NUEVAS FUENTES DE PROTEÍNAS DE ORIGEN ANIMAL. EL USO POTENCIAL DE INSECTOS.

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Insects in poultry nutrition: applications and perspectives

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Insects are currently considered a novel protein source for animal feeds (Sánchez-Muros et al., 2014). Insect meals exhibit a great potential for becoming a standard ingredient in animal feeding, because of the high quality and quantity of protein (Ramos-Elorduy, 1997). Invertebrates are included in the European Union Feed Material Register as a feed material, even though they are currently only authorized for pets and farm fish. However, insect-derived feeds could also represent a possible ingredient for livestock animals, such as poultry, pigs and fish (Veldkamp et al., 2012; Van Huis, 2013; Makkar et al., 2014; Henry et al., 2015). In particular, the most promising insect species for industrial production are *Hermetia illucens* (black soldier fly), *Musca domestica* (common house fly), *Tenebrio molitor* (yellow mealworm), *Bombyx mori* (silkworm) and several grasshoppers (Van Huis, 2013).

Considering that insects are consumed naturally by wild birds and free-range poultry (Zuidhof et al., 2003), some studies have evaluated the feasibility of using insects as an alternative feed source for poultry (Khatun et al., 2003; Wang et al., 2005; Oyegoke et al., 2006; Adenjii, 2007; Hwangbo et al., 2009; Ijaiya and Eko, 2009; Ballitoc and Sun, 2013; De Marco et al. 2015; Schiavone et al. 2017a). Some authors have observed no differences in growth performance (in terms of feed intake, body weight gain and feed conversion efficiency) in broilers fed a control diet and an insect-based diet (Wang et al., 2005; Oyegoke et al., 2006; Adenjii, 2007; Ijaiya and Eko, 2009; Bovera et al., 2015; Bovera et al., 2016; Biasato et al. 2016). Other studies have reported that insect meal inclusion in chicken diets improved animal growth indexes (Khatun et al., 2003; Hwangbo et al., 2009; Ballitoc and Sun, 2013). The same studies also observed an improvement in carcass yield characteristics, such as dressing percentage, breast muscle, thigh muscle, slaughter, dressed carcass and eviscerated weights (Khatun et al., 2003; Hwangbo et al., 2009; Ballitoc and Sun, 2103).

The majority of the oil sources used in poultry diets consist mainly of fat from poultry and other animals and crude vegetable oils. Among vegetable oils, soybean oil is a potential ingredient in poultry diets, however, currently, the limited supply of soybeans and their high price has caused increasing interest in the search for new alternative lipid sources for poultry feed. Certain insect species have a high fat content with higher levels in larval stages than in adults (Ramos-Elorduy, 1997; Barroso et al., 2014). In fact, lipids are also a main component of insects and are produced during protein isolation. Henry et al. (2015) and Surendra et al. (2016) pointed out the importance of defatting insect meal and then using insect protein concentrate as an animal feed ingredient and the lipids for both animal nutrition and the production of biodiesel. Such authors showed that fat removal is necessary to improve the storability of the feed and to increase the protein digestibility of the insect-derived feed. Schiavone et al. (2017b) demonstrated the safe use of *Hermetia illucens* (HI) oil in poultry nutrition.

Intestinal morphology is the main indicator of gut health and functioning (Kristy et al., 2005). Dietary protein level and digestibility have been reported to significantly affect the intestinal development and the mucosal

architecture of the gastrointestinal tract of broilers (Laudadio et al., 2012; Qaisrani et al., 2014). Intestinal development can be assessed through morphometric measurements of the villus height (to determine the area available for digestion and absorption) and crypt depth (the region in which new intestinal cells are formed) (Franco et al., 2006). The villus height/crypt depth ratio can also be evaluated, because it generally gives an indication of the likely maturity and functional capacity of the enterocytes (Hampson, 1986). The gut morphology in chicken was not affected by the insect protein concentrate administration (Biasato et al., 2016; Biasato et al. 2017 in press) or insect oil (Schiavone et al. 2017b).
Insect derived products (protein concentrate and/or oil) represent a promising ingredient in poultry nutrition.

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