

The Effect of Insects as An Alternative Protein Source on Broiler Meat Quality (Mini Review)

Running Title: Insects as An Alternative Protein Source

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Abstract

Meat is the most crucial protein source for human nutrition. Poultry meat production and consumption ranks first in the world ranking. However, in parallel with population growth, demand and production costs increase continuously. One of the main feed ingredients in chicken diets, protein sources constitute a significant part of the cost. Therefore, the look for cheaper and alternative sources to reduce feed costs is a current issue. In recent years, the number of studies using various insects including black soldier fly larvae, crickets, or mealworms as an alternative protein source has increased. In this review, the effects of using insects as an alternative protein source on broiler meat quality are discussed.

Keywords: Insect; protein source; broiler; meat quality

Introduction

Proteins are essential macronutrients in the human diet. Meat is the most important protein source in terms of the high digestibility rate (approximately 92%) and biological value of the protein it contains [1]. The amount of meat consumed and the preferred meat type is closely related to the economy, living standards, dietary habits, livestock production, and costs. Poultry consumption is higher than beef, sheep, and pork meat in World [2]. Data from the Food and Agriculture Organization of the United Nations (FAO) show that poultry meat production ranks first in the world meat production ranking. However, due to avian influenza epidemics and high feed costs, its production is declining, and its price is constantly increasing [3]. Although poultry meat production maintains its importance throughout the world, reducing feed costs will positively affect both the production amount and meat prices. On the other hand, it is very important to provide protein sources which are the second largest component of poultry feeds in a sustainable manner to meet the needs of the animal in mixed feeds. The dietary protein requirements of broilers are high. For example, the crude protein (CP) requirement for broilers 0 - 3 weeks old was set at 23% by the 1994 NRC [4]. In poultry diets, protein sources come in second place to energy as the main component and constitute a significant

part of the cost. In this case, the way to make the feed cheaper is to obtain economic resources or to use alternative resources by considering the needs of the animal. There are different protein sources of vegetable and animal origin that can be used in poultry diets. They all differ in their amino acid profile. Plant protein sources meet most of an animal's nutritional needs, and the most preferred protein source in the production of chicken feed is soybean meal (SBM). Typically, plant proteins are less expensive than animal proteins. Plant protein sources generally lack some essential amino acids and are nutritionally imbalanced, which reduces their biological value. On the other hand, while animal proteins are expensive for use in commercial broiler production, they are well-balanced in terms of the essential amino acids required for body growth and development [5]. While FAO predicts strong growth in chicken meat demand through 2050, the cost and availability of soybean meals and animal proteins for sustainable chicken meat production are likely to become a major issue. Thus, it is crucial to find new sources of dietary protein [6]. As predictable, different protein sources will vary in feed cost, but another issue to consider is how different protein sources affect broiler meat quality because feed is an influential factor on carcass composition, meat quality, tenderness, color, and fatty acid

profile [7,8]. The modifications in the muscle, skeleton, and fat depot development are intimately tied to the way an animal reacts to its food [8,9]. For example, breast meat yield, which makes up a significant amount of the body's protein synthesis, is sensitive to the diet's amino acid composition. The amount of protein and amino acids in the carcass can be increased by lowering the proportion of fat and increasing crude protein or individual amino acids in the diet [10]. The composition of amino acids in poultry meat is comparatively stable. It can be slightly altered, by varying the diet's consumption of amino acids. For instance, Baéza et al [11] reported that increasing the amount of valine, isoleucine, and leucine in the diet above the growth requirement (150%) increases the glutamate concentration of chicken fillets.

In recent years, the number of studies on the use of as an alternate protein source, several insects has increased. These insects, such as mealworms (*Tenebrio monitor*), crickets (*Gryllus testaceus* Walker), and black soldier fly larvae (*Hermetia illucens*), may contribute efficacious protein, energy, and fat for animals. Insects have attracted attention in recent years as potential alternative protein sources due to their rich in protein, omega 6, omega 3, lauric acid, and bioactive compound ingredients, and advantages such as low ecological charge, lower greenhouse gas emissions, lower feed-food competition, protein production in smaller landfills [12].

Schiavone et al. [13] in their study used fat-free black soldier fly (*Hermetia illucens* L., HI) larvae meal as a protein source in broiler rations. With increasing HI meal levels, they observed an increase in redness (a*), a decrease in yellowness (b*), a decrease in moisture content, and an increase in protein content in breast meat. At the same time, they determined that versus the polyunsaturated fatty acid component, the ratios of total saturated and total monounsaturated fatty acids increased. They reported that HI larval meal can be used as a valuable protein source in broiler feeds.

In another study, it has been reported that using lupine seeds and insect larvae meals (from silkworm (*Bombyx mori*) pupae, mealworm (*Tenebrio monitor*), or superworm larvae (*Zophobas morio*) as an alternative protein source, there is no significant difference compared to the control in terms of CP content, palatability, juiciness, tenderness, and flavor in broiler breast and leg meats. At the same time, the use of superworm larvae meal is not recommended because it negatively affects broiler growth performance, but it has been reported that silkworm and mealworm larvae meal can be used in broiler chicken rations without compromising the sensory quality of the meat [14]. On the other hand, Shaviklo et al [15] reported that mealworm (*Tenebrio molitor*) can be included in the diet up to 3% and that higher levels may adversely affect meat quality and sensory characteristics. In a similar study using worm meal from *Eudrilus eugeniae* (EWM) in different ratios as an alternative protein source, it was reported that as the dietary supplement of EWM increased, the juiciness

and flavor of breast meat increased, but there was no difference in terms of aroma, chewiness, first bite, pH and drip loss. It has been reported that EWM can be a suitable protein source for broilers and a good substitute for fish meals [16].

According to Altmann et al. [17], using partially de-fatted *Hermetia illucens* larval meal instead of soy flour in the broiler ration increases the yellowness, lowers the pH, reduces adhesive during chewing of breast meat, and increases the saturated fatty acid ratio in thigh meat. Kim et al. [18], who replaced soybean meal with 0, 25, and 50% Microwave-dried defatted Black Soldier Fly (*Hermetia illucens*) larvae meal in their study, reported that 50% substituted feed reduced the carcass weight, however at low rates could be used in broiler rations without adversely affecting heavy metal residues. Supportively, Pieterse et al. [19] also reported that Black soldier fly (*Hermetia illucens*) pre-pupae meal could be used in broiler rations up to 15% without affecting the carcass characteristics and the sensory properties of meat (such as aroma, taste, juiciness, and tenderness).

Conclusion

It seems that broiler breeding will maintain its importance for many years to meet the animal protein needs in human nutrition. However, it is inevitable to experience problems in the sector due to increasing demand and production costs. To reduce feed costs, the search for alternative sources continues. The results of the studies show promise that insects could be used as an alternative protein source in broiler rations without adversely affecting meat quality. Nevertheless, there is a need for more comprehensive studies on the diversity, dose, duration, and cost of using insects as an alternative protein source in broiler rations.

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