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MOLTING OF BROILER BREEDERS CONDITIONS FOR ECONOMIC JUSTIFICATION IN CONTINUED PRODUCTION

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MOLTING OF BROILER BREEDERS CONDITIONS FOR ECONOMIC JUSTIFICATION IN CONTINUED PRODUCTION

Branislav Pešić¹, Nikola Stolić², Božidar Milosević³, Zvonko Spasić⁴

Summary

The method of artificial interruption of the production process by hens, broiler breeders, today known as the molting, it is often used in recent years as one of possible reasonable steps in making decisions on feasibility of continuing exploitation of broiler breeder safer the regular production process. The aim of this study was to test the economic profitability molting hens-broiler, during one exploitation period. It included the throat of hybrid heavy line COBB500. The animals in the house were exposed to the same microclimate conditions, with identical positions in relation to light, ventilation, water, food and fertilization system. The analysis of food consumption per produced egg can be notice that parents' hens during the process of molting consume more food by 43% compared to the hens fed the normal cycle of production. Achieved income was 2.54% higher after billing code for molting chickens instead of the regular production cycle. Economic indicators egg production after molting demonstrate justification of these biological and technological operations, considering that the net income per hen housed is the same income in the normal production process.

Key words: molting, broiler breeders, capacity, chickens, economy.

JEL: Q10, Q11, Q13

Introduction

Intensification of production processes in poultry, improvement of the poultry

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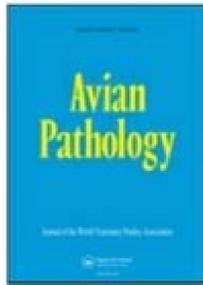
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Avian pathogenic Escherichia coli transmission from broiler breeders to their progeny in an integrated poultry production chain

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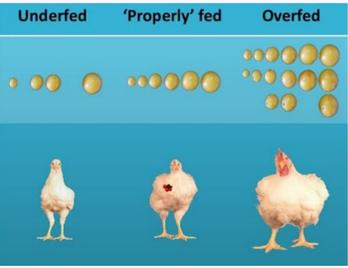
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[17] reported an increase in tenderness (low shear force value) for breast meat of broilers fed with dietary MWM. The essential amino acid profile (g/kg) of mopane worm, fish, and soybean meals. The effect of green tea (*Camellia sinensis*) leaf powder on growth performance, selected hematological indices, carcass characteristics and meat quality parameters of Jumbo quail. Some essential AA such as lysine and methionine found in MWM are comparable to those found in fish meal [51]. [Google Scholar] [CrossRef][Van Huis, A.M.W., 2017, 243, 769-778. Fatty acid composition of fry mirror carp (*Cyprinus carpio*) fed graded levels of sand smelt (*Atherina boyeri*) meal. The authors attributed the improvements in meat tenderness to rigor resolution due to the enzymatic breakdown of collagen that keeps meat fibres together.Lautenschläger et al. Thus, it is worth evaluating MWM as a potential protein source in quail feeds because of its high CP content (54–59%) and an AA profile comparable to those of fish and soybean meals [25]. The bioavailability [13], because imbalanced uptake can cause serious harm to quail growth and production [49]. The MW has notably higher amounts of lysine, methionine, valine, threonine, tryptophan, and phenylalanine than soybeans [26]. Academic Editors: Ana Isabel Lillebo and Olga M. Thus, their iron availability is, ironically, unknown, although their iron bioavailability is somewhat more similar to that of animals rather than plants [39].There is limited information on the lipid and essential fatty acid requirements for quail. [Google Scholar] [CrossRef][Lonerger, E.H., Zhang, W., Lonerger, S.M. Biochemistry of postmortem muscle—Lessons on mechanisms of meat tenderization. In *Forest Insects as Food: Humans Bite Back*, Proceedings of the a Workshop on Asia-Pacific Resources and Their Potential for Development, Chiang Mai, Thailand, 19–21 February 2008; Durst, P.B., Johnson, D.V., Leslie, R.N., Shono, K., Eds.; FAO Regional Office for Asia and the Pacific: Bangkok, Thailand, 2010; pp. 2019, 18, 852–865. Table 4. Management of non-timber forest products harvesting: Rules and regulations governing (*Imbrasia belina*) access in the South-Eastern Lowveld of Zimbabwe. Further studies are required to ascertain the probable usefulness and cost-effectiveness of MWM as an alternative protein source on quail performance, health, and quality of meat and eggs. However, more studies should be carried out to evaluate the actual protein feed value and the cost-effectiveness of including MWM in quail diets.Although mineral levels vary across different feed ingredients, the mineral content of the MW mainly depends on its diet [55]. The regulations in communal areas may involve managing the number of harvesters, the number and size of MW, and the number of days spent harvesting [37]. In Proceedings of the International Conference on Rural Livelihoods, Forests and Biodiversity, Bonn, Germany, 19–23 May 2003. Agric. The fact that mopane leaves have a high protein content of 50% may explain the increased protein content of the worm [40]. The Domestication of Mopane Worms (*Imbrasia belina*). Veld Products Research and Development: Gaborone, Botswana, 2003. Growth performance, blood profiles and carcass traits of Barbary partridge (*Alectoris barbara*) fed two different insect larvae meals (Tenebrio molitor and *Hermetia illucens*). Effects of banana peel meal on the feed conversion ratio and blood lipid of broiler chickens. 2017, 45, 64–70. Sustainable harvesting and trading of mopane worms (*Imbrasia belina*) in Northern Namibia: An experience from the Uukwaludhi area. *Agro Vet.* MWM has the potential to be used as an alternative due to its intrinsic nutritional qualities such as high concentrations of protein, amino acids, fatty acids, and minerals, which are precursors of better poultry performance. 2011, 31, 129–144. Finally, we postulate that mass production of this insect-based protein source and its sustainability would be an inventive strategy to develop a profitable quail business. Res. the α -linoleic and palmitic FAs are higher in dietary MWM and can be used to cure coronary heart disease and chronic ailments [59]. *Front.* Furthermore, Yebaoth and Mitefi [59] reported high concentrations of α -Linolenic and palmitic acids in MWM, which can help alleviate coronary heart disease and chronic ailments. Another vital meat quality trait is meat tenderness, which is affected by diet, sex, strain, age, and the environment [74]. [Google Scholar] [CrossRef] [PubMed][Dabbou, S.; Gai, F.; Biasato, L.; Capucchio, M.T.; Biasietti, E.; Dezzutto, D.; Meneguzzi, M.; Plachà, I.; Gasco, L.; Schiavone, A. However, there is a paucity of information on the use of dietary mopane worm meal (MWM) in various quail breeds. 2007, 24, 141–147. (69). and Schiavone et al. However, it is worth noting that these recommended protein levels are suitable for quail that are reared in temperate regions [23].Mopane woodlands are found in semi-arid regions of Southern Africa and host one of the most valuable larvae. *G. diet.* 2011, 24, 264–271. 2009, 41, 935–942. This paper reviews the nutritional profile and use of the MW as a protein source, as well as its potential future prospects in poultry diets. According to Maitane et al. This could reduce the over-reliance on costly fish and soybean meals. These variations in performance could be attributed to the involvement of different species as well as the age and sex of the birds, which are known to produce different results even when birds are offered the same feed [66].Increased average weight gain remains one of the tools vital to monitoring the nutritional value of a specific diet and animal growth. *Multidiscip. Rev.* Table 1. Rapatsa and Moyo [34] reported mineral element levels in MWM that are similar or higher to those in fish meal or soybean meals, as indicated in Table 4. That insect molitor and H. [Google Scholar] [CrossRef][Loponte, R.; Nizza, S.; Bovera, F.; De Riu, N.; Filiegerova, K.; Lombardi, P.; Vassalotti, G.; Mastellone, V.; Nizza, A.; Moniello, G. The ability of MWM to cure coronary heart diseases in humans is an indication that its proposed inclusion into the quail diet will further protect quail egg and meat consumers from such ailments, beyond the protein it offers them. The continued over-reliance on soybean and fish protein feeds by feed compounders is unsustainable for large-scale quail intensification. The larvae pass through five stages (instars) during their growth phases, each stage lasting for not more than a week. *Benha. Trop. Parametres*Mopane MealReferenceFish MealReferenceSoybean MealReferenceCalcium0.8–17b, d, e3.8c3.14cIron11.8–12.9b, d, e0.3c1.07bMagnesium4.3–56b, d, e0.6c2.1cPhosphorus0.46–14.8b, d, e2.7c6.59cPotassium1.2–36.3b, d, e0.6c19.78cSodium26.9–33.5b, d, e0.9c0.19–0.5a, cZinc1.9–2.3b, d, e0.6c0.12fTable 5. Mopane trees grow on nutrient-rich clay soil at a preferred altitude of 300 to 900 m, where they receive an average annual rainfall of 550 mm [28]. As such, MWM is an excellent dietary ingredient that can supply the needed composition and quality of fat. *Banglad. [Google Scholar]*Noboo, G.; Moreki, J.C.; Nsoso, S.J. Growth and carcass characteristics of helmeted guinea fowl (*Numida meleagris*) fed varying levels of Phane meal (*Imbrasia belina*) as replacement of fishmeal under intensive system. *Lett. [Google Scholar]*Thomas, B. Mopane worm utilisation and rural livelihoods in Southern Africa. [Google Scholar]Muchenje, V.; Chimonyo, M.; Dzama, K.; Strydom, P.E.; Ndlovu, T.; Raats, J.G. Relationship between off-flavor descriptors and flavor scores in beef from cattle raised on natural pasture. Iron bioavailability and dietary reference values. Department of Animal Science, School of Agricultural Science, North-West University, Matieling 2745, South Africa Food Security and Safety Focus Area, Faculty of Natural and Agricultural Science, North-West University, Matieling 2745, South Africa Department of Agriculture, Faculty of Applied Science, Cape Peninsula University of Technology, Wellington 7654, South Africa Department of Botany, School of Biological Sciences, North-West University, Matieling 2745, South Africa Author to whom correspondence should be addressed. 2019, 45, 1309–1320. *Acta-Bombom. Entomol.* Edible insects in a food safety and nutritional perspective: A critical review. *Quail (Coturnix coturnix)* farming is currently gaining global recognition as a source of high-quality animal protein in the form of meat and eggs [1]. Quail have high adaptability, fast growth rates, strong resistance to various diseases, and high feed efficiency [3]. *Int.* 2013, 70, 494–502. The concept of insect farming is a relatively a new venture of diversification that encompasses rearing insects in a confined area (i.e., a farm) and controlling their rearing conditions, diet, and food quality. In addition, commercializing insects of the Lepidoptera genus, such as MW and mulberry silkworms, could be an economically viable business because these worms are prolific. The intensive production of MW to ensure continuous availability has been investigated in Zimbabwe, South Africa, and Botswana [34]. [Google Scholar] [CrossRef]Teye, G.A.; Baffoe, F.; Teye, M. Thus, the utilisation of MWM in quail diets can complement both crop and animal food production systems because their production does not rely on the use of arable land and gallons of water [11].Moreover, the use of insect meals in quail diets is desirable due to better feed conversion efficiency, low greenhouse gas emission, low risk of transmitting zoonotic infections, and low water requirements with little or no animal welfare issues [12]. Fatty AcidsMopane MealReferenceFish MealReferenceSoybean MealReferenceLauric acid (C12:0)0.3c0.2–0.40b, d0.2dMyristic acid (C14:0)0.2c2.7–4.7b, d0.2–3.4a, b, dPalmitic acid (C16:0)5.3c2.3–27.5b, d12.4–27.3a, b, dStearic acid (C18:0)1.8c2.1–9.73b, d3.7–21.2a, b, dArachidic acid (C20:0)0.1c0.2d0.05aPalmitoleic acid (C16:1)0.1c0.42b0.02d α -Linolenic acid (C18:2n6c1)5c1.4d0.7–2.2a, b, linoic acid (C18:2n1)1.8c4.501d4.5.5dSF4A840.2–52.5b, d4.2–53.1a, b, dMUFA1.8c18.6–45.0b, d8.5–45.5a, b, dPUFA55c39.2b27.8–46.4a, b, dPublisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations. Impact of different preparations of the edible caterpillar *Imbrasia epimethea* from northern Angola. Table 3 shows that MWM contains all the essential AA needed by quail, which demonstrates that MWM has the potential to replace soybean and fish meals in quail diets. *Sustain. [Google Scholar] [CrossRef]*Manuyela, F.; Tsopilo, C.; Kamau, J.; Mogotsi, K.K.; Nsoso, S.J.; Moreki, J.C. Effect of *Imbrasia belina* (westwood), *Tylosma esculentum* (Burchell) Schreiber and *Vigna subterranea* (L.) Verde as protein sources on carcass and laying performance of Tswana quails reared under intensive production system. *Muscle Foss. Insects as a Sustainable Feed Ingredient in Pig and Poultry Diets—A Feasibility Study*; Wageningen UR Livestock Research; Lelystad, The Netherlands, 2012. *Ital. The Evaluation of Larvae of Musca domestica* (Common House Fly) as Protein Source for Broiler Production. Therefore, the AA constituent to be used in quail diets must come from a high-quality protein source with highly digestible AA content [24]. *Anim. Fish Meal, Protein* 65%. *Eur.* [67] and Pretorius and Pieterse [68] reported an increase in bodyweight gain in chickens fed with M. © 2022 by the authors. University of Pretoria/University of Cape Town/Göttingen University, South Africa, 2007, 68, 492–500. *Edible Insects: Future Prospects for Food and Feed Security*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2013. [Google Scholar] [CrossRef][Wessels, D.C.J.; Van der Waal, C.; de Boer, W.F. Induced chemical defences in *Colophospermum mopane* trees. A review. *Edible Insects' Future Prospects for Food and Feed Security*; Forestry Paper 171; Food and Agriculture Organization of the United Nations: Rome, Italy, 2013; Volume IX, pp. Léonard in Botswana. 2005, 8, 781–784. *Annu. [Google Scholar]* [CrossRef]Haryanto, A.; Miharta, K.; Wijayanti, N. However, MW consumption has religious restrictions on a large part of the population in South Africa, making it an ideal protein source for quail. *Revis. At this stage, they are now referred to as mopane worms (caterpillars) and can grow to approximately 80 mm long [29]. Number 65. Chemical composition and fatty acid profile in meat from grazing lamb diets supplemented with veygrass hay, fishmeal and soybean meal as PUFA sources. *Food Sci. Technol. [CrossRef]*Maitane, L.; David, L.; Pablo, V.E. This paper seeks to review the nutritional value of MW as a potential source of protein for sustainable quail production. Use of *Tenebrio molitor* larvae meal as protein source in broiler diet: Effect on growth performance, nutrient digestibility, and carcass and meat traits. *Feed Sci. [Google Scholar]* [CrossRef]Simone, B.; Losasso, C.; Maggioletti, M.; Alonzi, C.C.; Paolotti, M.G.; Ricci, A.A. Bio-Economic Modeling Approach. These birds have very short generation intervals, can reach sexual maturity by six weeks of age, and the hens can produce over 100 eggs in their first production cycle [1,2,3,4]. 2007. Due to the high cost of conventional protein sources (fish and soybean meal), several scholars have reported the potential of insect (worm) meals as an alternative protein source in animal feeds [13,14,15]. *Sect. [Google Scholar]*Lucas, L.T. The Evolution and Impacts of Mopane Worm Harvesting: Perceptions of Harvesting in Central Botswana. [Google Scholar]Makhado, R.; Potgieter, M.; Timberlake, J.; Gumbo, D. Fish. Insects farmed in captivity are isolated from their natural communities [32]. *World Sci. The collection of MW has also increased due to lack of regulations. 9–12. The MW contains higher protein, fat, carbohydrate, and mineral contents than chicken and beef meat [38]. Alternatively, insect-based protein sources such as *Gonimbrasia belina*, commonly known as mopane worm (MW), can be used to increase quail production due to their high biological value and low feed-cost competition. *Food Res. Mopane worms are overexploited during harvesting, and, as such, there is a need to enforce regulatory laws to sustain their production. Gahukar [7] pointed out that edible insects are renewable natural feed sources that provide nutritional, economic, and ecological benefits. 2006, 26, 265–274. 2019, 68, 207–218. *Med. In Nutrient Requirements of Poultry*, 9th ed., The National Academies Press, National Academy of Sciences: Washington, DC, USA, 1994; pp. Biotechnol. C. Nonethless, sustainable intensification of quail production relies heavily on the protein and energy levels of the feed, which is mostly generated from soybean and maize grains. *Amino Acid Mopane MealReferenceSoybean MealReferenceHistidine*1.9–3.5a, b, e1.6–4.3a, d1.5–1.9a, dIsoleucine2.6–3.5a, b, e2.6–2.7a, dZ2.2–6a, dIleucine3.8–7.6a, b, e4.7–8.4a, d3.49–3.5a, dLysine3.8–4.9a, b, e5.0–11.1a, d2.9–3.1a, dMethionine1.6–2.4a, b, e1.6–2.5a, d0.7–0.9a, dPhenylalanine2.5–5.1a, b, e2.9–5.2a, d2.4–2.6a, dThreonine2.7–3a, b, e2.7–5.4a, d1.8–2.0a, dTryptophan0.9–1.4a, c, e0.8–1.3a, d0.7–0.8a, dValine3.2–4.1a, b, e3.22–3.1a, d2.3–2.4a, dTable 4. [76] reported a positive influence on quail meat tenderness of birds fed with dietary *Eisenia foetida* worm meal. Fatty acid composition (g/100 g) of mopane worm, fish, and soybean meals. The eggs hatch after about 10 days to produce tiny black larvae (caterpillars) [29]. Positive results have been reported when insect-based protein sources were used in poultry diets. *Soybean and Nutrition*; El-Shemy, H., Ed.; IntechOpen: London, UK, 2011. *Sustainability* 2019, 11, 1697. [71] also observed better feed efficiency and increased body weight in barbary partridges fed with insect (T. Ph.D. Thesis, University of Kwazulu Natal, Pietermaritzburg, South Africa, 2016. Available online: (accessed on 10 March 2022).Henry, M.; Gasco, L.; Piccolo, G.; Fountoulaki, E. 2012, 2, 32–35. 2019, 79, 628–635. [77] reported improved appearance, juiciness, and tenderness of meat due to high dietary fat. *Parameters*Mopane MealReferenceFish MealReferenceSoybean MealReferenceCrude protein55–60b, c, e, 165.6d40.2–46.9a, d45h6.8–10.5b, c, e, 117.0d6.14dNDF28.8a5.8g14.6dADF17–59.4b, e, 10.5g9.6dADL5.4b0.2g1.5hADIN0.9b4.9g2.1hFat13.9–16.8b, c, e, f13.0d18.3–21a, dTable 3. Physico-chemical properties of breast muscle in broiler chickens fed probiotics, antibiotics or antibiotic-probiotic mix. Meat pH is essential to consider because it determines meat acid accumulation, which affects the colour and water-holding capacity of the meat [72]. 2015, 28, 241–247. S. Health *Propr.* They require minimal space for their production, meaning a large flock can be reared even under landless production systems [1,3]. 2015, 10, 1521–1530. Nutrient requirements of Ring-Necked pheasants, Japanese quail, and Bobwhite quail. R. 2010, 21, 424–432. [Google Scholar]Munsundire, M.T. Influence of Age and Sex on Carcass and Meat Quality Traits of Scavenging Guinea Fowls. [Google Scholar] [PubMed][Schiavone, A.; Cullere, M.; De Marco, M. When the larvae pass stage IV, they moult and displace from the unit. 2014, 14, 55–67. [Google Scholar] [CrossRef][Moreki, J.C.; Tirosebe, S.C. Prospects of utilizing insects as alternative sources of protein in Botswana. A review. [Google Scholar] [CrossRef]Maitane, L.; David, L.; Pablo, V.E. The effect of natural and synthetic fatty acids on membrane structure, microdomain organization, cellular functions and human health. These products can improve human nutrition and contribute towards achieving food and nutritional security, as well as achieve the sustainable development goals set by the United Nations [2]. *belina* [27]. The males follow chemical pheromones secreted by the females during mating, after which the mated female lays a cluster of 50–200 eggs around twigs and leaves of host plants. [Google Scholar]Hwangbo, J.; Hong, E.C.; Jang, A.; Kang, H.K.; Oh, J.S.; Kim, B.W.; Park, B.S. Utilisation of house fly-maggots as feed supplement in the production of broiler chickens. 2010, 91, 1461–1467. During instar stages I–III, the caterpillars cluster together in groups of 20–200, whereby they feed on leaves of mopane trees and other trees that grow close to the mopane woodlands [30]. [Google Scholar] [CrossRef][Van Huis, A.; Van Isterbeek, J.; Klunder, H.; Mertens, E.; Halloran, A.; Muir, G.; Vantomme, P. Nutritional Value of Soybean Meal. Thus, the supplementation of quail diets with MWM may offer an opportunity to balance and/or enhance the level of essential AA. This is mainly because birds generally utilize AA attained from dietary proteins for various structural and protective tissue functions, such as the development of feathers, skin, ligaments, and bone matrix, together with soft tissues including organs and muscles [23]. Partial or total replacement of soybean oil by black soldier fly larvae (*Hermetia illucens* L.) fat in broiler diets: Effect on growth performances, feed-choice, blood traits. The introduction of insect meal into fish diet: The first economic analysis on European sea bass farming. *Loponte et al. Bull. Nutr.* Trampling by harvesters, firewood collection, and litter also hinder MW production [31].In addition, on-site processing of the worms with fire leads to patches of the veld being burnt, reducing the grazing capacity of the veld. [Google Scholar] [CrossRef]Oyega, C.E.; Mlambo, V.; Muchenje, V. [Google Scholar] [CrossRef]Gahukar, R.T. Entomophagy and human food security. Non-harvest animals should also be established as nature reserves, which will serve as sacred and rotational harvesting sites. [Google Scholar] [CrossRef]Yebaoth, S.O.; Mitefi, Y.C. Further lipid profiling of the oil from the mopane caterpillar, *Imbrasia belina*. *Asian-Australas. [Google Scholar]*Hope, R.A.E. The effect of natural and synthetic fatty acids on membrane structure, microdomain organization, cellular functions and human health. 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