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Post-Weaning Diarrhoea in Piglets: Contributing Factors and Strategies for Mitigation

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Abstract

Post-weaning diarrhoea (PWD) remains a major health and economic problem in pig production, particularly during the first few days after weaning when piglets are highly vulnerable. Although enterotoxigenic *Escherichia coli* (ETEC) is one of the major causes, the development of PWD is influenced by several interacting factors, including weaning stress, dietary changes, immature gut and immune function, poor hygiene, environmental stress, and inadequate farm management. These factors can adversely affect feed intake, gut health, growth, and ultimately piglet survival. Therefore, effective control of PWD requires a holistic approach rather than dependence on a single intervention. Strategies such as gradual dietary transition, appropriate creep feeding, balanced nutrition, probiotics and prebiotics, improved housing and environmental conditions, strict hygiene and biosecurity, vaccination, and responsible antibiotic use can help reduce disease occurrence. Phytogenic feed additives may also offer promising alternatives. A coordinated approach combining nutritional, environmental, managerial, and welfare measures is essential for maintaining piglet health, improving productivity, and reducing the need for antimicrobial treatment.

Keywords: Post weaning diarrhoea, piglet, pig farming, *Escherichia coli*, ETEC, PWD

Introduction

Pig rearing is an important driver of rural livelihoods, especially in developing Asian countries like India. Pig rearing has a critical role to play in poverty alleviation and the improvement of socio-economic lives of smallholder farmers. Yet, in spite of its potential, India's swine industry still suffers from a variety of constraints, which are specifically related to modern husbandry technologies and disease control. Post-weaning diarrhoea (PWD) is one of the prominent health issues that affect piglet survival and development. PWD is a condition with severe economic consequences on pig production globally. PWD is mainly linked to enterotoxigenic *Escherichia coli* (ETEC) infection in young pigs.

It usually manifests itself in the first fourteen days following weaning, when piglets are at their greatest risk as a result of dietary adjustments, stress from being separated from the sow, and underdeveloped immune systems. Diarrhoea, dehydration, growth delay, and even sudden death are characteristics of the disease. Death rates for acute outbreaks have been as high as 20-30% in one to two months, making PWD among the swine industry's most difficult challenges. Economic development of sound strategies aimed at curbing the occurrence of PWD is contingent on the comprehension of the multi-factorial etiology of the disease. These include pathogen exposure, weaning stress, environmental factors, and management practices. In this essay, the primary causes of PWD will be discussed in detail, as well as existing and emerging control and prevention methods.

Risk Factors Associated with Post-Weaning Diarrhoea

The factors that influence the onset of PWD can be categorized broadly into predisposing, contributing, and determining factors. Age, weaning weight, immunity, and genetic predisposition are some of the risk factors. Research has shown that poor preweaning health and low weaning weight and age are major contributors to PWD (Laine *et al.*, 2008; Rhouma *et al.*, 2017) [5,9]. Furthermore, it has been shown that early weaned piglets have compromised

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immune systems, which makes them much more vulnerable to the development of diarrhoea during the weaning process. Litter size, sow parity, postpartum dysgalactia, and other piglet-related variables like birth order and genotype have also been linked to the vulnerability of piglets to PWD and other microbial illnesses (Hong *et al.*, 2006). Moreover, factors that occur immediately after weaning, including housing sanitation, the numbers of piglets per pen, feeding regimes and pig flow systems, contribute greatly to the scourge of PWD.

1. Weaning Stress and Gut Maturation

Weaning is a turning point and profoundly stressful event at the onset of piglet life. At that time, piglets undergo rapid dietary transition from easily absorbed milk to solid rations and great environmental and social upheaval. These rapid shifts put a big burden on piglet's physiologic and immune systems that tend to subvert their powers of resisting infectious diseases mainly enterotoxigenic *Escherichia coli* (ETEC)-induced diseases.

Complementing this hurdle is the immediate cessation of passive immunity, chiefly immunoglobulin A (IgA), passed on by the sow to its piglets in the form of milk. With this deprivation, the animals are more susceptible to pathogens. On the other hand, the incomplete digestive system and minimal enzymic activity curtail the enzymatic ability of the piglets to effectively break down the novel food, more commonly leading to gut problems and upsets in intestinal health.

2. Pathogenic *Escherichia coli*

ETEC is the most widely recognized pathogen of PWD cases. They attach to intestinal epithelium via fimbriae (F4, F5, F6, F18, and F41) to allow colonization and production of enterotoxins. The toxins cause disturbances in water and electrolyte balance in the intestine, leading to watery diarrhoea. ETEC is often associated with improper hygiene, polluted water sources, and poor biosecurity practices.

3. Environmental Conditions

VinodhKumar *et al.* (2019) ^[10] also found various environmental conditions that affect PWD prevalence. For example, exposure to shallow well water increased the odds of piglets developing diarrhoea significantly more (OR = 82.89) than those treated or given spring water. The incidence of diarrhoea was also greater during winter and was potentially linked to cold stress and immunity compromise. Temperature, humidity, and air quality make significant inputs to piglet health. Intestinal motility is reduced by cold temperatures and therefore promotes bacterial overgrowth, whereas high humidity supports growth of pathogens. Increased diarrhoea prevalence in winter was also documented by the research with an odds ratio of 2.80, which can be explained possibly by increased environmental stress and lowered resistance to pathogens.

4. Farm Management Practices

Inadequate management practices, such as overcrowding, poor cleaning, and poor disinfection, are highly associated with increased PWD incidence. VinodhKumar *et al.* (2019) ^[10] indicated that pig farms with poor ventilation and temperature control systems had increased diarrhoea rates. Farms that applied disinfectants on a regular basis had reduced PWD incidences, highlighting the significance of

biosecurity.

In disinfected and clean barns, pigs do not breathe the same air as mature pigs and do not have access to the same environment, so the pigs will have fewer challenges and fewer PWD outbreaks. The mortality is lowered because there will be less diarrhoea and other illnesses.

Other research, such as Deep *et al.* (2023) ^[3], correlated PWD prevalence with farm worker numbers and frequency of sanitation. Farms with lower numbers of workers had less hygienic conditions and increased prevalence of ETEC-associated diarrhoea.

5. Feeding Practices and Nutrition

Feed intake is typically lower for the first time following weaning and the piglet is apt to become anorectic of variable duration and intensity between farms, given the circumstances of livestock management and the quality of feed. Madec *et al.* indicated that the low feed intake during the first week following weaning is highly related to the disease risk of occurrence during the post-weaning period. Underfeeding during weaning diminishes growth performance of pigs, and leads to intestinal inflammation and negatively impacts villous height and crypt depth.

Weaning practices are an essential factor influencing gut health. Feeding habits involving high levels of crude protein are known to produce fermentation in the large intestine, enhancing the yield of undesirable metabolites such as ammonia and amines. Such modifications make changes in gut microbial profile, causing intestinal mucosa damage and inducing diarrhoea (Heo *et al.*, 2013; Pluske, 2013) ^[4, 8].

Laine *et al.* (2008) ^[5] demonstrated that frequency of feeding after weaning affected incidence of PWD. Piglets fed twice daily were more likely to develop diarrhoea compared to those receiving continuous or ad libitum feeding. Reduced feeding enhances hunger and stress and further compromises gut health.

6. Immunity and Pre-Weaning Health

Low birth weight, compromised health at lactation, and diseases such as postpartum dysgalactia syndrome in sows decrease the transmission of maternal antibodies and influence the development of gut in piglets. Piglets weaned at an earlier age or with compromised immune status are at a very high risk of diarrhoea (Rhouma *et al.*, 2017) ^[9].

7. Weaning Status

As per VinodhKumar *et al.* (2019) ^[10], diarrhoea was significantly more common in weaned piglets compared to the nursing ones and had an odds ratio of 3.73, indicative of a strong association. The augmented susceptibility was chiefly attributed to the interaction effects of abrupt weaning, changes in diet, and the underdevelopment of the immune systems of the piglets, all of which play a contributing role in increasing physiological as well as nutritional stress.

Mitigation Strategies for Post-Weaning Diarrhoea

1. Nutritional Management

One of the most critical sudden changes piglet experiences during weaning is the switch in the composition and consistency of the feed. A gradual change from milk to solid diet is essential. The introduction of creep before weaning may enhance early digestion system adaptation. In addition, and noteworthy, creep feed consumption is assumed to be responsible for gut function maturation by stimulating the

maturation of the GI-tract microbiota and digestive enzymes' activity. Providing milk-like consistency liquid feeds is also able to avoid sudden feed texture changes, minimizing feed rejection and anorexia risk.

Decreasing crude protein concentration in weaning diets, supplemented with essential amino acids, was found to lower protein fermentation and promote the growth of healthy gut flora. Further, raising dietary fiber content, particularly insoluble fibers, enhances gut integrity and inhibits ETEC adherence to the intestinal mucosa (Wang *et al.*, 2018) ^[11].

2. Zinc Oxide

Weaned piglets are usually supplemented with pharmacological levels of zinc, most commonly as zinc oxide (ZnO), for the first two to three weeks after weaning to reduce pathogen-induced diarrhoea. ZnO does not kill *E. coli* directly, but it seems to act by inhibiting receptor sites on the intestinal mucosa, thus preventing the bacteria from adhering to the mucosa and maintaining the integrity of tight junctions. Aside from this protective function, high levels of zinc and copper have also been found to promote growth and digestive health, highlighting their dual role in piglet nutrition and prevention of disease.

3. Probiotics and Prebiotics Use

Probiotics are viable microorganisms that provide health benefits and may inhibit pathogens such as *E. coli* from attaching to and obtaining nutrients in the gut. Probiotics stimulate the immune system and release antimicrobial compounds. Prebiotics and synbiotics (mix of prebiotics and probiotics) increase further gut microbiota balance (Bogere *et al.*, 2019). If these supplements are given early in life, either directly or through the sows' feed, it can encourage the development of the good bacteria and lower PWD chances.

4. Environmental Control

Incorporating appropriate ventilation and climate control systems within weaning spaces is imperative in reducing heat stress and strengthening piglets' immune response during the susceptible post-weaning period. Maintaining the environment between 26-28°C optimal temperature range ensures that piglets are kept in their thermal comfort zone. Cold exposure has been found to impair gut motility and decrease the strength of the intestinal wall, thus exposing piglets to infection (Le Dividich & Herpin, 1994) ^[6]. Evidence, as by Laine *et al.* (2008) ^[5], has indicated that automated temperature control systems in housing piglets have been associated with fewer cases of post-weaning diarrhoea.

5. Biosecurity and Hygiene

Strict hygiene measures such as cleaning and disinfection between batches by a step-wise approach (removal of organic matter, detergent soaking, high-pressure washing, drying, disinfection, and a second drying phase) can effectively lower pathogen load (AHDB, 2020a). Regular disinfection routine and biosecurity practices, such as pen cleaning and equipment and restricted animal transfer, and minimum contact with exterior vectors, help to prevent the spread of microbials. Having all-in-all-out systems, where the piglets are transferred in their entirety and are not mixed, restricts disease transmission. Weaning units kept in segregation along with good ventilation and sanitation procedure are critical to disease control.

6. Vaccination and Antibiotic Stewardship

Pregnant sow vaccination against ETEC stimulates passive immunization in piglets via colostrum and milk. A number of effective intramuscular vaccines against fimbrial adhesins and enterotoxins exist and are in common veterinary use.

Because of growing concerns regarding resistance to antibiotics, therapy must be culture and sensitivity test-based. Excessive use of in-feed antibiotics needs to be substituted with pathogen-directed therapy, particularly in view of the widespread presence of ESBL-producing and multiresistant *E. coli* (VinodhKumar *et al.*, 2019) ^[10].

7. Use of Phytogetic Compounds

Garlic, oregano, and cinnamon essential oils and plant extracts have exhibited effective antimicrobial activity. Essential oil and plant extract treatment has indicated the decrease in coliform colonisation and total anaerobes like *E. coli* F4, *Clostridium* spp, *Salmonella* in caecum, colon and rectum, which would alleviate PWD in piglets (W. C. Liu *et al.*, 2018). Research indicates that some of these essential oils are active against ETEC strains and can be added to feed to avert PWD.

8. Weaning Age

Research has demonstrated that extending the weaning age can help decrease the stress that is typically characteristic of this phase, giving piglets more time for their digestive system to mature and to switch over gradually to solid feed on the mother's milk. This leads to enhanced growth performance and immune function. Practice strategies like delayed weaning and split suckling can also be utilized to develop piglet resilience as older piglets possess more digestive enzyme activity and a stronger immune system and will be in a better state to cope with the change.

9. Feeding Practice

Early solid feeding training, employing palatable creep feed pre- and post-weaning, promotes a normal eating regimen, minimizing hunger and its concomitant stress. Open, readily accessible feed and frequent feeding (3-4 times per day) have been demonstrated to enhance post-weaning consumption and growth performance.

10. Managemental and Housing Practices

Improved ventilation, proper disinfection, and keeping appropriate environmental conditions within pig sheds. Daily monitoring and surveillance for enteric disease and resistance profiles will help with early control and containment of outbreaks.

Conclusion

Post-weaning diarrhoea in piglets is an intricate, multi-factorial syndrome influenced by microbial, nutritional, environmental, and managemental factors. Its implications on pig productivity and health are critical issues facing current pig production systems. Managing PWD needs a comprehensive approach from enhancing weaning procedures and feeding formulation to increasing farm biosecurity and environmental management. Nutritional interventions at an early stage, the utilization of probiotics, judicious use of antibiotics, and biosecurity are all part of reducing diarrhoea incidence. Additionally, the implementation of welfare-conscious management practices can contribute to maintaining piglet health and reducing the usage of antibiotics, in concurrence with the international drive to

tackle antimicrobial resistance.

Conflict of Interest

Not available.

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