

Probiotics and Medicinal Plants in Poultry Nutrition: A Review

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Abstract — The use of medicinal plants and probiotics has recently gained interest since the ban on the use of antibiotics as growth promoters by the European Union in 2006. They are new alternatives to bridge the gap between food safety and production. Medicinal plants are cheaper and loaded with several minerals, vitamins and phytochemicals such as: alkaloids, saponin, flavonoids, phenols, tannins etc. which allows them to perform multiple biological activities. Probiotics on the other hand, repopulates the gastro intestinal tracts (GIT) with beneficial bacteria which controls the action of pathogens and control their population, thereby reducing mortality and improving general performance of an animal.

Keywords— Probiotics, medicinal plants, pathogens, phytochemicals.

I. INTRODUCTION

Poultry production has experienced a remarkable growth within the past four decades in its bid to attain viable level of production but there are still a lot of problems confronting the industry such as disease, high cost of feed cost and most recently the indiscriminate use of antibiotics. The sub-therapeutic use of antibiotics in poultry production is a public health concern because of antimicrobial resistance and the presence of their residues in final products leading to several health challenges in humans. These situations prompted the European Union in 2006 to place a ban on the use of the use antibiotic feed additives to promote food safety. Among the potential alternative to antibiotics is the use of medicinal plants (phytobiotics/phytogenics) and probiotics which contains one or more useful bacteria or yeast (Waldroup et al., 2003; Nava et al., 2005) which promotes healthy gut and prevents dysbiosis which could occur during stress, prolonged water deprivation, feed fasting and infections (caused by viruses, bacteria, fungi and protozoa), causing an imbalance of flora with a proliferation of undesirable microorganisms (Filipe (2014).

According to Sommer and Backhed (2013), the gastro intestinal tract (GIT) is an important site of digestion, nutrient absorption, intestinal integrity, nutrient

metabolism and fermentation. McDevitt et al. (2006); Neeraj (2016) opined that exposure of GIT to harmful infectious agents or pathogens (*Escherichia coli*, *Clostridium*, *Pseudomonas*, *Blastomyces* and *Salmonella*) could cause an imbalance in intestinal flora, productivity loss and immune suppression.

Probiotics are live cultures of organisms supplemented in poultry diets that can beneficially affect the host animal by improving the microbial balance in the gut (Kroimayr and Zhang, 2006). They have shown positive results towards improving performance in birds (Vicent et al., 2007), feed efficiency (Hassan et al., 2014; Samliet et al., 2007), change in gastrointestinal microflora (Mountzouris et al., 2007; Kudoh et al., 1998), nutrient absorption (Amatet et al., 1996; Alagbe, 2019), reduction in pathogenic microorganisms (Leandro et al., 2010; Liu et al., 2008), immune booster (Kim et al., 2009; Knap et al., 2011). Organisms used as probiotics must fulfill the above criteria before been considered and must be generally regarded as safe [GRAS] as presented in Fig 1. The most commonly used include *Lactobacillus acidophilus*, *Enterococci faecium* and *Bacillus* spp. (Schone, 2006).

According to Filipe (2014), probiotics administration repopulates the GIT with beneficial with beneficial bacteria which curbs the action of pathogens and controls their population. This is especially after stressful events such as drastic changes in the diet, fasting, erratic temperatures or after exposure to aggressors such as enteritis of bacteria or viral origin in the microbiota and mycotoxin contamination in feed.

1.1 MECHANISM OF ACTION OF PROBIOTICS

The mode of action of probiotics is not always well understood due to different strains that may have various functions and survivability throughout the gut affecting the host in different ways. The effects of probiotics can be classified in:

- 1) Interaction between probiotic-microbe-gut epithelium: Adhesion to mucosal epithelial cells, stimulation of mucus secretion, prevention of adhesion of pathogens as probiotics blocking intestinal receptors, thereby excluding pathogens,

enterotoxins and hampering proliferation of pathogens, competition with pathogens for important nutrients, secretion of antimicrobial and antitoxin substances that affects establishment and or replication of pathogens in the gastrointestinal tract (Collado, 2009)

- 2) Interaction between probiotic-immune system: Immunomodulation by innate as well as systemic ways, enhancing and reinforcing gut integrity and gut barrier function, eventually decreasing secretory and inflammatory molecules against microbial infection (Servin, 2004). The general mechanisms by which probiotics may have an effect can be divided into various categories: adhesion activity to gut mucosal epithelium, antitoxic effect, modulation of immune system, production of antimicrobial substances and competitive exclusion between probiotics and pathogenic bacteria.

1.2 RELEVANCE OF A BALANCED GUT

According to Klasing (1987), there is a correlation between gut microbiota imbalance and poor growth performance. In other words, pathogenic organisms compete with animals for nutrients which could lead to poor performance and eventually death depending on its severity. Kristy (2015) opined that the acquisition of a positive microbiota in the first few days after hatching has a profound effect on the overall health of the bird. Similar observation was made by Filipe (2014) who reported that newly hatched industrial chicks do not come into contact with mother hens and are placed in a clean, sanitized environment with little opportunity for rapid development of a protective intestinal microflora that can successfully compete with pathogens. The first days of life are a critical period of time with high risk of infection by pathogens such as *E.coli*, *Salmonella* etc. that may be present in the litter. Thus, probiotic supplementation is beneficial measure as expressed in Fig 2.

1.3 PROBIOTICS FOR POULTRY

In modern broiler production many factors can enhance stressors, they include feed changes or imbalances, transportation, processing at the hatchery and high stocking densities. During post hatching period, which ultimately affects the colonization of the gastrointestinal tract by bacterial pathogens due to weakened immune system, posing a threat to bird and food safety.

In a comprehensive research in turkeys and chickens, commercial researches have established that proper administration of probiotics mixture increased performance, reduced costs of production as well as was effective in reducing abdominal fat deposition (Vincente et al, 2007). Timmerman et al. (2006) reported that the main factors affecting the efficacy of the probiotic preparations depend on way and timing of the administration. Application through the feed than application in the drinking water resulted in a higher increase of average daily gain.

Eggs production has been also investigated in relation to probiotic application. A combined mix culture of *Lactobacillus acidophilus*, *L. casei*, *Bifidobacterium thermophilus* and *Enterococcus faecium* enhanced egg size and lowered feed cost in laying hens (Davis and Anderson, 2002). Moreover, *Bifidobacterium thermophilus* and *Enterococcus faecium* improved egg production and quality (Kutoglu et al, 2004).

The use of Enterococci as probiotics in chickens prolonged feeding with *E. faecium* based probiotics increased egg laying intensity and feed conversion efficiency (Koudela et al, 1996). In poultry, benefits of yeast probiotic supplementation are established in broilers' production performance and increased resistance of chickens to enteric pathogens infections (*Salmonella*, *Campylobacter jejuni*, *E. coli* or *C. perfringens*) (Banjeree and Pradhan, 2006). Furthermore, supplementation with yeast treatment significantly decreased the frequency of *Salmonella* colonization to lower than the pre-stress (before transport) levels, whereas non-supplemented birds had higher levels of *Salmonella* colonization (Line et al., 1997).

1.4 MEDICINAL PLANTS

The use of plants in traditional medicine has been in existence for thousands of years because plants have proven to be a natural renewable resource with valuable bioactive compounds (Cherkupally et al., 2017; Lina, 2017; Oluwafemi et al., 2020) and also provided a clue on the discovery of new products of medicinal value for drug development (Senthilkumaret al., 2018).

According to Rates (2001) out of the about 250,000 – 500,000 plant species estimated by the WHO (1992), only a small percentage has been investigated phytochemically and even a smaller percentage has been properly studied in terms of their pharmacological properties.

The primary benefits of using plants or herbs (essential oil, spices, extracts) is that they are relatively safer than synthetic alternatives offering profound therapeutic benefits and more affordable (cheaper) in the treatment of diseases (Manjue et al., 2011).

The presence of phytochemicals or bioactive (flavonoids, alkaloids, saponins, phenol, oxalate etc.) confers plant the ability to perform multiple biological functions as anti-inflammatory (Sathya et al., 2012; Omokore and Alagbe, 2019; Khan et al., 2009), antioxidants (Wang et al., 2008; Alagbe et al., 2019), antifungal (Parkash et al., 2002), expectorant (Partap et al., 2012; Arczewska and Swiatkiewicz, 2012), antimicrobial (Olafadehan et al., 2020; Wojdylo et al., 2007), anti-parasitic (Ighodaro et al., 2012; Zinoviadou et al., 2009), antiviral (Olafadehan et al., 2020; Srinivasan, 2005), antihyperglycemic (Tassou et al., 2000) and antidiabetics (Viegi et al., 2003).

Phytochemicals can be used in solid, dried and ground form or as extracts (crude or concentrated), and also can be classified as essential oils (essential oils, volatile lipophilic substances obtained by cold extraction or steam/alcohol distillation) and oleoresins (extracts derived by non-aqueous solvents) depending on the process used to derive the active ingredients (Gadde et al., 2017).

The secondary metabolites in plants varies in composition and concentration, method of extraction (aqueous, ethanolic and methanolic), stage of growth, storage conditions, geographical location (Alagbe, 2019; Hyun et al., 2018).

1.5 ROLE OF MEDICINAL PLANTS IN MONOGASTRIC

1.5.1 Maintaining the integrity of the gastro intestinal tract (GIT)

According to Bravo and Ionescu (2008) mixture of a mixture of carvacrol, cinnamaldehyde and capsicum oleoresin in broilers stabilizes the intestinal microbiota and reduces microbial toxic metabolites in the gut, owing their direct antimicrobial properties on various pathogenic bacteria which result in relief from intestinal challenge and immune stress.

Hanan (2015) evaluated the effect of supplementing different levels of turmeric on the turmeric on the caecal microbial population of broiler chicks he observed that birds fed diet supplemented at 0.4 % significantly ($P < 0.05$) reduced *Escherichia coli* count in the caecum.

However, *Lactobacilli* count, weight gain were significantly ($P < 0.05$) highest for all treatment supplemented with turmeric powder.

Phyo et al. (2017) also observed the effect of dietary garlic and thyme seed supplementation on the production performance and gut microbial population of broiler chickens.

Treatments were control diet (T1), control diet with 1% thyme seed powder (T2), control diet with 1% garlic powder (T3) and control diet with 0.5 % thyme seed and 0.5 % garlic powder (T4). *E.coli* count in the gut of the birds did not show dietary treatments compared to control.

However, *Lactobacilli* in the gut of broilers significantly ($P < 0.05$) increased in T2, T3 and T4 compared to that of T1. It was concluded that thyme and garlic could provide positive advantages to the colonization and proliferation of *Lactobacilli*.

Alagbe et al. (2019) conducted to evaluate the carcass, caeca microbial parameters of broilers fed different levels of mixed lemon grass and garlic extract (CLGE). Five hundred broiler chickens (Ross 308) were allotted to five treatments with five replicate consisting of 20 birds each in a completely randomized design (CRD).

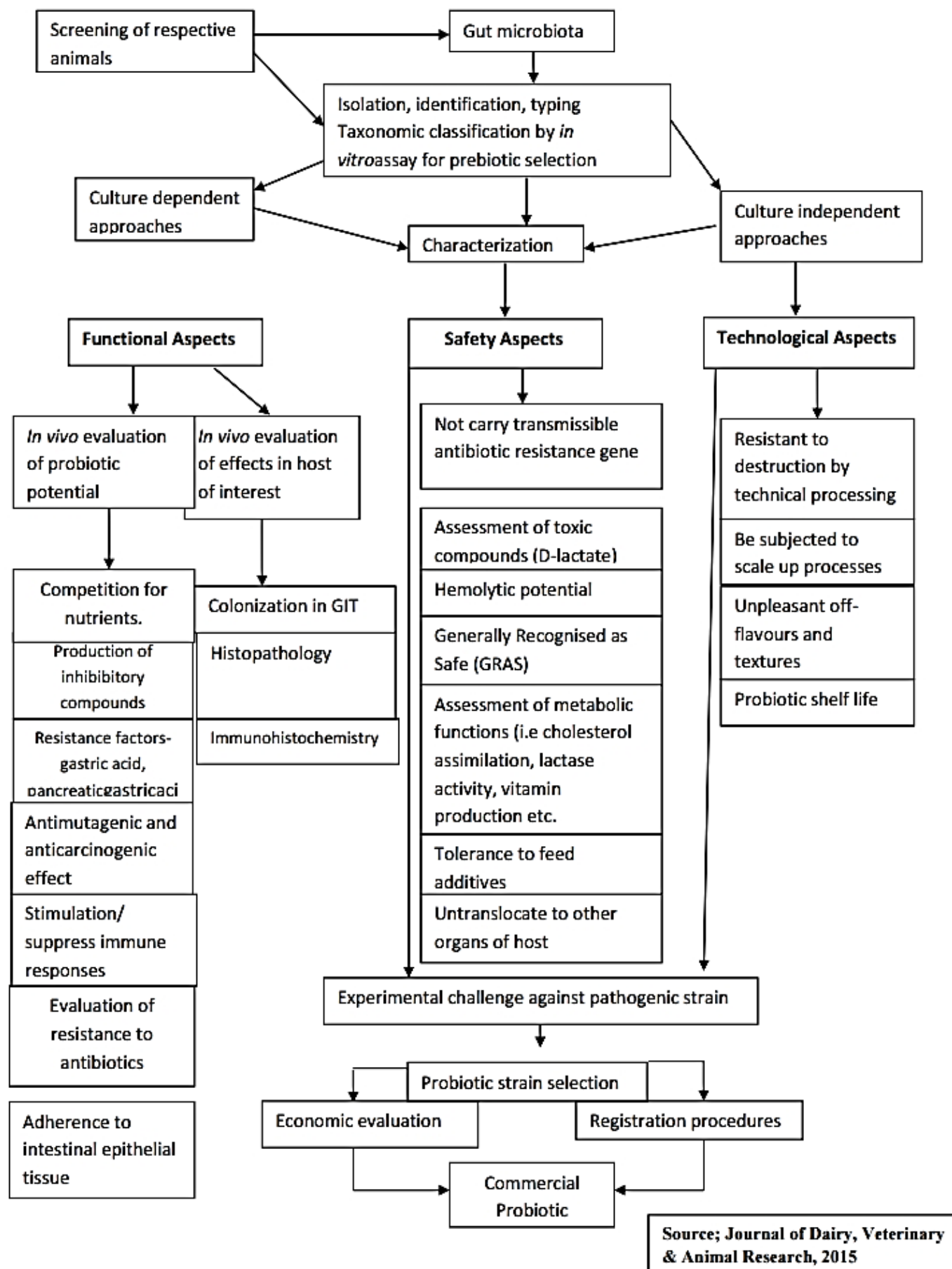
The first group T1 was given 0.025g/litre Neomycin in water while T2, T3, T4 and T5 were given CLGE at levels 3.0ml/litre, 6.0ml/litre, 9.0ml/litre and 12.0 ml/litre of water respectively.

The experiment lasted for four weeks each for the starter and finisher respectively. Results on dressing percentages revealed that birds given 12.0 ml/l CLGE was highest (76.87%) followed by those in T4 (76.54 %), T3 (75.61 %), T2 (75.00%) and T1 (70.01%). Significant influences ($P < 0.05$) were also observed in the relative organ weight (liver, kidney, spleen, heart, pancreas, gizzard and proventriculus).

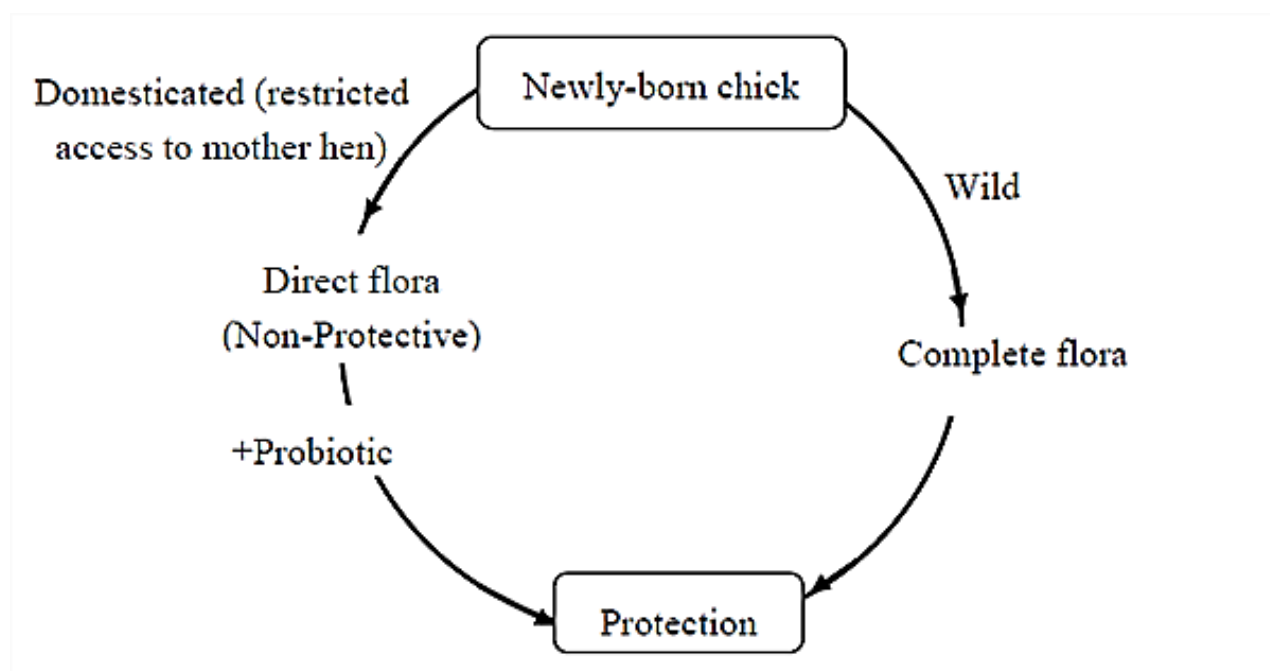
There were also significant differences ($P < 0.05$) in the caeca microbial population of *E.coli* and lactobacillus count as well as the antibody titer against Newcastle and gumboro disease.

Birds in T5 had the lowest *E.coli* count (9.00 cfu/g) when compared to T1 (22.19 cfu/g) with the highest proportion of the bacteria. It was concluded that CLGE could be given to broilers at 12.0ml/liter without any negative effect on the health and can be used to effectively replace antibiotics.

FIGURE 1: PROBIOTICS SELECTION CRITERIA



*Figure 2. Schematic representation of the concept of probiotics



*Source: Fuller (2001); LutfulKabir (2009)

CONCLUSION

Phytogenics and probiotics have the ability to stabilize the intestinal environment and provide positive advantages to the colonization and proliferation of Lactobacilli and reducing pathogenic organisms. Also the use of medicinal plants is safer and cheaper. It could also serve as a way of bridging the gap between food safety and production as well as reducing mortality in animals.

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