Evaluation of Worms as a Source of Protein in Poultry

Bülent KÖSE¹, Ergin ÖZTÜRK²

¹S.S. Hazelnut Agricultural Seles Cooperatives Union, Espiye Cooperative, Giresun, Turkey
²Ondokuz Mayıs University, Faculty of Agriculture, Department of Animal Science, Samsun, Turkey

ARTICLE INFO

Article history:
Received date: 10.05.2017
Accepted date: 27.06.2017

Keywords:
Poultry
Worm
Protein
Feed value
Nutrition

ABSTRACT

Continuous improvement of the genetic potential through breeding studies in poultry has led to an increase in the nutrient density of the feed rations given to these animals. In poultry farming, approximately 70% to 75% of the operating costs constitute feeding costs, of which about 15% are animal proteins. The protein requirement of poultry is provided by feed stuff rations and usually by soybean meal or fish meal. Limited production opportunities and price increases have led to the need to use alternative feed additives that can be substituted for these products. Research conducted to date suggests that worms, rich in essential amino acids and a high digestible protein source can be used as substitutes. As a source of alternative protein, worms are consumed by their poultry in their natural habitat, while intensive and extensive studies are needed to be used as a sustainable feed additive. In this review, research on the usability of worms as an alternative protein source in poultry diets has been compiled and evaluated.

1. Introduction

The fast increase in the population of the world has caused that the problems in nutrition also increased (Özen et al., 2005), and brought with it the difficulties in covering the animal protein needs, which are important for human nutrition (Makkar et al., 2014).

Eggs and chicken meat, which are among the animal protein sources, are inevitable products for human nutrition. Egg contains nearly all of the energy, fat acids, protein, vitamin, and minerals needed by human body at suitable amounts and rates. Chicken meat, on the other hand, is preferred more than red meat because of its ease in production and consumption, low cholesterol, calorie and fat amounts, high protein and calcium rates, and because of its cheap price. When compared with other nutrients, egg protein ranks the first in biological availability with 95% digestibility. Chicken meat, on the other hand, contains the amino acids that are not synthesized by human body in a sufficient amount and rate, and has proteins with high biological availability (Öztürk, 2016).

Poultry husbandry is more economic than the other farm animals due to better food conversion ratios and short production periods. Poultry husbandry has been performed in cages where animal comfort has been provided and the most poultry husbandry amounts are achieved with lowest costs per unit with traditional and modern organic methods and with backyard poultry husbandry (Öztürk, 2016). The biggest cost in all systems applied in poultry husbandry is the feeding. Nearly 70-75% of the total poultry husbandry activities consist of feeding costs, and 15% of this rate consists of proteins (Özen et al., 2005; Banerjee, 1992). Soybean meal and fish meal, which are used as protein sources in poultry rations, being costly increases poultry husbandry costs (Adeniji, 2007). For this reason, it has been reported that worms and insects may be used as protein sources to ensure that poultry animals are fed in a balanced and sufficient manner and poultry husbandry activities are sustained (Van Huis et al., 2013).

Worms are natural nutrient sources for poultry animals. For example, chicken can pick up the earth worms and their larvae in and on the surface of the soil. When the natural role of worms in some farm animals as nutrients is considered, they may be re-evaluated for
the purpose of being used as nutrients for certain poultry (Van Huis et al., 2013). Studies conducted so far have shown that it is technically possible to grow insects in large scales, and several authors have claimed that these insects may be used as alternative and sustainable nutrients that are rich in protein in poultry rations (Veldkamp et al., 2012; Khan et al., 2016). It was also reported that the plant wastes and other organic wastes of worms that have less hard crusts or chitosan and which are lower in digestion when compared with insects may be converted into protein with high value, and be used in feeding poultry. They may also be used in recycling of organic substances (Harwood and Sabine, 1978; Prayogi, 2011). When suitable conditions appear, earthworms pass the soil through their stomach at a rate of 60% of their own live weights and make the soil become organic thus contributing to sustainable agriculture at an important rate. Including the worms, which constitute an important place in natural lives of poultry animals, again in poultry husbandry activities may create an important potential in terms of the comfort of animals, ensure quality protein at reasonable prices, and protection of the environment. In this compilation, the possibility of using worms as alternative protein sources in feeding poultry will be summarized.

Table 2.
Nutrient and Energy Contents of Worms (Bernard et al., 1997).

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

*: Value not determined.

Watson (1957) show that approximately 80% of the cuticle consists of a protein component, which contains a high proportion of hydroxyprolyl and glycoly residues. The remainder of the cuticle is chiefly composed of polysaccharide, which when hydrolysed yields galactose and small amounts of both pentoses and hexosines. He also reported that the remaining part consisted of galactose, pentose and hexose-giving polysaccharides at smaller amounts. Edward (1985) conducted a study and reported that the muscle tissue of 100 kg worm consisted of protein at a rate of 60-70%, ether extract (EE) at a rate of 6-11%, carbohydrates at a rate of 5-21%, minerals and vitamins at a rate of 2-3%.

2. Nutrient Composition of Worms

Worms include protein in dry matter at a rate of 64.5% and 72.9% (Table 1), and are very precious protein sources (Lieberman, 2002). The level of the proteins, which are accepted as structural elements and which take part almost in every physiological function, is directly related with the growth of worms (Hatti Shankerappa, 2013). In addition, worms contain carbohydrates at a rate of 8-20% of the dry matters of their bodies (Edwards, 1985; Ghatnekar et al., 2000).

Table 1.
Comparison of Worms with Fish Meal and Soybean Meal (Ghatnekar et al., 1995; 2000; Rumpold and Schlüter., 2013).

<table>
<thead>
<tr>
<th>Protein source</th>
<th>Crude protein (%)</th>
<th>Ether extract (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worm</td>
<td>64-73</td>
<td>7-10</td>
</tr>
<tr>
<td>Fish meal</td>
<td>61-77</td>
<td>11-17</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>49-56</td>
<td>3</td>
</tr>
</tbody>
</table>

When the energy contents and nutrients of some worms are examined, it is observed that worms have high nutrient values in terms of protein, fat and mineral contents (Table 2).

Sabine et al. (1986) analyzed the protein content of 3 worm species in South Africa, and determined the CP content at 66.1%, 58.4% and 61.6% for Eisenia fetida, Eudrilus eugeniae and Perionyx excavatus respectively with 61% for fish meal. Ghatnekar et al. (1995; 2000) reported that the dry matter of worm consisted fat 60-70% protein, 7-10% of fat, 8-20% carbohydrates, 2-3% minerals and various vitamins. Zhenjun et al. (1996) reported that the earthworm had a CP content at a rate of 54.7-71% in dry matter. Bernard et al. (1997) determined that the earthworm contained in 1.72% Ca, 0.90% total P, 0.14% Mg, 0.02% Na, 0.06% K. Paololetti et al. (2003) reported that the earthworm contained in
64.5% and 72.9%. Sogbesan and Ugwumba (2008) reported that the earthworm contained in 63.0% CP, 5.9% EE, 1.9% crude fiber (CF), 8.9% ash, 11.8% nitrogen free extracts (NFE), 0.43% Na, 0.53% Ca, 0.62% K, 0.94% P and 1476 kJ/100g metabolic energy. In addition, the same authors found out that the essential amino acids composition (g/16gN) for the earthworm they analyzed as arg 2.83%, his 1.47%, iso 2.04%, leu 4.11%, lys 6.35%, met 5.30%, phe 6.26%, thr 4.43% and val 4.43%. Hasanuzzaman et al. (2010) reported that Perionyx excavatus worm contained 46.57% CP and 8.03% EE. Hatti Shankerappa (2013) determined that Polypheiretima elongata species contained 63.1% CP, 7.3% EE and 15.4% glycogen.

It has been reported in studies conducted so far that the differences between the mineral contents of worms vary depending on the components of the soil. The mineral composition in the bodies of the worms may vary with the existence of minerals in the soil. The differences between the mineral contents of worms occur due to the mineral content of the soil. The mineral composition in the bodies of the worms may vary depending on the components of the soil (Ouachem et al., 2015). Since the lifecycle of worms occurs in soil, the existence of minerals in the soil affects the composition of the worms. For this reason, this situation should be considered in feeding animals.

It is estimated that poultry kept in open air consume 10g soil, 7g plant and 20g insects and worms a day (Ouachem et al., 2015). It is observed that the soil and worm consumption of the chicken kept in free systems is not in rates that can be underestimated. It has been reported in the literature that the differences in the mineral compositions may be affected by these two sources at high levels. For this reason, this situation must be considered in feeding animals.

3. Using Worms in Poultry Nutrition

The main limiting factors in feeding poultry are the protein and energy contents of the rations. Generally, fish meal and soybean meal are used as protein sources in poultry rations in today’s conditions. However, the increases in the prices of fish meal and soybean meal due to various reasons also because some increases in the prices of the rations of poultry (Tacon and Metian, 2008). Continuous increase in the prices of these products gave rise to the need for the search for new protein sources as alternatives to these two previous agents. Worms are among the alternatives that may be used as protein sources for this purpose (Zhenjun et al., 1996; Guerrero, 1983; Kostecka and Piaizka, 2006).

When the compositions of the nutrients are analyzed it is observed that worms contain amino acids, lipids, carbohydrates and minerals that are necessary for poultry animals at high levels (Paoletti et al., 2003; Dedek et al., 2010). As a matter of fact, since worms contain protein and amino acids at adequate levels, it has been reported that they may be used as protein sources in poultry (Akiyama et al., 1984; Mason et al., 1992).

Fisher (1988) determined that the rates of making use of the rations in poultry for which worms were used as being higher. It was also reported that the essential amino acid structure of the earthworms that will be added to the rations of poultry was suitable and could be covered with earthworms that would be added to the ration at a rate of 15% (Taboga, 1980).

Zhenjun et al. (1996) conducted a study and concluded that earthworms could be used as animal feed with the protein levels they contained, and added that they had a high nutritional value that was higher than that of the fish meal and soybean meal in terms of protein rate and amino acid structure.

Ali (2002) conducted a study and reported that the Perionyx excavatus epige worm in Bangladesh among the many earthworms had a potential to be used in feeding poultry because it stayed in ecological conditions nearly all year round.

Hatti Shankerappa (2013) reported that the chemical contents like protein, lipid and glycogen of Polypheiretima elongata, Peronxyx sansibaricus and Dichogaster bolaui worms, and the changes in their weights were at the highest levels in summer months, at the middle levels in monsoon rains, and at the lowest values in winter months. The author claimed that these worms could be used as nutrients in human consumption with fish, poultry animals and pigwash due to the high protein, lipid and glycogen contents.

Ton et al. (2009) determined that adding 2% worms to broiler rations caused increases in the live weight of broilers in the 10th week, and this did not have any negative effects on meat quality.

Prayogi (2011) conducted a study to determine the rate of replacing the fish meal with worm meal in quails, and reported that using 10% worm meal in the mixture was possible to use in the rations instead of fish meal without any detrimental effect; however, when the rate was increased to 15%, the consumption of feed decreased. Son and Jo (2013) reported that adding 0.4% worm meal to the broiler rations improved the feed consumption and live weight, and increased the digestibility of the nutrients.

Sharma et al. (2005) defended that heavy metals and other pollutants could be received by worms and they might be transferred to the poultry that consumed these worms. Son (2009) reported that there were Cd (1.23 ppm), Cr (1.18 ppm), Hg (0.00 ppm) and Pb (3.39 ppm) heavy metals in worm meal. However, Son also reported that these metals were not transferred to the meat or egg, and did not affect the quality. The findings show that the environment where worms are fed affect the body compositions of these worms; however, the compounds of the worms is not reflected in the poultry at the same rate.

In this context, it may be concluded according to the data reported in this study that some toxic minerals may not be transferred to products through worms;
however, further studies are needed to make sound
conclusions in this topic.

4. Results

Studies conducted so far show that earthworms
have nutrient contents that are close to those of the fish
meal and more valuable than those of soybean meal;
and for this reason, they may be used as alternative
potentials for fish meal and soybean meal.

Earthworms pass soil through their stomach each
day and make the soil become organic at a rate of near-
ly 60% of their body weights thus contributing to sus-
tainable agriculture. With these properties, and by
including worms, which have an important place in the
natural lives of poultry animals and which are im-
portant elements in the ecosystem of the soil, in poultry
husbandry again, the comforts of animals will be im-
proved and the protein will be provided at a cheaper
price, and an environmental protection effect may be
achieved with the help of recycling of animal and plant
wastes.

Using worms in feeding poultry animals as protein
sources may not be accepted immediately in some
societies. However, this must be kept in mind that
poultry animals naturally consume worms in their natu-
ral habitats, and this situation may be accepted by soci-
eties in time.

5. References

Adeniji AA (2007). Effect of replacing groundnut cake
with maggot meal in the diet of broilers. Interna-
tional Journal Poultry Science, 6: 822-825.

Supplementation of various means to fish meal diet

Lagshai Tekshoi Kenchoprozuki, Utyoron Offset
Printing Press, Rajshahi, Bangladesh.

IBH publishing Co. Pvt. Ltd. New Delhi, 168-172.

captive insectivorous animals: Nutritional aspects
of insects as food. Nutrition Advisory Group Hand-

profile of four earthworms species from Nigeria.
Agriculture And Biology Journal of Nort Amerika.
ISSN Print:2151-7517, ISSN Online:2151-

Edward C A (1985). Production of feed protein from
animal waste by earthworms. Philosophical trans-

Fisher C (1988). The nutritional value of earthworm
Meal for Poultry. In Earthworm is Waste and Envi-

Biomanagement of wastes through vermiculture.
Encology,10(7):1-7.

Ghatnekar S D, Kavian M F, Ghatnekar M S, Ghat-
nekar S S (2000). Biomanagement of wastewater from
vegetable dehydration plant. In: Trivedy, R.K.,
Kaul, S.N., (Eds). Advances in wastewater treat-
mentTechnologies (Vol 2), Global Science Publica-

Guerrero R D (1983). The culture and use of Perionxy
excavatus as protein resource in the Philippines. In:
J.E. Satchell (Ed.), Earthworm Ecology, Chapman

Harword M, Sabine J R (1978). The nutritive value of
worm meal. Pro. 2nd Austr. Pou. Stockfeed Conv.,
Sydney, p. 164-171.

Hatti Shankerappa S (2013). Chemical composition
like protein, lipid and glycogen of local three spe-
cies of earthworms of Gulbarga city, Karnataka-India.
International Journal of Advancements in

Khan S, Naz S, Sultan A, Alhıdary L A, Abdelrahman
(2016). Worm meal: a potential source of alternati-
ve protein in poultry feed. World’s Poultry Science

Essenia fetida (Suv.) Biomass for breeding,
aquarium fish. European Journal of Soil Bio-
logy, 42: 231-233.

Lieberman S (2002). Worms, beautiful worms. Interna-
tional Worm Digest, 4: 11–18.

State-of-the-art on use of insects as animal feed.
Animal Feed Science and Technology 197:1-33.

Mason W T, Rottmann R W, Dequine J F (1992). Cul-
ture of earthworms for bait or fish food. Florida co-
operative extension service, Institute of Food and
Agricultural Sciences. University of Florida 10539,
pp. 1-4.

Nutritional potentiality of earthworm for substituti-
fishmeal used in local feed company in Ban-
25-30.

Ouachem D, Kaboul N, Meredef A, Abdessemed F, Gaid,
of droppings and health status of poultry: an overview.

Özen N, Kirkpinar F, Özdoğan M, Ertürk M, Yurtman I
VI. Technical Congress Turkey, 3-7 January Ankara,
753-771.


