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NUTRITIONAL AND HEALTH ASPECTS OF EARTHWORMS (*EISENIA FOETIDA*) SUPPLMENTATION IN POULTRY DIETS: REVIEW ARTICLE

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ABSTRACT: In recent years and globally, the poultry industry has become of great importance in the production of animal protein, with the increase in per capita consumption of meat and eggs around the world. It is noteworthy that the cost of feed production represents 60-70% of the total poultry production, where protein is the most expensive component. Protein sources are known to be of either animal or vegetable origin, with animal sources having a more balanced amino acid profile. But due to the limitations on the availability of traditional feeds for poultry as well as the remarkable development in the development of new genetic strains, all this has led to a change in nutritional needs. So researchers began looking for new and alternative protein sources to reduce feed costs, such as using the *Eisenia foetida* earthworm, which is a new and safe source of animal protein. But until now, the possibility of using Eisenia foetida as one of the new and safe sources of poultry feed in Egypt has not been studied. On the other hand, *Eisenia foetida* can be used for other purposes, such as the technique of producing vermicompost, which is one of the new technologies for the safe treatment of non-toxic organic waste using earthworms, because there is an urgent need to recycle poultry waste in a safe and environmentally friendly manner, and this can be applied through the use of earthworms. Therefore, the aim of this article is to shed light on the use of *Eisenia foetida* as one of the new partial alternative sources of protein that can be used in poultry rations to reduce production cost without affecting production performance, health aspects or the quality of its products.

Key words: *Eisenia foetida*, poultry rations, nutritional and health aspects.

INTRODUCTION

It is remarkable that the world population is increasing very rapidly in recent years, where the number is expected to reach 8.5 to 12 billion by the year 2100 (Singh *et al.*, 2016). The demand for poultry meat and eggs has increased recently due to its quality, nutritional value and favorable price, but with the increase in demand for eggs and meat, the demand for poultry feed is also increasing (Mallick *et al.*, 2020). In this context, Gunya and Masika (2021) found that the total cost of production is about 60-70%, where about 175% of which is animal protein. Therefore, Sanchez-Sabate and Sabaté (2019) showed that at the global level, feed raw materials represent the highest input for poultry production, and therefore the great challenge facing many is the effective use of environmental resources to convert them into animal feed. However, in another study reported by Köse and Öztürk (2017) indicated that about 70% to 75% of the total costs are feed, in which the protein cost is about 15% of animal proteins, and while protein is provided by adding soybean or fish meal the worms contain an abundance of the essential amino acids, and their protein content is easy to digest, where it is a good alternative in terms of adding them to the feed. In this concern, Nalunga *et al*. (2021) showed that there is a significant increase in the demand for animal protein sources such as fish meal in many countries, but this is hindered by its high cost, which makes earthworms an alternative protein source. Clearly, earthworm scan be used as a good alternative in poultry diets (Bahadori *et al*., 2015). According to Khan *et al.* (2016) indicated that earthworms contain a high level of protein, up to about 73%, which contains high levels of amino acids, thus it can be added to poultry diets as a safe alternative through commercial production (Parolini *et al*., 2020). However, there is not enough research or information's regarding the use of *Eisenia foetida* in poultry diets. Therefore, this review article aims to shed light on the possibility of evaluating and using earthworms as a new and safe alternative to protein in poultry diets in addition to other benefits that can be obtained from these worms. However, there is not enough research or information's regarding the use of *Eisenia foetida* in poultry diets. Therefore, this review article aims to shed light on the possibility of evaluating using earthworms as a new and safe alternative to protein in poultry diets

Characteristics, description and species of *eisenia foetida.*

Earthworms are very important to the ecosystem because they work on modifying and improving soil properties and thus increasing plant productivity. Recently, interest has been increased in the possibility of using earthworms, either alone or in combination with other soil organisms, to treat soils contaminated with toxic elements (Ran *et al.*, 2022). The results published by Ali and Kashem (2018) showed that earthworms are small macroscopic clitellate oligochaete annelids that live in the soil, where they are segmented symmetrically diploid with an external gland (clitellum) to produce the egg (cocoon), sensory lobe in front of the mouth (prostomium), and anus at the end of the body, with a few hairs (bristles) on each segment. The worm is

hermaphrodite in which reproduction occurs through copulation and cross fertilization, which is followed by each of the mated individuals producing cocoons containing 1-20 fertilized eggs. Unpigmented earthworms hatch only a few millimeters long as they emerge from the cocoons, and some days acquire their adult pigment. Assuming favorable conditions, they reach sexual maturity within several weeks after emergence. Accordingly, Schubert *et al.* (2019) reported that the earthworms is one of the most widespread living organisms due to its wide spread, tolerance to different temperatures, its great ability to live in organic waste under different levels of humidity, as well as its ability to reproduce and grow very quickly. In addition, Rodriguez- Campos *et al.* (2014) found that there are characteristics of earthworms such as rapid reproduction and ability to grow on many organic residues.They also added that there are about 4000 species of earthworms of which few have been used in worm composting because they exhibit suitable characteristics such as tolerance to a wide range of environmental conditions, short life cycles, and high reproductive rates (Bahadori *et al.*, 2015). However, Amador *et al.* (2013) illustrated that earthworms have many physical, chemical and biological effects that are beneficial to the soil and many researchers have indicated that these effects can increase plant growth and productivity. Also, currently, earthworms are of great importance to the soil where some species have the great ability to convert organic waste into valuable compost of great value. Therefore, understanding the growth and reproductive efficiency of earthworms would be essential for the effective use of earthworms in a sustainable waste management system (Jesikha and Lekeshmanaswamy, 2013). Results of Reynolds and Wetzel (2004) indicated that there were more than 8300 species in the Oligochaeta. Half of which are terrestrial earthworms. Also, Shalabi (2006) who reported that average time to reach sexual maturity for *Eisenia foetida* was about 70 days. Furthermore Degefe and Tamire (2017) indicated that when the soil contains a moderate percentage of nitrogen, earthworms produce cocoons that have the ability to live, and this is due to that protein is very important for the growth required for them. The following Tables shows growth parameters, rate of cocoon production and incubation period of different species of worms according to Ali and Kashem (2018).

Production, growth and reproduction of *eisenia foetida.*

Due to the direct relationship associated with the availability and quality of food and their importance to the growth and reproduction of earthworms (Dabral *et al.*, 2013), research has indicated that earthworms can grow and reproduce on different types of waste obtained from industrial and household waste. Similarly, Nath and Chaudhuri (2014) discovered that organic matter provides earthworms with the appropriate environment to facilitate their metabolism and thus the speed of growth and reproduction. In this context, Loh *et al.* (2004) mentioned that when the earthworms were supplied with waste from cattle, the total mass and production of cocoons was greater than the supply with waste from goats. Moreover,

Gunadi and Edwards (2003) studied the long-term growth, reproduction and death of *Eisenia foetida* on different types of waste. They found that worms could not survive when fed livestock and pig waste, fruit scraps, or vegetable waste. On the other hand, the growth of *Eisenia foetida* was faster when fed with pig waste compared to feeding on cattle waste.

During vermicomposting, earthworms eat and grind the various substances, aided by anaerobic microflora to increase the surface area for bacterial colonization and enzymatic action (Edwards and Fletcher, L988). Therefore, Ali and Kashem (2018) found that *Eisenia foetida* start to produce a cocoon at the sixth week and *Eudrilus eugeniae* begins to release a cocoon at the seventh week of age. While, cocoon production ceased after 12 weeks for *Eisenia foetida* and 9 weeks for *Eudrilus eugeniae* (Fig. no 1). The maximum weights achieved per earthworms (1116 ± 16.4 mg), net weight gain per earthworms (819 ± 12 mg) *(Fig. no 2).* On the other hand, Giraddi *et al*. (2010) found that the cocoons of *Eisenia foetida* reach sexual maturity in about 6-8 weeks compared to the cocoons of *Eudrilus eugeniae*, which reach sexual maturity in less than five weeks to produce their first cocoon.The results of Shalabi (2006) reported that the standard mean time to reach sexual maturity for *Eisenia foetida* was about 70 days. However, Mahboubkhomami *et al.* (2016) illustrated the weight gain for *Eisenia foetida* per gram of dry weight of the feed source in cow waste + sugarcane bagasse was (39 ± 0.66 mg/g) and cow waste was (37 ± 0.36 mg/g), which were greater than in cow waste + sawdust waste (34 ± 1.05 mg/g). According to Domínguez and Edwards (2011) found that *Eisenia foetida* has a high rate when its environmental conditions in terms of temperature and humidity were around 25°C and 85% respectively, where it can reproduce after only 45-51 days with a hatching rate of pupae of 72-82%, and the time it takes for young *Eisenia foetida* earthworms to reach sexual maturity is between 21 and 30 days

The importance of *eisenia foetida* from an environmental point of view

Earthworms are the dominant invertebrate organisms in the soil in terms of overall activity and total mass. These worms play a major role in the soil ecology because they carry out soil movement, nutrient flow, water movement and plant growth. In this context, Lemtiri *et al.* (2014) indicated that earthworms are important organisms in the analysis and recycling of waste, which actively contribute to the nitrogen, phosphorous and carbon cycles in the soil, which are known to affect soil fertility by participating in important processes such as regulating soil structure and organic matter dynamics. On the other hand, earthworms work to control and modify microbial communities, where earthworms are characterized by their great ability to decompose organic matter in many wastes, where they not only fertilize these materials but also provide a high quality and disinfectant for improve soil properties (vermicompost) and represent additional source of protein for feeding farm animals and aquaculture species (Edwards *et al.*, 2011). In addition, Butenschoen *et al.* (2009) showed that earthworms are important decomposers that actively contribute to the cycling of nitrogen-containing nutrients and

thus accelerate the mineralization of nitrogen in organic matter, but this work depends on species and their interaction with soil, organic matter and soil organisms. Also, earthworms contribute to nutrient cycling processes involving nitrogen (Lavelle *and* Martin, 1992), phosphorus (Chapuis-Lardy *et al*., 1998) and carbon (Curry and Schmidt, 2007). However, Barré *et al.* (2009) stated that earthworms affect the mechanics of loose or compacted soil, as the soil turns into a more suitable form for structural stability and root growth.

Chemical composition and nutritional importance of *eisenia foetida*

Earthworms contain protein in dry matter of 64.5% and 72.9% on average and are therefore good sources of protein (Lieberman, 2002), and amino acids, fats, carbohydrates and minerals present in high levels in worms are essential for poultry (Dedeke *et al.,* 2010). They also contain 8-20% carbohydrates of the dry matter of their bodies (Ghatnekar *et al.,* 2000).

In a study reported by Janković *et al.* (2015) showed that the earthworms is characterized by having a protein content of 41.42% in the dry matter and suitable amounts of lysine and methionine up to about 3.33%, 0.96% on a dry matter basis. Also, Kostecka and Paczka, (2006) showed that earthworms are one of the new alternatives that are used as a new source of protein, where it contains 580-710 g/kg on a dry matter basis in addition to containing high level of lysine, which is nutritionally important for poultry. In this regard Istiqomah *et al.* (2009) found that earthworms are a very important source in meeting the requirements of poultry for lysine. However, Sogbesan and Ugwumba (2008) they indicated that earthworms contain protein, fats, crude fiber, ash and nitrogen-free extract in percentages of 63.0%, 5.9%, 1.9%, 8.9 % and 11.8% respectively. Also, they added that the essential amino acid present in the earthworms were found to be 2.83%, 1.47% , 2.04%, 4.11%, 6.35%, 5.30%, 6.26%, 4.43 % and 4.43% for Arginine, Isoleucine, Lucien, Lysine, Methionine, Phenylalanine, Threonine, and Valine respectively. Moreover, Gunya *et al.* (2016) showed that *Eisenia foetida* contains 45.8% saturated fat, 22.2% monounsaturated fat, 31% polyunsaturated fatty acids, 23.5% n6 and 8.3% n3 fatty acids on a dry matter basis. Research indicated that worms were rich in essential amino acids and digestible protein which can be used as alternatives (Köse and Öztürk, 2017). Tables 4 and 5 show comparisons of earthworms with different protein sources and nutrients for some worms according to data reported by Rumpold and Schlüter (2013) and Köse and Öztürk (2017).

The ecological importance of *eisenia foetida*

Some types of earthworms have their great advantages in converting organic waste into vermicomposting of vital value. Earthworms also have beneficial physical, chemical and biological effects on the soil, which effects on plant growth (Amador *et al.,* 2013). According to Kale and Karmegam (2010) indicated that earthworms are important indicators of the level of soil contamination with agricultural chemicals, heavy metals, toxic materials and waste resulting from industrial activity. Also, Dittbrenner *et al.* (2010) showed that earthworms were a major

indicator of the condition of the soil, but attention should be paid to the effects of environmental toxins on these organisms, where the level of toxins in the soil may have a fatal effect if they are found in the soil at high levels. Furthermore, Kumar *et al.* (2018) observed that earthworms have a behavioral activity that positively affects the physical, chemical and biological properties of soil organic matter, and these effects are of great importance in increasing the growth of agricultural crops. Also, earthworms are considered important indicators of environmental change in soil related to fertility and chemical contamination (Bustos-Obreg and Goicochea, 2002). Also, Köse and Öztürk (2017) found that when the suitable conditions are present in the soil earthworms pass soil through their stomachs at a rate of 60% of live weight and this work makes the soil organic, where earthworms can be used to recycle organic matter. Thus, earthworms are considered environmentally friendly and effective to be used in converting organic waste into a product with a high fertilizer value (vermicompost).

Protein sources and *eisenia foetida* as new alternative sources in poultry nutrition

In fact, earthworms contain large amounts of protein and amino acids, and therefore, they are a good protein source when added to poultry feed (Mason *et al.*, 1992). It is known that the main determinants of poultry feed prices are its protein and energy content in general, where fish meal and soybean meal are used as protein sources in poultry feed, but the disadvantage of their use is their high costs (Tacon and Metian, 2008). In this context, Kostecka and Paczka (2006) found that the continuous increase in the prices of previous raw materials led to the urgent need to search for new sources of protein as alternatives. Therefore, earthworms are among the alternatives that can be used as protein sources for this purpose. In addition, Gunya and Masika (2021) indicated that *Eisenia foetida* is considered as a promising alternative to protein due to its high content of protein, amino acids and fatty acids. However, approximately 70-75% of the total cost of poultry production consists of feed costs of which 15% of this rate is made up of proteins (Özen *et al.,* 2005). Also, Adeniji (2007) showed that the use of soybean meal and fish meal in poultry feed leads to an increase in the cost of rations, therefore the search for alternative sources is of great importance in poultry production (Admasu *et al.,* 2019). Also, Ncobela and Chimonyo (2015) published that there are many other alternative protein sources that can be used such as house fly maggots, terminates, snails, grasshoppers, silkworm caterpillars and earthworms, where several authors indicated that *Eisenia foetida* is a good source of protein for chickens (Tiroesele and Morecki, 2012). In other studies published by Abro *et al.* (2020) noted that protein contributes recently to about 60% of the total costs associated with the production of broiler chickens in many countries, with negative effects on both producers' profits and the food supply of the population. Due to the high price of traditional protein sources, especially with regard to seasonal changes in prices, there is an increasing interest in alternative protein sources for broiler chickens, where earthworms are considered one of the new

sources in this regard (Köse and Ozturk, 2017).

The effects of *eisenia foetida* on performance of poultry

In a study reported by Miri *et al*. (2014) noted that adding earthworms at a level of 20-60 g/kg of diet improved gain of broiler chickens, while feed intake was insignificantly affected. In this context, Gunya *et al*. (2019) showed that the addition of 3% of *Eisenia foetida* in ration significantly improved live weight compared to the control group of broiler chickens. Therefore, the use of earthworms in diets is an important source of protein for feeding broiler chickens (Zang *et al.,* 2018). According to Kostecka and Pączka (2006) showed that earthworms contains high levels of protein which is used in chickens, pigs, rabbits and fish. Also, Son and Jo (2003) reported that adding 0.4% of roundworm powder to broiler diets improved feed intake and live weight as well as increased nutrient digestibility of birds compared to feeding 0% and 0.2% earthworm's meal. Furthermore, Sofyan *et al*. (2010) evaluated the effect of earthworm supplementation on the growth of broiler and indicated that feeding broiler chickens on diets containing earthworms improved daily growth and feeding efficiency. Also, Prayogi (2011) showed that a significant improvement in the value of feed conversion ratio of broilers was observed when earthworms were added to rations at levels of 5% and 10%. In addition, Istiqomah *et al.* (2017) showed that when earthworms was added at a level of 0.375% to the diets resulted in an increase in the feeding efficiency of quails. Also, Bahadori *et al.* (2017) indicated that the diets containing earthworms at a level of 30 g /kg of dry matter positively affected the growth performance of broiler chickens and meat traits.

The effects of feeding *eisenia foetida* on organs and meat quality

In a study published by Gunya *et al*. (2019) showed that adding 3% of *Eisenia foetida* in broiler rations resulted in a significant improvement in the percentage of dressing carcass compared to the control group. In addition, there was also a significant improvement in the color of the breast muscles, where the highest values L* (lightness) and b* (yellow) was observed when feeding diet with level of 5%. Also, Nalunga *et al.* (2021) found that when increasing earthworms in broiler diets from 0, 1, 3, 5 and 7% resulted in an increase in the juice and flavor of breast meat. Whereas, the addition of earthworms did not affect the quality of the meat in terms of pH and dripping loss. Also, the weights of the cecum, heart, pancreas, proventriculus, and lungs were not affected by the increased supplementation of earthworms. In addition, Janković *et al*. (2020) indicated that there were no significant differences in the pH value of breast meat in broiler chickens fed on diets containing earthworms. Also, Bahadori *et al*. (2017) showed that when feeding broiler chickens on diets containing earthworms at high levels, cussed a change in the value of pH and water holding capacity of breast and thigh meat. Furthermore, Jahanian and Golshadi (2015) reported that feeding broilers on earthworms did not significantly affect the heart and spleen percentages. On the other hand, Ozturk *et al*. (2012) found that feeding broilers on diets containing

humic substances resulted in a change in the pH and water holding capacity values in the breast and thigh, which positively affected consumer acceptance.

The effects of *eisenia foetida* on health status of poultry.

Results of Reynoso-Orozco *et al.* (2021) showed that a marked attraction depending on the nutritional status of the birds for *Eisenia foetida* and differences in hematological parameters, but not for urological parameters. They added that diets containing 12.5 and 25 g/kg *Eisenia foetida* induces low intensity symptoms when measuring joints, organ size, blood and possibly urological parameters. In as study reported by Bahadori *et al*. (2017) found that broilers fed diet containing 100 g earthworms /kg showed an increase in total protein, albumin, calcium and phosphorous content compared to the control ($P < 0.05$). Moreover, they added that there was a positive effect on serum cholesterol and uric acid ($P > 0.05$) compared to the control. While the values of glucose, globulin, triglycerides and hemoglobin were not affected by the addition of earthworms in the diets. On the contrary, an increase in bursa of Fabricius was observed with feeding earthworms compared with the control group. Also, there were no significant differences in the morphology of the relative weight of the ileum, villus height, villus length, villus width, villus surface, and villus diameter compared with the control group. In other reports, Ozturk *et al*. (2012) observed that earthworms can be used as a safe and organic alternative to antibiotics and ion carriers due to the potential for residues since their use was banned in the European Union. Also, Cooper (2002) discovered that certain molecules in the earthworm's immune system can be used as a natural antibiotic. The evidence for this is that the addition of earthworms increased the weight of bursa of Fabricius without affecting the lymphocyte/lymphocyte ratio. Moreover, the relative weight of spleen and thymus was significantly increased, which had a significant effect on the humoral immune system of broiler chickens. In this regard, Chashmidaria *et al*. (2021) found that adding earthworms and vermi-humus to broiler diets had a positive effect on the immune response of broilers chickens.. Furthermore, Sun *et al*. (2020) found that feeding laying hens on diets containing earthworms resulted in an increase in the levels of protein, globulin and albumin, while, there was a significant decrease in triglycerides, cholesterol and glucose values. In a more recent study reported by Hesami *et al*. (2021) indicated that when Japanese quail was fed on diets containing earthworms and vermi-humus at levels of 2.5 and 0.8% resulted in a significant increase in the cellular immune response. In other reports Janković *et al*. (2015) reported that earthworms did not have any health problems and did not negatively affect the productive performance when feeding chickens on them, this is what was known when conducting bacteriological and heavy metal analysis of the bodies of these worms. Other results obtained by Islam *et al*. (2005) showed that the EW supplementation could be used as a safe and organic alternative for antibiotic and ionophores due to the potential appearance of residues since their usage has been banned in the European Union.

The effects of *eisenia foetida* on digestive system, digesability and microbiota.

It is known that the broiler microbiome and its relationship to the intestines have been studied extensively and it has been confirmed that it has a positive relationship to the health of the host in terms of its positive impact on the work of the immune system and the functions of the digestive system and their relationship to productive performance (Clavijo *et al.*, 2018). The results of Bahadori *et al.* (2017) showed that there is a significant increase in the intestinal villi of broiler chickens fed on diets containing earthworms compared to the control group. Furthermore, Loh *et al.* (2009) noticed that there was a noticeable increase in the total number of lactic acid bacteria in broiler chickens when fed on diets containing earthworms. Similarly, Popović *et al.* (2005) found that earthworms consist of a glycoprotein called (G-90) as well as a mixture of homogeneous tissues, both of which have strong antibacterial effect on *Staphylococcus sp.*, this observed effect was stronger than that of antibiotics such as gentamicin and enrofloxacin. Also, Chashmidaria *et al.* (2021) found that the addition of earthworms and vermi-humus in broiler diets caused a significant decrease in aerobic intestinal bacteria. Therefore, the use of earthworms and vermi-humus is very effective in improving feed efficiency in poultry (Bahadori *et al.*, 2015), due to the improved gut microbiota profile (El-Husseiny *et al.*, 2008) and higher protein content (Vielma *et al.*, 2003). However, Miri *et al.* (2014) indicated that when broiler chickens fed diet inclusion earthworm had a greater crude protein digestibility and crypt depth of jejunum than the control group. In other reports published by Castro-Bedriñana *et al*. (2020) indicated that increasing the level of *Eisenia foetida* from 10 to 20% in guinea pig diets improved the digestible nutrients and ME content.

Limitations of *eisenia foetida* in poultry nutrition

Through studies conducted on earthworms, it was found that they can be a major mediator of parasites in in free-range chickens (LeeMaster, 2007), where chickens may pick up earthworms that contain parasites. Therefore, Gabanakgosi *et al*. (2012) showed that the parasites present in the digestive system of birds have a negative effect on chickens, causing a poor growth rate, poor feed efficiency, reduced egg production and even death in severe infections.

GENERAL CONCLUSION

In conclusion, it should be noted that it is necessary to understand the general description and the nature of earthworms growth and reproduction in order to be able to produce them commercially, where that they can be used in the field of poultry production. But in some countries, the use of these worms in poultry feed as protein sources may not be accepted. In addition, the use of earthworms for feeding led to an improvement productive performance, health status and enhancement of immune response. Also, an important effect that appears as a result of the use of earthworms is the improvement of the intestinal bacterial community. In general, this review presents the benefits of using earthworms and their importance in the field of poultry production, where we can say that the use of earthworms can lead to the maximization of poultry production.

Table (1): Growth parameters of two earthworm species

Earthworm species	Initial weight (mg)	Maximum weight (mg)	Maximum weight period	Net weight gain (mg)	Growth rate/day (mg)	Clitellum development started in
Eisenia fetida	196±69	889±90	6th week	686±22	16.3±0.52	3rd week
Eudrilus eugeniae	297±4.1	1116±16.4	7th week	819±12	17.43±1.4	4th week

Table (2): Rate of cocoon production by two earthworm species.

Earthworm species	Cocoon production started in	Total no. of cocoons produced	No. of cocoons produced/ earthworm	Net weight gain (mg)	No. of cocoons produced/ earthworm/day	Cocoon production ceased after
Eisenia fetida	6th week	109±14.9 (12 weeks)	21.8±3.0	686±22	0.39±0.05	12th week
Eudrilus eugeniae	7h week	1016±31 (9 weeks)	7th week	12.61±1.0	0.21 ± 0.07	9th week

Table (3): Incubation period and hatching performance of cocoons by two earthworm species.

Earthworm species	Incubation period (in days)	Number of hatchlings from one cocoon	Mean number of hatchlings from one cocoon	Hatching success
Eisenia fetida	18-26	2-4	3.3±0.57	86.6%
Eudrilus eugeniae	12-21	2-3	2.23 ± 0.18	75.3%

Table (4): shows comparison of worms with fish meal and soybean meal.

Protein source	Crude protein (%)	Ether extract (%)
Worm	64-73	7-10
Fish meal	61-77	11-17
Soybean meal	49-56	3.0

Table (5): Nutrients of some worms

Worm Species	Dry matter (%)	Crude protein (%)	Ether extract (%)	Ash (%)	Acid detergent fiber (%)	Gross Energy (kcal/g)
Black	18.4	47.8	20.1	4.5	0.7	5.57
worm	9.9	52.8	9.7	11.3	ND*	ND
Blood	20.0	62.2	17.7	5.0	9.0	4.65
worm	16.3	60.7	4.4	11.4	15.0	4.93
Earth	11.8	46.1	15.1	6.9	ND	ND
worm						
Night						
worm						
Tubifex						
worm						

ND=Not determined

Fig. (1): The cocoons of *Eisenia foetida* and hatchling emerged from them.

Fig. (2) : Adult *Eisenia fetida.*

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الملخص العربى

الجوانب الغذائيه والصحيه لاضافه ديدان الارض *EISENIA FOETIDA* فى أغذيه الدواجن
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من المشاهد في السنوات الأخيرة وعلى الصعيد العالمي ان صناعة الدواجن أصبحت ذات أهمية كبيرة في إنتاج البروتين الحيواني مع زيادة نصيب الفرد من استهلاك اللحوم والبيض حول العالم. ومن اللافت للنظر أن تكلفة انتاج الأعلاف تمثل من 60-70% من إجمالي إنتاج الدواجن حيث يمثل البروتين العنصر الأغلى تكلفه. ومن المعروف ان مصادر البروتين إما ان تكون من أصل حيواني أو نباتي حيث تحتوي المصادر الحيوانية على توازن اكثر من الأحماض الأمينية. ولكن بسبب القيود المفروضة على توافر الاعلاف التقليديه للدواجن فضلا عن التطور الملحوظ في مجال تطوير السلالات الوراثية الجديدة كل هذا أدى إلى تغيير في الاحتياجات الغذائية. لذلك بدأ الباحثون في البحث عن مصادر بروتينية جديدة وبديلة لتقليل تكاليف العلائق مثل استخدام ديدان الأرض من نوع *Eisenia foetida* والتى تعتبر احد المصادر الجديده والامنه للبروتين الحيواني. ولكن حتى الآن لم تتم دراسة إمكانية استخدام *Eisenia foetida* كأحد المصادر الجديدة والآمنة لتغذية الدواجن في مصر. ومن جهه أخرى يمكن استخدام *Eisenia foetida* لأغراض أخرى مثل تقنية انتاج السماد الدودي وهو من التقنيات الجديده لاجراء المعالجة الآمنة للمخلفات العضوية غير السامة باستخدام ديدان الأرض وذلك لان هناك حاجة ملحة لإعادة تدوير مخلفات الدواجن بطريقة امنه وصديقة للبيئة ويمكن تطبيق ذلك عن طريق استخدام ديدان الأرض. لذلك فإن الهدف من هذه المقالة المرجعيه هو إلقاء الضوء على استخدام *Eisenia foetida* كأحد المصادر البديلة والجديدة والتي يمكن استخدامها في علائق الدواجن لتقليل تكلفة الإنتاج دون التأثير على الاداء الإنتاجى أو الصحة العامة أو جودة المنتجات الناتجه منها .