



Prospects for Livestock Nutrition in the View of COVID-19

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Abstract

Coronavirus Disease 2019 (COVID-19), caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), is a global pandemic. Remarkable negative impacts of the pandemic have already been observed in ecosystems, human civilization, food security and safety, and global environments. In addition, various sectors involved in the food production chain, particularly the agricultural and livestock sectors, also severely affect food production, food security, food safety, as well as cause economic loss. A sharp reduction in the production of meat, milk, eggs, etc., as a consequence of the global pandemic, has already been well documented. Movement restrictions were imposed locally and internationally as part of the COVID-19 control strategy. As a result, businesses related to the supply of raw materials to livestock, farmers, farm output, veterinary services, and farm workers have dramatically decreased. So has animal welfare. A few months have passed since the Centers for Disease Control and Prevention (CDC) officially announced the COVID-19 pandemic over and the food chain has not yet recovered. This review highlights the prospects of livestock nutrition in view of the COVID-19 crisis for global pandemic prevention.

Keywords: COVID-19; SARS-CoV-2; Livestock Farming; Beneficial Losses; Food Chain; Animal Welfare

Abbreviations: WHO: World Health Organization; PPE: Personal Protective Equipment; CDC: Centers for Disease Control and Prevention.

Introduction

The world has been suffering from the devastating impact of the Coronavirus Disease 2019 (COVID-19) outbreak. The World Health Organization (WHO) has identified the disease as a pandemic owing to its global and ominous effects on health, the economy, and social life [1]. However, several months ago, the CDC announced that COVID-19 was no longer classified as a pandemic, and the

last update on COVID-19 is provided in a Supplementary File [2]. This newsletter delivered updated information on the confirmed COVID-19 cases, deaths, and various variants of the virus recorded until now [<https://conta.cc/3tQJDxH>]. Severe Acute Respiratory Disease Corona virus-2 (SARS-CoV-2), the etiology of COVID-19, has circulated globally [3,4]. COVID-19 has become more subversive owing to its zoonotic nature [1,5,6]. Within a few months of the outbreak, COVID-19 disrupted the traditional ways of life and broke down communities. In addition, it has influenced all key sectors supporting global food and feed security and safety, including people's livelihoods and livestock nutrition. The COVID-19 pandemic had a massive effect on agriculture

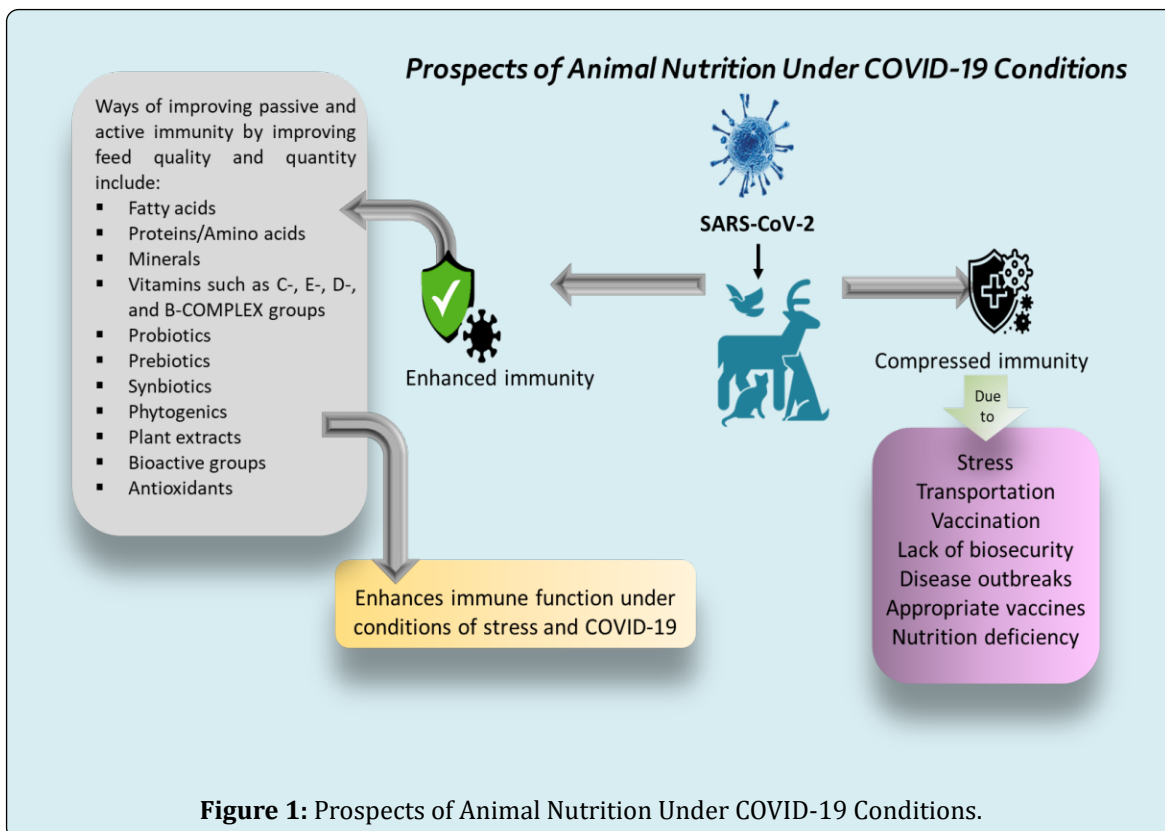
sectors globally [7-9] and Even after it formally ended, the adverse effects continued, but with less impact [2]. It also directly affected livestock production chains, particularly the egg, meat, and milk supply chains, trade, consumption, and so on. Livestock plays a substantial global role in many countries' gross domestic product (GDP) [10]. The COVID-19 pandemic has negatively influenced food chains at every step (e.g., processing, logistics, production, and consumer behavior [11]. In this review, we highlight the prospects of livestock nutrition, in view of the COVID-19 crisis, for further global pandemic prevention.

Prospects of Animal Nutrition Under COVID-19 Conditions

Nutrition has played an essential role in maintaining and enhancing the health of living organisms for decades. Dietary modifications are a prospective tool to improve immune function but are costly [12]. Nutrition, in terms of quality and quantity, is an essential way to sustain the functioning of the immune system.

The importance of nutrition and its significant immune role emerged after the outbreak of COVID-19. Receiving proper nutrition before immunization is reached is essential, as immunity is the main line of defense against COVID-19 until specific vaccines and/or drugs are found. Its importance continued after the presence of vaccines, owing to the development of more variant strains of the virus. Therefore, food strategies must be considered when designing strategic plans for programs of control, protection from diseases, and healthcare for herds [13-17].

Passive and active immunity is affected by various factors, including nutrition, feed quality, and quantity (including not only fatty acids, proteins/amino acids, minerals, and vitamins, but also probiotics, prebiotics, synbiotics, phytochemicals, plant extracts, and bioactive groups). These aspects play a vital role in augmenting the immunity and health of organisms (Figure 1) [18,19].



Immunity generally decreases under several conditions such as stress, transportation, vaccination, lack of biosecurity, disease outbreaks, appropriate vaccines, and nutrition deficiency. Therefore, strengthening protection, prevention, control programs, and health promotion should

be considered a proper strategy for sustaining animal production and achieving reasonable returns [9,12]. Several animal species have been cited to be affected by SARS-CoV-2, threatening humans and raising the risk of zoonotic disease transmission (Figure 1) [5,9,12,13].

Based on current knowledge of the nutrition of different species after COVID-19, packed bioactive plant compounds, antioxidants, microelements (e.g., zinc and selenium), and vitamins such as C-, E-, D-, and B-complex groups are essential for enhancing immune function under conditions of stress and COVID-19. These additives have been used in their raw form to improve health and welfare for decades in folk medicine and may be applied to livestock nutrition under preventative treatments and/or protection to eliminate new strains of COVID-19 in animal species [18-26].

Nutrient deficiencies increase the risk of emerging diseases; therefore, fortifying the feed with additional amounts of vitamins C, D, E, and B-complex groups, and minerals such as zinc and selenium are beneficial for boosting immunity [27-29]. Other substances, such as phytochemical active substances [30], proteins, essential amino acids, energy, and essential fatty acids (in particular, omega-3 fatty acids) [12], can help boost immunity and improve tolerance to COVID-19 pre-infection, during infection, and post-infection. However, increasing the aforementioned supplements can increase the dietary cost; therefore, the cost/benefit ratio should be considered. The benefits may include increasing productivity, reducing the risk of disease and medication, and reducing morbidity and mortality [12]. They may also delay and/or protect humans and animals from developing a new variety of viruses and zoonotic diseases [1,2,12,13]. The risks of nutritional deficiency, malnutrition, and gastrointestinal diseases lead to poor digestion and absorption, cardiovascular diseases, diabetes, obesity, chronic lung disease, and many other factors that increase disease susceptibility [18-26]. Therefore, enhancing immunity effectively improves health under conditions of stress and infection but has limited influence and does not replace treatment and immunization [27-30].

Improve Animal Health Practices

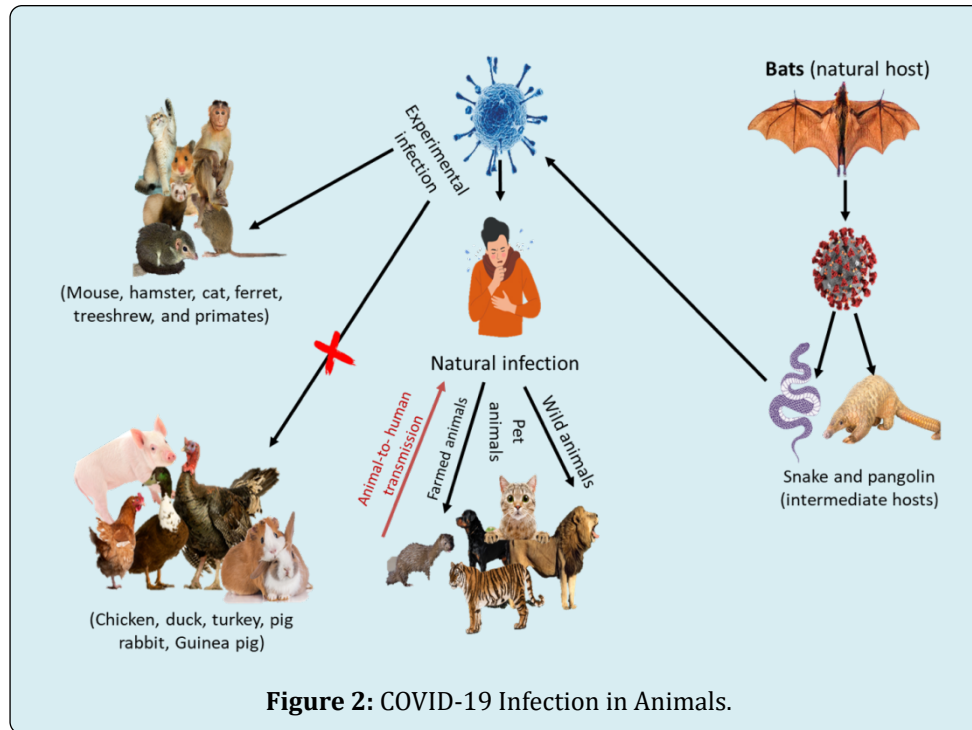
New light has been cast on disease prevention and control, and interest in these areas has reawakened after the SARS-CoV-2 outbreaks due to the global health threat. This emphasizes the need to impose the One Health measure that reflects the unity of human, animal, and ecological health [2]. The One Health approach stresses controlling and limiting the spread of zoonoses and reducing the spread of infection from potential epidemic reservoirs to avoid direct and indirect dissemination of zoonotic pathogens [9,12,13]. In essence, the idea of One Health is the preservation of human health, the ecological balance, and animal health and production. It reduces the risk of developing new strains of pathogens because of mutations and changes of unknown origin [2,13,31].

All of this emphasizes the role of monitoring the infrastructure and occurrence of common infectious diseases in both humans and animals; coordination between various medical, veterinary, and other disciplines; the unity and effectiveness of institutional work; and stressing the inseparability of animal and human health in an effort to prevent and protect all from common diseases [32,33]. In general, implementing the "One Health" approach varies from country to country, and is less implemented in developing countries. This must be addressed and coordinated globally for a global health strategy to be effective [34-36].

COVID-19 in Animals

Some coronaviruses cause flu-like diseases in humans. In contrast, others cause diseases in certain animals such as camels, bats, and cattle. In addition, some coronaviruses, such as feline and canine coronaviruses, only affect animals [12,13,37]. The exact cause of the current COVID-19 outbreak is not well documented, but evidence shows that it originated from bats [4]. There is no evidence that animals are responsible for circulating SARS-CoV-2 (the virus that causes COVID-19 in humans), but we are uncertain about the future [2]. Based on published literature, the threat of animals transferring COVID-19 to people is minimal [9,12,13]. However, COVID-19 can spread from people to animals in some situations, particularly during close contact. Thus, patients with suspected or confirmed COVID-19 should avoid interacting with animals including livestock, wildlife, and pets. Further studies are required to elucidate how various animal species could be influenced by COVID-19 [35,38].

Current knowledge indicates that SARS-CoV-2 can be transferred from humans to animals, particularly when in close contact. Animals such as dogs, cats, and big cats (tigers, lions, snow leopards, pumas, cougars, and minks) can be infected with SARS-CoV-2 [39]. Nevertheless, it is too early to declare all the animal species that can be infected with SARS-CoV-2. There is evidence that minks spread SARS-CoV-2 to people on mink farms, mainly in the Netherlands, Denmark, Poland, and the U.S.. One ferret in Slovenia was found to be infected with SARS-CoV-2 [40,41]. It is suspected that these animals became ill after being exposed to animal keepers with COVID-19. In many circumstances, this is induced irrespective of wearing Personal Protective Equipment (PPE) and following COVID-19 protection guidelines by animal keepers [13,38]. These results highlight the need to regularly test the genetic makeup of SARS-CoV-2 in vulnerable animal communities, such as minks, and the need for people to monitor viral mutations and jumps across species [42]. COVID-19 Infection in Animals is illustrated in Figure 2.



Conclusion

Considering the effects of the COVID-19 pandemic and the experiences we have gained, it is time to rethink existing animal diseases and pandemic controls, particularly those with zoonotic importance. We recommend focusing more on coordinated, unified activities that push toward a health model of disease surveillance and monitoring to detect newly emerging diseases and pandemics. Animal nutrition is essential to avoid nutritional deficiency, improve immunity, increase production, and enrich product quality and animal health. Nutritional concepts should focus on the nutrient balance, quantity, and quality. However, increased nutrient fortification above the recommended levels may increase dietary costs; therefore, cost/benefit analyses should be considered. In addition, smart livestock farming systems need to be adopted. A strong local, national, and international network is crucial for effective preparedness to prevent future outbreaks.

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