

Uganda's production potential of Black Soldier Fly larvae for use in pig diets: A mini-Review

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Abstract

Uganda's pork consumption has steadily grown over time and will follow the same trend even in the next two decades. However, the commonly used protein sources (silver fish and soybeans) for formulating pig diets in Uganda are expensive and are used as human food. The current review explores the potential of using Black Soldier Fly (BSF) larvae as an alternative protein source in pig diets. The review mainly delves into the potential of using the unexploited raw material base (organic wastes) to raise enough BSF larvae for sustaining Uganda's pig feed production. On an annual basis, the food wastes from Uganda's urban centres alone can produce enough BSF larvae for formulating pig diets that can feed the 4.4 million pigs in Uganda for over 5 months. Due to insufficient information on other wastes like animal manure and crop wastes from rural areas, it was extrapolated that the total annual organic waste production from all over the country could sustain raising BSF larvae for use in formulating pig feeds that can feed the 4.4 million pigs all year round, and even be extended to some other enterprises like poultry. This extrapolation was based on the assumption that all pigs in Uganda are intensively managed and fed on complete feeds formulated using BSF larvae as the protein source. In conclusion, Uganda can produce enough BSF larvae for feeding her pigs all year round, and can potentially sustain her future pork demand. There's need to sensitize the different stakeholders on the importance of using BSF larvae as an alternative protein source in pig diets.

Key words: Black soldier fly larvae; food waste; pig diets; pork; organic wastes

Introduction

Pig production is one of the fastest growing and most important sub-sectors in Uganda's agricultural economy (Mutua *et al.*, 2020). The hastened growth of Uganda's pig sub-sector stems from the high demand for pork in the country, with consumption of up to 3.4kg/capita (FAO, 2021). The projections by FAO (2017) indicate that Uganda's annual pork consumption will be up to 474,000 metric tonnes, by 2030 and will reach 1720,000 metric tonnes by 2050, which will be the highest in the region.

On the other hand, statistics on the future pig production, and the ability to sustain the projected demand, is scanty. Primarily, future increase in pig production will most likely be constrained by the persistently high feeding costs. For example, only 1.3% of the feeds needed in intensive pig production systems is produced annually, resulting in a deficit of almost 99% (Straub and

Vernooij, 2021). Most importantly, the key protein sources in pig diets are fish soya bean meals which are costly and also act as primary protein sources in human diets. Continued dependence on these ingredients as protein sources in pig diets may not sustain the efforts to produce enough pork to meet the projected demand.

In their review, Kasima *et al.* (2023) applauded several low-cost alternative protein sources for use in producing what they called “*high-quality pork.*” Among these, the black soldier fly larvae (BSFL) were the most outstanding as they reported them to be readily raised on organic materials. Several studies have also dwelt around the protein quality of BSFL and realised that BSFL meal can potentially substitute both soybean meal and fishmeal in pig diets (Hong and Kim, 2022; Chia *et al.*, 2021). Although much work has supported the use BSFL in pig diets due its high protein content, it is not yet clear whether Uganda has the potential to sustainably produce enough BSFL for use in pig diets. Establishing this potential is critical in guiding policy with regards to laying strategies for ensuring sustainable production of pig feeds. The current review, therefore, employs a prospective approach, with assumptions based on the current pig population in Uganda and availability of wastes, to model the potential of producing enough quantities of BSFL for use in pig feed production. The review has assumed an intensive operation where all pigs are fed on feeds formulated using BSFL meal as the main protein source with no free-ranging to augment the diets. The review has adopted the current population of pigs (4.4 million pigs) in Uganda (UBOS, 2020b) in estimating Uganda’s potential to feed her pigs on diets comprising of BSFL meal as the protein source.

Use of Black Soldier Fly Larvae in pig diets

Using BSF larvae in pig diets has been widely studied and proven feasible and sustainable. The BSF larvae has attracted attention of animal nutritionists chiefly because of their high protein content ranging from 40% to 61% (Hong and Kim, 2022) and low-cost investment in raising them (DiGiacomo and Leury, 2019; Shumo *et al.*, 2019). Most importantly, BSF larvae have a higher (88%) ileal digestibility of Lysine, the most limiting amino acids in pig diets than fishmeal (86%) and is comparable to the 89% of soybean meal (Crosbie *et al.*, 2020). Consequently, BSF meal can better serve as a substitute to the other protein sources in pig diets without compromising performance of pigs.

Current state of BSF production and potential of sustaining pig production

Intensive livestock production systems are primarily dependent on imported feeds (Chia *et al.*, 2019). This is despite the low investment requirements in raising black soldier fly larvae (Abro *et al.*, 2022). Currently, the inclusion of BSF larvae in pig diets is acceptable in Uganda, hence production will meet a ready market (Chia *et al.*, 2020b). In addition, scaling up the rearing of BSF is likely to be embraced by the government of Uganda, as the enterprise could be a source of employment to many nationals. In their work, Abro *et al.* (2022) reported that using BSF larvae in animal diets could create between 1,252 and 563,203 new jobs annually in Uganda and lift over 4 million people from poverty in the next two decades. This implies that BSF larvae, if embraced as an ingredient to replace fish or soybean meals, could significantly contribute to improving the economy well-being of many Ugandans.

However, production statistics remain scanty, probably because the insect has not yet gained popularity, particularly in the pig sub-sector. On the other hand, BSF larvae purely grow on organic wastes, like animal manure and food wastes. Considering food wastes, for example, an average

income earner in Kampala produces about 0.4 kg of wastes per day (UNEP, 2021). According to Ibadurrohman *et al.* (2020), 800g of BSF larvae can be produced from 4 kg of waste. As of 2020, the population of Kampala city was 1,680,600 people (UBOS, 2020a), resulting into 672,240 kg of food wastes and about 134,448 kg of BSF larvae per day. At 14% level of inclusion in pig diets (Chia *et al.*, 2021), about 960,343 kg of complete feed could be prepared from BSF larvae raised on the food wastes from Kampala on a daily basis. Assuming 2 % losses during feed preparation (EW Nutrition, 2023), about 941,136.14 kg of complete feed can be prepared on a daily basis and 282,340,842 kg generated per year, assuming a 300-days feed preparation operation annually.

The urban population statistics for 2022 showed that there were over 12 million people in the urban centres of Uganda (Macrotrends, 2024). In this review, we estimated an average of 0.3 kg per day of food waste to be produced by an urban dweller. With such level of waste generation, urban dwellers are able to generate about 3,600,000 kg of food wastes per day equating to 720,000 kg of BSF larvae per day. At 14% level of inclusion of BSF larvae in complete pig diets, food wastes from urban dwellers can produce 5,142,857 kg of complete feeds per day. At 2% level of losses during preparation, food wastes from urban centres can produce 5,039,999.86 kg of complete feed on a daily basis and 1.51 million tons of complete feed a year, assuming a 300-days operation. According to Straub and Vernooij (2021), 1.5 million tons of complete feeds are needed to support intensive pig production systems a year. However, this figure is low, probably because they only considered the number of pigs which are actually currently reared intensively. For our case, however, we have assumed that all pigs in Uganda are reared intensively.

To estimate the possibility of Uganda to produce enough BSF larvae for her pigs, the following assumption have been laid: A daily feeding regime of averagely 2 kg per pig- not considering the physiological condition of the pig (whether piglet, sow, or boar) whose requirements may vary. All pigs are intensively managed and feeding is from the feeds containing BSF larvae as the protein source with no supplementation, as would otherwise be the case for semi-intensive management or free-range systems. If this be the case, annual food wastes from urban centres alone can produce enough BSF larvae for preparing feeds that can feed the 4.4 million pigs (UBOS, 2020b) of Uganda for approximately over 5 months.

Unfortunately, statistics on food wastes generated from rural areas is missing. In addition, information on wastes like animal manure, crop residues and other organic wastes is not well documented. However, a literal extrapolation from the statistics of urban centres could give a picture that Uganda can provided enough BSF larvae to sufficiently and sustainably supply proteins required in feeding pigs yearly, and even other enterprises like poultry and fish.

Potential challenges in the use of BSFL in pig diets

Although Uganda could potentially produce enough BSF larvae for use in pig diets, the use of BSFL in pig feed production is liable to a set of challenges. The most constraining factor reported is the inability to ensure a constant supply of organic wastes for raising BSF larvae. In addition, some people still perceive black soldier fly larvae as yucky (Adetunmbi, 2023), and this could deter uptake of their rearing. There is also a risk of accumulation of heavy metals in the BSF larvae, especially, if the substrate had a high heavy metal load (Adetunmbi, 2023; Shumo *et al.*, 2019). With poor sanitation there is also potential threat of pathogenic microbes occurring in the Black soldier fly larvae (Shumo *et al.*, 2019). Therefore, the source of substrate and hygiene in the rearing

room are crucial in preventing heavy metal and microbial accumulation. The animal feed industry should thus guard against these challenges.

Conclusion

Although there is limited evidence, our review of the available information, especially on the abundance of raw materials for growing BSF larvae reveals a potential of sustaining the use of BSF larvae as a protein source in pig diets. This implies that, if the use of BSF larvae in pig diets is embraced by all practitioners, the postulated pork demand can be met by local production. In the raising of BSF larvae, however, it is important to establish a reliable source of heavy metal-free substrates to avoid heavy metal accumulation in the larvae, which would end up in the food system. Furthermore, there is need to sensitize all stakeholders on the capability of using BSF larvae to sustain future pig production and its potential in ensuring food security as it will avert competition for soybean meal and fishmeal, thereby preserving them as ingredients in human diets. Studies need to be conducted on pig producers' perception of using BSF larvae in pig diets and on the consumer willingness-to-pay for pork from pigs raised on the diets.

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