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Synbiotics (A review)

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ABSTRACT

The poultry industry is developing continuously and rapidly, this development takes several trends in the poultry industry, such as searching for new alternatives feed additives. The research focused on finding new alternatives feed additives, among these alternatives is Synoptic, which used to maximize the benefit of the two important compounds (probiotics and prebiotics) as these two compounds are considered one of the most alternatives feed additives, which have been used a lot in poultry feeding to maximize the value of these compounds, they were combined into one compound called synbiotic. Several studies confirm that the synbiotic effect on the intestine morphology, which, the ratio villus height and villus: crypt ratio in the small intestinal significantly increased ($p < 0.05$). This explains the improvement in growth performance and nutritional efficiency in most of the research that has found that synoptic influences growth performance traits. Other important effect for add synbiotic on diets is increase the benefit microorganism in the intestine and increase the competition with pathogenic bacteria, this will reduce the pathogenic bacteria, also the benefit bacteria secrete inhibitor substrate effect on the pathogenic microorganism. The previous studies confirm that the synbiotic increase the immunity, improve the health performance and reduce the mortality. In this chapter, we will discuss more details about synoptic in poultry feeding in terms of its components, physiological mechanism in the body and its effect on productive performance and immunity.

Keywords: Growth performance, Immunity, Intestine morphology, Intestine microorganism, Synbiotics, Probiotic, Prebiotic, Poultry.

Introduction

At last decades, the important to search for natural production to increase the productive performance in addition to the immunity against diseases infection in the domestic animal and birds. The consumer always prefers organic chicken that is free of antibiotics, and most research has indicated the great harm of using antibiotics in poultry to increase the resistance of pathogenic bacteria to antibiotics over time and harm to humans if they accumulate in the meat. Therefore, it was necessary to search for biological alternatives that improve growth and increase immunity in poultry as alternatives to antibiotics (Figure 1) and other unwanted growth stimuli (Gadde et al 2017 and Dunkley, 2018; Abd El-Hack et al., 2022 and Wickramasuriya et al., 2024). Among the most important of these alternatives the Probiotics and Prebiotics, the probiotic (FAO, 2002), which the probiotics defined as live microorganisms which when administered in adequate amounts confer a health benefit on the host, however the prebiotics are known as non-digestible food ingredients that beneficially affects the host by the

selectively stimulating the growth and activity of one of or limited number of bacteria in the intestine (Markowiak and Śliżewska 2018) for further benefit, both compounds (probiotics and prebiotics) were combined to produce a new compound called Synbiotics. The Synbiotics is a combination for both compounds (probiotics and prebiotics) (Ouwehand et al., 2007; Cencic and Chingwaru, 2010 and Yassine et al., 2025). The previous studies referred to the befit of Synbiotics to increase the balance between microbial clans in the intestine, reduce pathogenic bacteria, improving the growth performance, and stimulating immunity (Pontes et al., 2007 and Singh et al., 2008; Nisar et al., 2021 and Naeem & Bourassa 2025). The aim of this chapter is to discuss previous studies done on symbiotic growth and immunity traits in poultry as alternative additives on the feed.

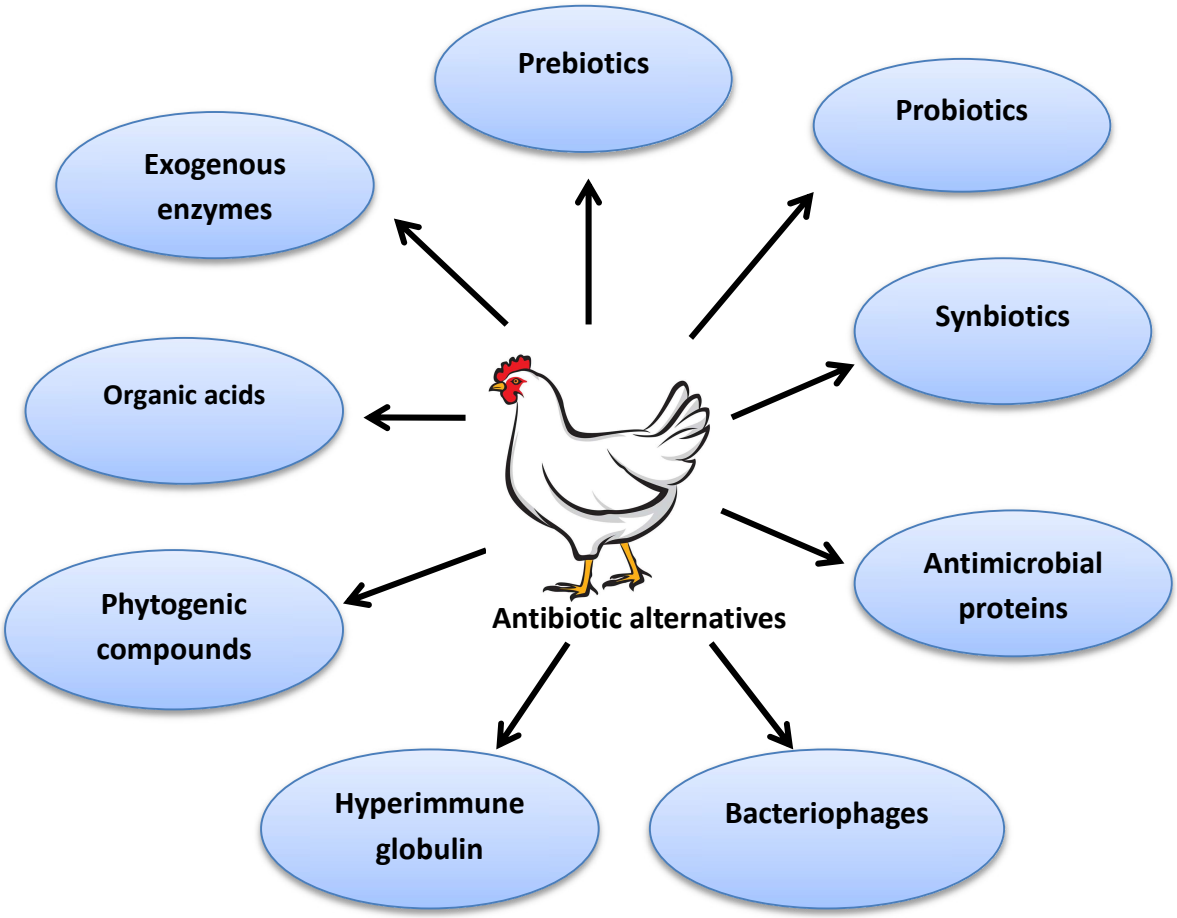

Figure (1): Antibiotic alternatives used in poultry sector.

Synbiotic components: Synoptic is the combination of probiotic and prebiotics as shown in Table 1, through the table, we find that most of the Synbiotics are compound of two main parts, microorganism and substances (besides carbohydrates). The objective of this combination from the two compounds to maximize utilization in the production process as shown in Figure 2. The number of surviving live microbial increased in the GI tract when adding synbiotics to diets, also stimulate the growth of health-promoting bacteria and this will improve the host's performance (Gibson and Roberfroid, 1995).

From the figure (2) we can conclude that, the important of prebiotic and probiotic when add alone without combination together (Markowiak & Śliżewska 2018 and Mirza 2018) as follows:

Prebiotics: the prebiotic increases the lactobacillus counts and reduces the gastrointestinal pH, stimulate growth and selective some species of bacterial and some bifidobacterium, also the prebiotics support on modulate immune function.

Probiotics: Balance the ecosystem and increase the benefit of bacteria and reduce the risk of the pathogenic microorganism and modulation the intestinal microorganisms and this improve the absorption and utilization of the feed and increase the growth performance.

Nowadays the livestock feeding on the probiotics and prebiotics together is not fed separately under the name Synoptic. There is other study by (Śliżewska et al., 2020) had used the recommendation synbiotic from FAO after adjusting the types of some microorganism before adding to the diets (Table 1), the objective from their study was to investigate the effect of add synbiotics to diets, on the dominant microbiota count in the intestinal of broiler chickens. The authors used the synbiotics with three different commercial probiotics (Three treatments) compared with control group (without add synbiotic) and the last treatments was feed on synbiotic only without add probiotic (recommended by FAO/WHO and EFSA). They found that the new synbiotics was positive effect on the growth performance, also improve the benefit microorganism in the intestine and the pathogenic decreased in the intestine compared to tested synbiotics and control group.

Many studies are still needed to investigate different probiotics or different types of microorganism in the synoptic component to the effect of the activity of microorganism in the intestine to get the best synthesis of synoptic for the best productive and immune performance of the host.

Also, there are factors that determine the efficacy of synoptic action, strain, dose and age these factors control the results of adding synoptic to the feed, for example, (Chen et al., 2018) add 1.5 kg of synbiotics/ tone of Cherry Valley ducks, which the group with synbiotics was better for growth performance and feed conversion (1.89) compared to control group (1.97), other study found the body weight was significantly heavier at 21 and marketing age of broiler chickens (Min et al 2016), however, opposite trends was found in other studies (Willis et al., 2007 and Jung et al., 2008), most of researches in the broiler chickens indicate to increasing of the benefit bacteria and morphology change in the intestine when used synbiotics (Edens 2003; Schneitz, 2005 and Min et al., 2016; Chayatid et al., 2019 and Slizewska et al., 2020). however, (Iriyanti and Hartoyo, 2017), did not found any effect on the morphology of the intestine of the males Tegal ducks when used synbiotic on the diets for 60 days. We can conclude that the effect of synbiotic depends on the species' administration and age, so there need to be more studies to investigate the best administration with each species and strains, also, determine the age that gives improvement in growth.

Table (1): The synthesis and the administration of Synoptics on diets

Information about probiotic strains from the elaborated synbiotic preparations (Śliżewska et al., 2020)			
Microorganism	**Beneficial activities of strain**		
*L. paracasei*a	Hostility to pathogens, adhesion to Caco-2, prevents adhesion to c2, resistance to antibiotic, resistance to change in the pH, hydrophobicity, auto- and coaggregation		
*L. pentosus*a			
Lb. plantarum			
*L. reuteri*a			
*L. rhamnosus*a			
S. cerevisiae	It has the ability to remove some toxins and decrease the concentration		
B. licheniformis	*Safety has been confirmed for use in the laboratory*		
B. subtilis			
E. faecium	*Its safety and efficacy have been confirmed by some studies*		
The commercial name for the synbiotics (Markowiak and Sliżewska 2018; Mirza R.A. 2018)			
Trade name	**Probiotic**	**Prebiotic**	**Animal type**
Biomin®IMBO (ME BIOMIN GmbH)	*Enterococcus faecium*	FOS	Poultry, pigs, calves
DigestAid™	*Pediococcusacidilactici, Saccharomyces: cerevisiae, boulardii*	β-glucan, MOS	Horses
PoultryStar® (ME BIOMIN GmbH)	*Bifidobacterium animalis, Enterococcus faecium, Lactobacillus: reuteri, salivarius, Pediococcusacidilactici,*	inulin	Poultry
Synbiotic poultry	*Lactobacillus: acidophilus, casei,*	inulin	Poultry

(Vetafarm*)*	*salivarius, plantarum, rhamnosus, brevis, Bifidobacterium: bifidum, lactis, Streptococcus thermophiles*		

Supplemntaion types	***The dose***	**The degree of influence on productive performance**	***References***
Bio-MOS	2 kg/ton was add to the diets	Positive significant effect on the productive performance	Hooge (2004)
MOS[a]	0.5 kg/ton was add to the diets	Positive significant effect on feed conversion ratio	Flemming et al. (2004)
Probiotic and prebiotic (MOS)	From 1–42 days the synbiotic add to diets 1 kg/ton	Feed conversion ratio was better	Pelicano et al. (2004)
Synbiotic (Biomin/IMBO)	1 kg/ton on the starter and 0.5 kg/ton on the grower diets	Positive significant effect on the productive performance and intestinal morphology change	Awad et al. (2008)
Synbiotic	0.5 kg/ton was added to the diets	Positive significant effect on the productive performance and benefit bacteria counts	Śliżewska et al., (2020)

FOS =fructo-oligosacharides, *MOS* = malto-oligosacharides, *scFO = S*short chain fructo oligosaccharides

Physiological of synbiotics: The benefits of synbiotics achieved depend on the mode of action for their compounds (prebiotics + probiotics) within the host body that ultimately lead to productive and immunological effects of the animal as shown in Fig (3). The mechanics of working inside the host body depend on the method of each compound that gets involved in the synthesis of synoptic. First, we will start with probiotics.

Probiotics are different types of microorganism that perform several tasks upon reaching the intestine as follows:

1- Competition exclusion: Competition between bacteria depends on the adhesion sites and organic substrates. Therefore, when adding Synbiotics, the microorganisms in it multiply and colonize in the intestine, this will block the site receptors and reducing the count of harmful species of the bacteria as E. coli sp and Salmonella sp (Schneitz 2005).

2-Bacterial Antagonism: The Synobiotics contains many different strains of microorganisms reduce the number of pathogenic bacteria through the production of acids and antibacterial substances, which have an a inhibitory effecton the pathogenic bacteria, such as the secretion of hydrogen peroxide by some strains(Edens 2003).

3- Modulation in the immunity: There are important aspect of Synbiotics is the activation the immune response of the gastrointestinal against some pathogenic microorganisms, by increasing production of cytokines; macrophage, lymphocyte, immunoglobulin (IgG, IgM and IgA); natural killer (NK) cell activity and stimulating the γ-interferon production (Koenen et al. 2004; Lan et al. 2005; Haghighi et al. 2006; Yang et al. 2009; Alkhalf et al. 2010; Wlaźlak et al., 2023 and Ayalew et al., 2025). Therefore, using Synbiotics is a good method to protect against diseases in animal.

The benefit from the microorganism part of the Synbiotics (Probiotics) will maximize by the second part (Prebiotics) of the Synbiotics, which the substrates of the Synbiotics achieved better results for the effect of the microorganism in the intestine for the host. To achieve the objective of the components in Prebiotics, some conditions and a certain mechanism required to benefit from the substrate of Prebiotics as follows:

1. The substrates in the prebiotics are not digested, also not absorbed in the gut
2. The substrate should be helping select the benefit microorganisms at the intestine
3. After a large substrate reaches the large intestine, it will ferment and this causes a change in metabolic processes, also, improving the immune system for the host.
4. It increases to increase and growth of the colonies of microorganisms found in probiotics

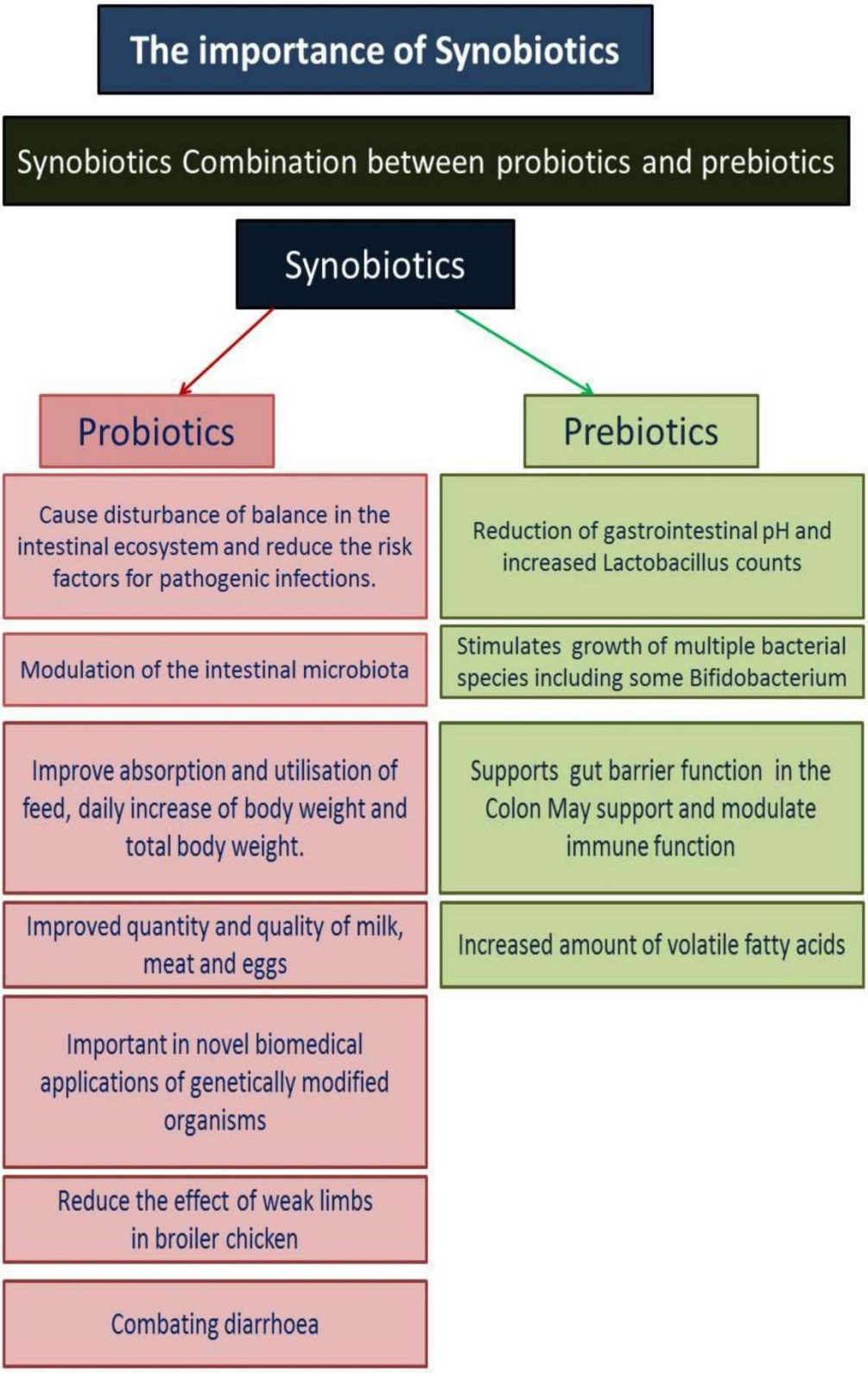

Figure (2): Explain the benefit of add the Synbiotics for poultry dietary

In the end, because of the positive interaction between probiotics and prebiotics on the growth of microorganisms in the intestine, which increase the growth causes production for some compounds that affect pathogenic bacteria, reduce their numbers, activate immunity, and improve the efficiency of absorption of nutritional elements, consequently, growth and food efficiency will improve.

The mechanism of the synoptic action in the body does not depend on the microbal balance only in the intestine, but also some studies have confirmed that synoptic changes in the morphology of the intestine, which increase the ratio of villus height and villus: crypt ($p < 0.05$) (Min et al., 2016). Also, synbiotic stimulates the gastrointestinal tract stimulates causing increase feed intake and growth, however, the gastrointestinal tract development slowly in the slow growing breeds compared to the fast-growing broiler chickens (Mabelebele et al., 2014 and 2016; Chayatid et al., 2019 and Sunu et al., 2021). The longer in the ileum and ileal villi increase the utilization of feed and this reflects on the live body weight (Jamroz et al., 2002; Hassan and El-Ghazali, 2019 and Ravindran & Abdollahi, 2021).

From previous study the morphology changes in the intestine increase the growth performance and feed efficiency.

performance as shown in figure (4), which, the combination between probiotics and prebiotics (Synbiotics) enhance the activity and the survival of microorganisms of the probiotics and can stimulate endogenous bacteria such as *Lactobacillus* and *Bifidobacteria* (Tuohy et al., 2003).

Pelicano *et al*. (2004) investigated that the feed conversion ratio (FCR) and growth was significantly improved when malto-oligosacharides (MOS) was added with probiotics such as *Lactobacillus acidophilu*s, *faecium, Streptococci lactis, Bifidobacterium bifidum* and *Aspergillus oryzae* but the improvements were only evident during 1-21 days of age.

Awad *et al.* (2008 & 2009) confirm that, ther are improbe in growth performance and relative carcass traits ($P< 0.05$) when added thef the symbiotic to diets (1 kg of Biomin IMBO/ ton of the starter diets and 0.5 kg/ton of the grower diets to dietary supplementation) compared with the control. Also, they found that both absolute and relative lymphoid organs, liver and small intestine were increased ($P< 0.1$) for the treatments with probiotic only compared with the synbiotic-treatment. On other hand, Ghasemi et al. (2010) found that, the dits with synbiotics (Biomin®IMBO) had positive effect on body weight gain and feed conversion ratio of broilers chicken of age. The same trend was found on growth performance and meat quality trait, when ovo-injection of synbiotics (Maiorano et al., 2012) and supplying synbiotic had low effect on the performance traits. Other studies confirmed that the use of synbiotic. (a mixture of Lactobacillus and fermentative products of Aspergillus fungi) increased body weight gain and feed-intake of broilers (Falaki *et al*., 2011 and Ghahri *et al* 2013; Salehimanesh et al., 2016 and Kumar et al., 2025).

Another study by Mousavi et al. (2015) investigated that, the synbiotic had significant effect ($P< 0.05$) on the body weight gain and the maximum effect was from at 0–2 week of age. Although feeding the synbiotic increased feed intake at the first week of age, the feed efficiency was significantly better during the starter phase of broilers chick. Also, the consumption of metabolizable energy (ME) and crude protein (CP) were increased when feeding the synbiotic at 0.075 and 0.15% of diet ($P< 0.05$) of broilers chick. The birds fed the 0.075% of the synbiotic showed higher production index and revenue margin ($P< 0.05$), also live body weight and feed conversion ratio were increased, when feed the broiler chicks on a diet containing 0.1, 0.15 and 0.125% of the synbiotic compared to control. In conclusion feeding broilers with 0.075% Biomin®IMBO (25% lower than proposed levels) in the diet was the most cost-effective level and growth traits compared to the remain treatments.

Productive performance: Many studies confirm that there is a significant effect of synbiotics on growth. Other study by (Sarangi et al., 2016), which they investigated the effect if added synbiotics at four treatments, the first, was the control group feed on basal diets, the second treatment was feed on basal diets+ prebiotics (400 g/tonne), the third treatment was feed with probiotic which add to the starter diets (100 g/tonne) and to the finisher diets (50 g/tonne), the last treatment was feed on diets with synbiotic (500 g/tonne).

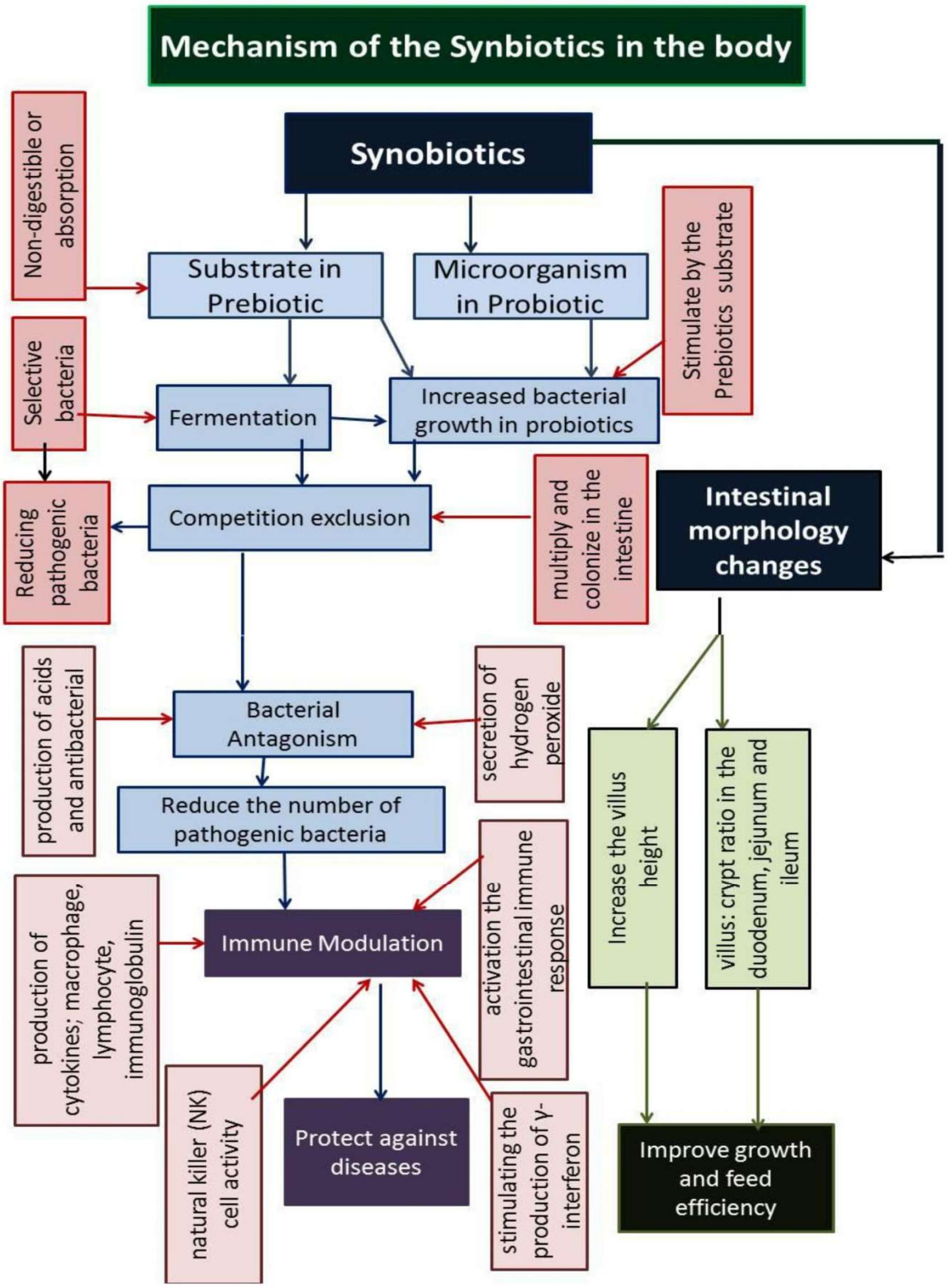

Figure (3): Explain the Mechanism of the Synobiotics in the body

The authors confirmed the diets with synbiotics did not different than the control groups, However, the other groups were significantly lower on body weught than the synbiotic and control groups., Also, the authors confirmed that there was no effect of diets with probiotic, prebiotic and synbiotic compared to control groups. The same notice found by (Abdel-Hafeez et al., 2016) which no effect found on growth performance and relative carcass weight with treatments with add synbiotic, prebiotic and probiotic. for effect of probiotic, prebiotic and synbiotic (with and without feed restriction), however, the authors confirm that the control groups were significantly lower for live body weight and feed conversion ratio. also, the cost of the ffes per kg was higher in the control groups They recommended restricting feed on diets with add synbiotic or probiotic, which improve the feed efficiency, live body weight and decrease the cost of the feed.

Min et al. (2016) found that the body weight gain and feed efficiency ($p < 0.05$) significantly increased on 21 and 42 days, when add synbiotics. They indicted that, the diets with synbiotics (*B. subtilis* and xylooligosaccharide and mannanoligosaccharide) had effect on the changes on the intestinal morphology, antioxidant capabilities and sIgA content, these changes related to improve feed efficiency and live body weight. The same results obtained by (Shokri et al., 2016) when use the Synbiotics on feed the broiler chicken, they found significantly in the same traits at 21 and 42 days, this was also, related to change on the morphology of the intestine, by significantly increased the villus height and villus:crypt ratio ($p < 0.05$), intestinal mucosa sIgA content ($p < 0.05$), serum T-SOD activity ($p < 0.05$) and lysozyme content ($p < 0.05$) compared with control group. However, Erdoğan et al. (2016) didn ont found effect of feed birds on diets with synbiotic and phytobiotic on growth performance.

Immunity: In addition to the effect of synbiotic on growth performance, also it effect on the immunity of the bird and reduce the mortality and pathogenic bacteria as showed in figure (5), there are many studies confirm the effect of synbiotic on the immunity (Tiihonen et al., 2010; Viveros et al., 2011; Zhang et al., 2013; Zhao et al., 2013; Liu et al., 2014; Shah et al., 2023 and Acharya et al., 2024).

Salehimanesh *et al*. (2016) reported that birds fed diets with probiotics influenced by increasing some immune blood components, such as IgM anti-SRBC titres on days 28 and 42, also, antibody titter against Newcastle virus disease increased ($p < 0.05$). for 42 days. The authors confirm that the synbiotics increased ($p < 0.05$) anti-SRBC at 28 days. They concluded that an increased in humoral immunity of broilers when feeding on diets with prebiotic. Another study by (Erdoğan et al., 2016) investigated that, the caecal coliform count decreas ($p < 0.01$) when feeding in both Synbiotics and phytobiotics. Also, the levels of plasma malondialdehyde (MDA) increased ($p \leq 0.05$) when use the synbiotics and phytobiotics in combination, the same trend was recorded, the same results for the same groups (Synbiotic and phytobiotic) for the level of nitric oxide (NO) which increased ($p \leq 0.001$) in the blood. But there is no significant different was found for the superoxide dismutase (SOD) activities among all treatments. Finally, the authors concluded, that the synbiotic and phytobiotic increased the gut health by decrease the the caecal total coliform count, but no effect for synbiotic and phytobiotic found for growth performance. The coccidial oocysts decreased when add 0.15% synbiotic compared to control groups (Awad *et al* 2008 & 2009). Another study confirms that the no effect of add synbiotic to diets on some blood parameters (hemoglobin, serum total protein, albumin, globulin, glucose, and total cholesterol), however, the packed cell volumeand bursa of fabricius increased in the treatments with additive synbiotics compared to control groups (Abdel-Hafeez et al., 2016).

Kavita et al (2015) indicated to the benefited of the synbiotics on the health performance of the host, which the synbiotics effect on the microorganisms in the intestine to produce some inhibitory substances like H_2O_2, bacteriocins and organic acids, also, decrease the competition for nutrients between the pathogenic bacteria and benefit bacteria by block the adhesion sites for pathogenic bacteria, also the benefit bacteria in the synbiotics block the toxin receptors, finally the synbiotics modulate the immune responses

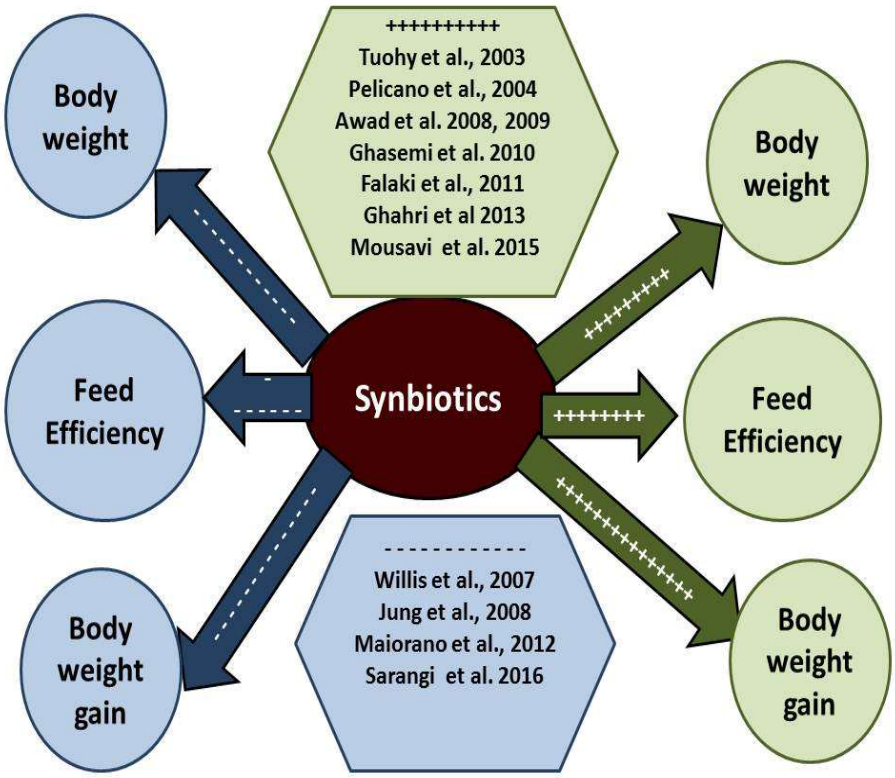

Figure (4): Concluded the result from differences studies for the effect of synbiotic on growth performance traits, which (+++) indicate to significant increase and (- - -) indicate to non- significant effect.

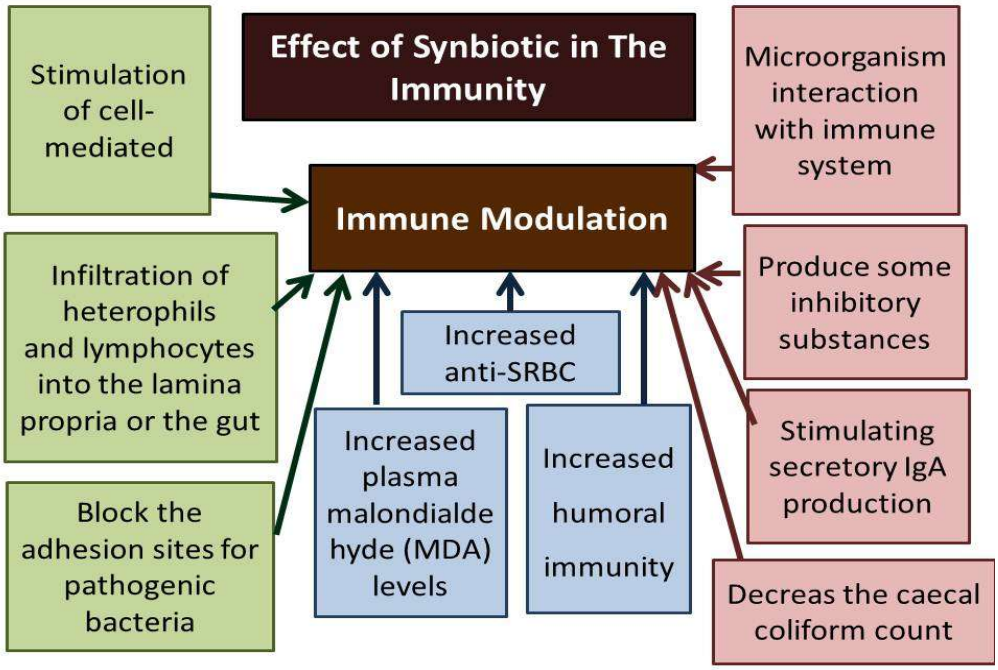

Figure (5): Concluded the effect of synbiotics on the immunity

Conclusion

Synbiotics could be recommended as alternative growth promoters that can possibly overcome the inconsistent effects on the responses reported by different authors to probiotics and prebiotics. The previous study confirm that, the synbiotics improve the productive performance and the immunity of the host through he mechanization of its components (Prebiotics and Probiotics), which depends on the of quantitative and qualitative microorganism in the intestine and morphology of the intestine, which consequently positively affects immunity and productive performance.

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