhoea. Recovery was evident from day-14 onwards. Birds dead during the study period showed severely ruffled feathers and drooping of wings, before death. Similar changes were observed in birds from garlic supplemented infection group but the signs were comparatively less severe on day-1. Moderate to severe dullness and depression were observed in 9 (45%) birds which exhibited huddling, where as others exhibited milder symptoms and infrequently moved away from other birds. Increase in water intake was noticed in all birds during the second week. Greenish diarrhoea was observed in only few birds. Recovery was markedly evident after 2nd week PI.

The clinical signs in this infection and garlic supplemented infection groups of broiler birds were seen within 12 to 15 hours following infection. In the infection group, all the birds appeared dull, depressed, and huddled together. Moderate to severe depression with ruffled feathers, drooping of wings and reluctance to move or feed was observed in 11 (55%) birds. From day-3 PI, 13 (65%) birds exhibited increased thirst and greenish-yellow diarrhoea. Although the severity of disease decreased progressively especially from day-14 PI, but some birds continued to show milder symptoms till day-21 PI. Birds dead early during the course of study showed severe depression, stood with sunken head and closed eyes with markedly ruffled feathers and drooping wings and did not move even when forced to do so. Nature and progression of the disease in garlic supplemented infection group was comparable to that in infection group with all the birds exhibiting dullness, depression, fever and huddling together. On day-2 PI, 7 birds showed severe symptoms with ruffling of feathers, drooping of wings and reluctance to move or feed. From day-4 to 14 PI, 14 (70%) birds exhibited increased thirst and greenish-yellow diarrhoea. Recovery was evident after day-14 PI. The birds dead during the course of study exhibited severe depression, complete inappetance, reluctance to move with sunken head and closed eyes, droopy wings, and ruffled feathers before death.

Comparatively analysis of Vanraja and broiler chickens revealed that the nature and progression of clinical disease was similar in both types of birds. However, the symptoms appeared earlier and were comparatively more severe in broiler chickens. Also, relative percentage of birds showing more severe symptoms was more in broilers. Also recovery started comparatively earlier in Vanraja birds.

**Mortality**

The number of birds that died in different experimental groups at various intervals of infection is given in Table-2 and graphically depicted in Fig. 1 and 2.

A perusal of this table reveals that no mortality was seen in uninfected birds of control and garlic groups from either Vanraja or broiler chickens.

Total mortality observed, during the period of study, in Vanraja birds was 25% (5/20) in the infection group and 20% (4/20) in garlic supplemented infection group with one bird each dead on day-1, 3, 5, 12 and 14, and day-2, 5, 6 and 16 in the two groups, respectively. Although, mortality was first recorded in Infection group, maximum mortality (3 in each group) in both the groups was noticed during first week following infection as shown in (Fig 1,2)

Total mortality observed, during the period of study, in broiler chickens was 35% (7/20) in the infection group and 25% (5/20) in garlic supplemented infection group. Mortality in both the groups started on day-1 PI. Maximum mortality in the infection group was noticed on days-2 and 3, with 2 birds dead on either day. Also, out of a total of 7 mortalities, 5 died during the first week following infection. In garlic supplemented group 3 out of a total of 5 mortalities were noticed during first week following infection where as two birds died during the 3rd week post infection (day-16 PI) as shown in Fig (1 and 2)

Comparative analysis of the mortality pattern in Vanraja and broiler chickens revealed that mortality in general was lower in Vanraja chickens. However, maximum mortality in both Vanraja and broiler chickens was observed during first week post infection. The overall ratio of mortalities in Vanraja vs broiler chickens was 5:7 in infection group and 4:5 in garlic supplemented infection group. The ratio of mortalities during first week was 3:5 and 1:1 in infection and garlic supplemented infection groups, respectively. In present study both Vanaraja and Broiler chickens were found susceptible to *Salmonella gallinarum* infection, and the nature and progression of clinical disease was similar in both types of chickens. Salmonellosis is one of the important disease problems in poultry affecting commercial broiler and layer chicken globally. *S.* Gallinarum causes systemic disease, fowl typhoid, affecting all age groups causing heavy morbidity and mortality (Geetha and Palanivel, 2018; Sreekantapuram *et al.*, 2021) [11, 31]. Varying prevalence rates have been reported among broiler farms (Arora *et al.*, 2015; El-Sharkawy *et al.*, 2017; Jibril *et al.*, 2020) [2, 7, 17]. High rearing density and production stress has been frequently incriminated as a cause for higher susceptibility of the commercial chicken (Machado Junior *et al.*, 2020) [22]. In contrast, the native chicken traditionally reared in backyards or range are continuously exposed to pathogens and ambient conditions (Ayala *et al.*, 2020) [3], but are considered more resistant to infection or development of more severe clinical disease (Kannaki *et al.*, 2021) [19]. Vanaraja are the improved chickens for backyards. Although well adapted to backyard (Singh *et al.*, 2019) [28], *Salmonella gallinarum* infection has been reported under natural conditions (Dey *et al.*, 2016; Pal *et al.*, 2017) [6, 24]. However, during current study, the symptoms appeared earlier and were comparatively more severe in broiler chickens. Also, the relative percentage of birds showing more severe symptoms was more in broilers as well as recovery started comparatively earlier in Vanaraja birds. Vanaraja birds have been observed to exhibit better resistance against *Escherchia coli* infection, and a more potent humoral and cell mediated immune response when compared with broiler chicken. However, the resistance has been found to be lower than native breeds (Reddy *et al.*, 2002; De *et al.*, 2013) [27, 5]. Resistance to disease in chicken has been genetically mapped to different quantitative trait loci (QTLs) which interact with environment determines immunopathological response to infections (Jie and Liu, 2011;). Differential expression of these genes in different chicken breeds/ types have been associated with the varied response to *Salmonella* infection (Hu *et al.*, 2016).

Maximum mortality in both Vanaraja and broiler chickens was observed during first week

post infection. *Salmonella gallinarum* causes acute septicaemic disease with mortality ranging from 10% to 90%. Maximum mortality due to *Salmonella gallinarum* has been observed during 1-2 week aged birds (Kumari *et al.*, 2013) [21]. *Salmonella* being an intracellular pathogen with the virulence genes facilitating its adaptation and growth in modified endosomes of macrophages. The activation of phagocytes for bactericidal activity is IFN-γ dependent. Development of *Salmonella*-specific Th1 cells capable of producing sufficient IFN-γ for controlling intracellular bacterial replication takes several weeks leading to heavy mortality during early period following infection (Griffin *et al.*, 2009; Jackson *et al.*, 2010) [12, 16]. The overall ratio of mortalities in Vanaraja vs broiler chickens was 5:7 in infection group and 4:5 in garlic supplemented infection group. The ratio of mortalities during first week was 3:5 and 1:1 in infection and garlic supplemented infection groups, respectively. The study reflects that Vanaraja chicken are comparatively more tolerant to *Salmonella gallinarum* infection than commericial broiler but there was no marked difference in susceptibility. Similar observations have been reported for local vs commercial layers as well as among various local chicken ecotypes (Weerasooriya *et al.*, 2017) [32]. Garlic supplementation could not prevent the disease but the overall severity of the disease as well as acute mortality was considerably reduced. Garlic has been shown to have beneficial effects against different infections in chicken and other animals with a significant impact on reducing mortality and facilitating recovery (Gautam *et al.* 2017; Navidshad *et al.* 2018; Kumar *et al.*, 2022) [8, 23, 20].

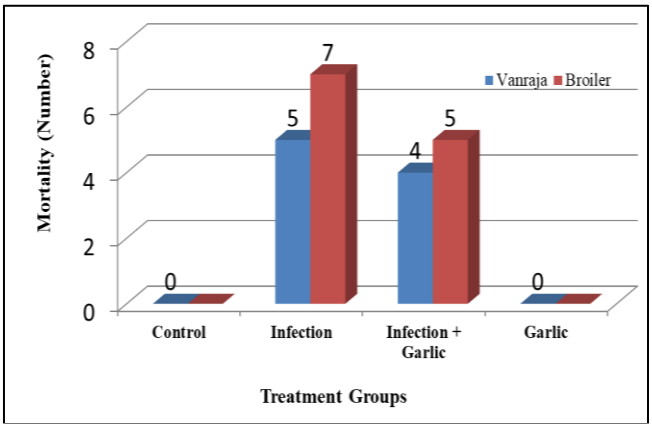


**Fig 1:** Number of birds dead in the different groups of Vanraja and Broiler chickens following *Salmonella enterica subsp. enterica* serovar Gallinarum infection

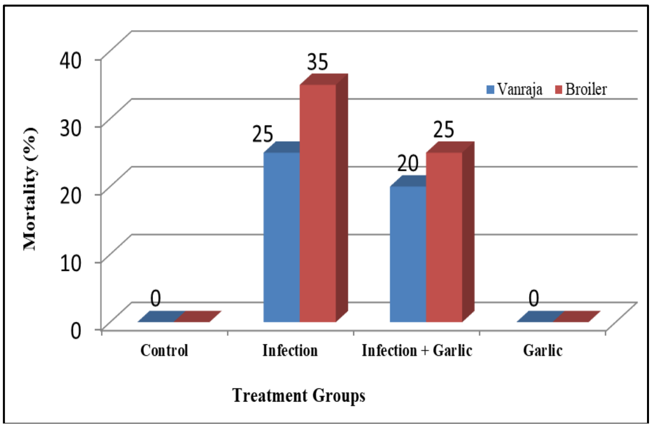


**Fig 2:** *Per cent* Mortality in different groups of Vanraja and Broiler chickens following *Salmonella enterica subsp. enterica* serovar Gallinarum infection

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