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# Farmers and Consumers Awareness and Acceptance of the Novel Practice of Utilizing Insect Protein as an Alternative Protein Source in Poultry Feed: A Survey

Obed Opoku, Jacob Alhassan Hamidu, Benjamin Adjei-Mensah, Bernard Quaye, Victor Benante, Michael Adu Amankrah, Armstrong Donkoh, and Comfort Charity Atuahene

## ABSTRACT

**The use of insect protein as an alternative protein source in poultry feed has gained significant attention due to its potential benefits in terms of sustainability, cost-effectiveness, and reduced reliance on traditional protein sources. However, the adoption of this novel practice in the poultry industry may depend on awareness creation for farmers as healthy feed for poultry into the human food chain. This study aims to investigate poultry farmers' awareness and readiness to adopt insect protein as an alternative protein source for poultry. A cross-sectional survey was conducted using structured questionnaires administered to 177 poultry farmers and consumers in the Ashanti and Bono regions of Ghana by simple randomisation. The survey collected data on farm size, feed dynamics, protein sources, and awareness and readiness to adopt insect protein as a protein source in poultry feed. Data were analysed using descriptive statistics in the form of percentages and graphs. The study found that 75% of the farmers interviewed had a farm capacity of over 1,000 birds, making them medium to large-scale commercial farmers. However, the feed formulated was not always balanced. Some farmers fed an excess of the required protein levels. Furthermore, while 52% of farmers had knowledge of the insect as an alternative protein source only 3.8% were willing to adopt it. Additionally, 82.5% of the consumers are willing to patronise insect-fed-derived meat with the insect protein qualifying as an organic product. The study concludes that awareness of the use of insects as protein for poultry is important. There is a need to increase research on the benefits of insects to address meat and egg quality and benefits.**

**Keywords:** acceptance, awareness, insect protein, poultry, survey.

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## I. Introduction

Entomophagy has recently attracted significant attention and promotion, particularly among urban inhabitants both at home and abroad, as an alternative protein source to help solve the protein shortfall in the human diet [1]. It is regarded as a capable alternative not only because of its culinary potential but also because of the nutritionally promising properties and availability of notable edible insects such as crickets and Palm weevil larvae, both of which are undeniable delicacies throughout cultures. This has resulted in the development of insect farming among a variety of entrepreneurs attempting to shift the future narrative of protein intake. Even more noteworthy is the fact that, in recent years, insects have grown in popularity as a replacement for fishmeal and soybean meal in chicken production [2]. This has led to the spread of small-scale insect farming around the world in an attempt to solve the ever-increasing cost of chicken production due to high feed costs [3] and [4].

From the perspective of laying hens, replacing soybean meal with live insects, namely black soldier fly larvae (BSFL), has been shown to reduce the environmental impact of poultry feed production, reduce food waste, and boost

chicken welfare, with no or little influence on egg quality and taste [5] and [6]. The Commission of the European Union (EU) recently allowed the use of live insects for poultry feeding [7]. Even though some European feed firms have pledged to include insects in their poultry feed, eggs from insect-fed hens remain a niche commodity [8].

Once it has been established that the use of insect protein is promising in animal production, there should be a high level of awareness, demand, and acceptance among industry players in order to elevate the use of insects as an alternative protein source in poultry, fish, and other livestock feed from subsistence use and production. Fish, pig, and poultry farmers, feed input dealers and suppliers, feed milling firms, and the final consumers of animal products are among the important industry stakeholders in this regard. Consumers are increasingly accepting of insect-fed meals, particularly insect-fed fish and chicken [8], [9] and [10]. However, little is known about the determinants of consumption for these products and the limited literature available mostly considers insect-fed fish [10] and insects as feed in general [9], [11]–[15].

The diet of some livestock species, particularly in the wild before domestication, has influenced the consumption of some livestock species or otherwise by various groups of people (tribes) and individuals in Africa. A good example from Ghana is the Akan tribe's abhorrence of scavenging birds such as the vulture, which is considered a delicacy in other countries. Among the numerous reasons why the Akans will never crave vulture meat is that anything it consumes is considered unwholesome and dirty, which is why it is constantly referenced around heaps of garbage and carcasses. Thus, it is hypothesised that consumers' awareness and acceptance of insect protein as an alternative protein source in poultry feed will be positively correlated with their attitudes towards sustainable and environmentally friendly food production practices. *The objective of this study aimed to explore farmers and consumers awareness and acceptance of using insect protein as an alternative protein source in poultry feed, and to identify the factors that influence their perceptions.*

## II. Methodology

### A. Study Area

The Ashanti and Brong Ahafo regions are located in the southern part of Ghana, with the Ashanti region to the east of Brong Ahafo. The Ashanti region covers an area of about 24,390 square kilometres and is home to an estimated population of about 5.8 million people, according to the Ghana Statistical Service's [16] population projection. The Brong Ahafo region, on the other hand, covers an area of about 39,557 square kilometres and has an estimated population of about 2.5 million people. In terms of commercial poultry farming, both regions have a significant presence in the industry. The Ashanti region has a total of 56 commercial poultry farms, while the Brong Ahafo region has 35 commercial poultry farms, according to a 2019 report by the Ghana Poultry Project. These farms produce a variety of poultry products, including broiler chickens, layer chickens, and turkeys, among others. The research design for this study is a cross-sectional survey. A structured questionnaire was used to collect data from poultry farmers and consumers in the Bono and Ashanti regions of Ghana.

### B. Research Population

The study's population included two poultry industry stakeholders. These stakeholders included poultry farmers and poultry product customers. All large-scale poultry farmers in the Ashanti and Bono regions were included in the poultry farmer population. Additionally, the consumers of poultry products were individuals who were 18 years and above in these regions.

### C. Research Sample

With a 10% margin of error and a 90% confidence level, a total sample size of 177 was calculated using the formula:

$$S = (z/e)^2 \quad (1)$$

where
S = sample size; Z = degree of confidence (in this case 90% →1.64),
e = the accepted error as a proportion of the standard deviation (in this case 10%).

### D. Data Collection

Structured questionnaires were distributed to poultry farmers and consumers of chicken products to obtain primary data. The questionnaires were pre-tested to guarantee their validity, and the required revisions were made to ensure reliable data collection. The questionnaire contained closed-ended questions that were designed to capture information on consumers' awareness and acceptance of using insect protein as an alternative protein source in poultry feed.

### E. Sample Technique

The study adopted multi-stage sampling techniques to select respondents for the field survey. The Bono and Ashanti regions were chosen purposively due to their relatively large population of poultry farmers. The following groups of respondents were selected: Poultry farmers: A list of commercial-scale poultry farmers was obtained from the Ghana Poultry Farmers Association. A simple random sampling technique was used to select 80 farmers from the list. Consumers: A list of households that consume poultry products was obtained from the National Population and Housing Census. A simple random sampling technique was used to select 97 households.

## III. Data Analysis

The completed questionnaires were cleaned, and the data were entered into a pre-coded SPSS template. Data were analysed using SPSS (20) and Microsoft Excel. Descriptive statistics such as frequency, percentages, and graphs were used to summarize the data.

## IV. Results and Discussion

### A. Farmers

Fig. 1 shows the socio-economic background of the respondents. Among the farmers, respondents were

dominated by males (95%). This is not surprising, given the hectic nature of poultry farming which demands a lot of physical effort in terms of operations. That is not to say females cannot venture into the sector. The 5% of respondents are testimony that women can also engage in poultry farming with the requisite human resource to assist in operations. A similar finding was reported by Quaye et al. [17] when the impact of the Covid-19 pandemic on poultry production was explored in the Kumasi metropolis, Ghana. Per the locations chosen for this survey, it is also not surprising to observe that the religious affiliation of respondents is dominated by Christians (86.3%) with Muslims in the minority (13.8%). This is supported by the Ghana Statistical Service's 2021 national population census, which revealed that the majority of Ghana's population are Christians and concentrated in the southern and middle belts of the country where the survey was conducted [16].

Ethnically, the location of the survey is home to the Akans who form 85% of the respondents with other tribes such as Ewes, and Northerners featuring in minority proportions (3.8% and 7.5%) respectively. The modal age of respondent farmers was above 35 years (63.7%). This implies that a significant population of poultry farmers are very youthful given that the remaining 46.3% are below the age of 35 years. Not only does this indicate a vibrant youthful and energetic workforce in the poultry sector, but also indicates that, given the right business environment, the industry has promising potential by virtue of its available workforce. The presence of relatively young people in the sector is in itself a motivation to other young professionals and the unemployed population to venture or invest in the industry, should the success of existing farmers be evident. This could be a positive step in addressing the troubling issue of rising unemployment and also help to boost general productivity and investor confidence in the industry.

It is worthy of note that the majority of the respondents to this survey of poultry farmers are farm owners. This is important because it gives credibility and confidence to the responses obtained in the study as first-hand information coming from the primary source, the farmer. That is not to say that the responses obtained from other categories in the minority of the respondents (Technician, Labour and other positions) cannot be trusted. In some cases, some of these respondents who are not farm owners, had more readily available information than even the farm owners, owing to their continuous presence and involvement in the day-to-day operations of the farm.

Even though poultry farmers were being interviewed, it was worth considering that 'Poultry' does not only refer to chickens and hence a poultry farmer may keep other birds aside from chicken. Typically, the Ghanaian poultry farmer may have on the same farm other species of farm animals aside from poultry. It was revealed as shown in Fig. 2 that, 12.5% of the respondents kept only broilers, 27.5% kept both broilers and layers, 57.5% kept only layers, while 2.6% kept layers and other poultry species like guinea fowls and turkey. The Low percentage of farmers producing or raising broilers only, could be explained by the inability of local farmers to compete with the dreadful huge inflow of frozen chicken products through importation from foreign countries [18]. It is estimated that Ghana imports tonnes of poultry products (frozen chicken) to a tune of over 350 billion cedis annually for local consumption [19]. Given the relatively expensive production cost of broilers in the country, farmers find it difficult to compete with the price of imported poultry products and hence, the demotivation to venture into broiler production. This development compels many poultry farmers to focus mainly on layer production (57.5%) where egg production and sale of spent layers, post-production cycle, can compensate for the cost of production and still yield some marginal profits if operations run smoothly. Only 30% of farmers who responded to the survey admitted to keeping other animals aside from poultry on their farms. This could be because farmers are not interested in overburdening themselves with raising other animals commercially since poultry farming itself presents its challenges. Others also understand the possibility of disease transmission among species and are not willing to risk raising other species of animals on their poultry farms.

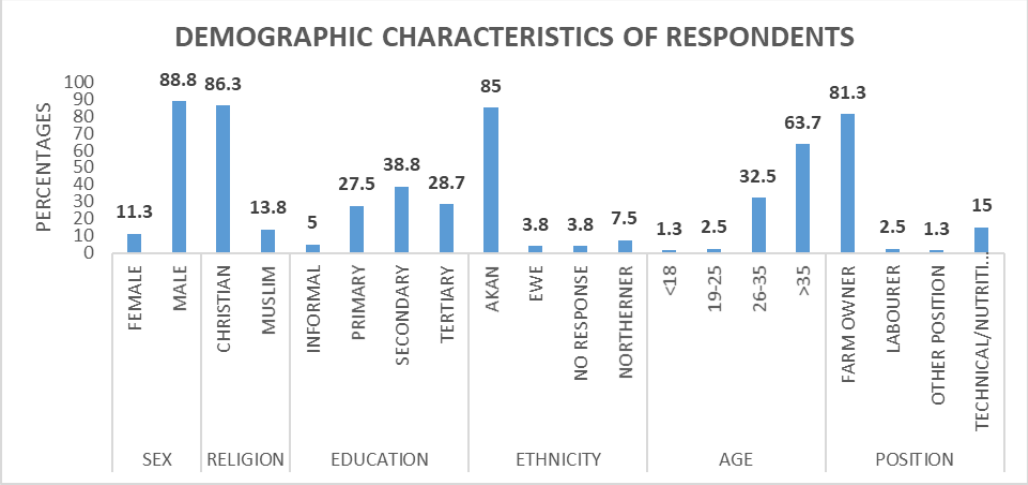


Fig. 1. Socio-economic background of respondents (Farmers).

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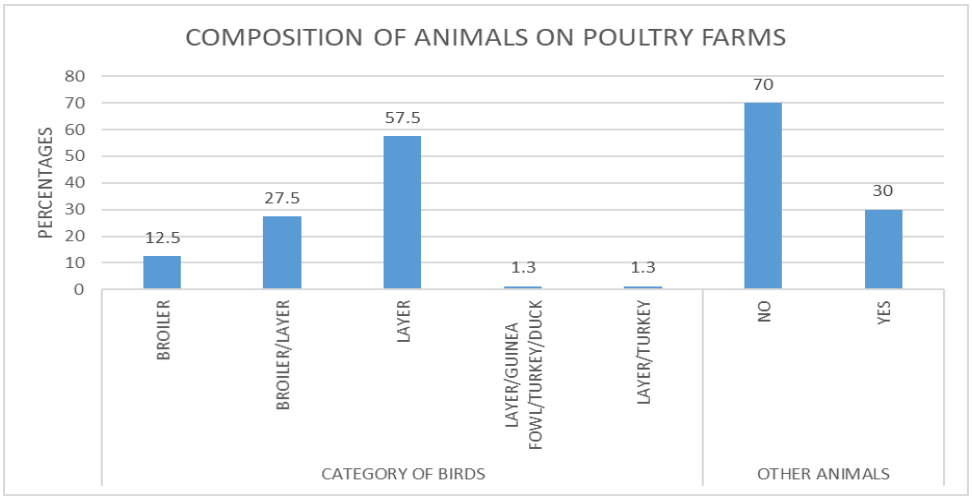


Fig. 2. Animal composition on the farm.

The response on farm size and feed dynamics is presented in Fig. 3. Seventy-five percent (75%) of farmers interviewed had a farm capacity of over one thousand (1000) birds making them medium to commercial scale farmers, the majority (78.8%) of whom prepare their feed on-farm. In Ghana, it is not unusual to see commercial poultry farms set up a feed mixing unit on the farm to formulate its feed by purchasing the ingredients which are mainly grains, protein concentrates or other protein sources and other minor ingredients like additives. This is confirmed by the 78% of respondents who admitted to preparing their feed on-farm. But feed compounding does not only require the mixing of ingredients in any uncalculated proportions. It requires technical expertise which takes into account factors such as the animal for which feed is being formulated, the physiological and nutritional requirements, breed, among many other factors [20]. One key factor that cannot be overlooked in the exercise of feed formulation is how the energy-to-protein ratio of the feed is balanced according to the physiological and nutritional demands of the animals. It has already been established that the majority of the respondents (over 57%) raised layers which have a protein demand of about 15-18% crude protein depending on the physiological stage of the birds, according to the NRC [21] nutrient requirement tables. Yet, 50% of farmers admitted to formulating and feeding their layer birds with feed containing as high as 21-25% crude protein, while 7.5% of respondents fed feed containing over 25% crude protein. Five percent (5%) of farmers could not tell the percentage protein composition of their feeds. The relevance of these findings stems from the fact that majority of poultry farmers are not feeding balanced energy: protein ratio diet, which undoubtedly, has an adverse effect on the general productivity and profitability of the poultry farming business. Given the relatively expensive cost of protein ingredients, feeding way in excess of what is required cannot only be described as an economic loss but also absolute wastage since the bird cannot in any way store or make use of the excess protein. It is however not surprising to witness as shown in Figure 3 that, 85% of farmers blamed 30% of the total feed cost on the percentage of protein inclusion in the feed alone. Similarly, 81% of respondents again admitted that the 30% of total feed cost attributable to the percentage of protein inclusion in the feed is very expensive. Protein ingredients generally have a relatively higher cost per kg, compared with the energy source ingredients in the feed. Therefore, disproportionate use of protein ingredients in the feed formulation can be very dire, increasing significantly the cost of production while eroding marginal profits and general productivity. Unfortunately, that seems to be the reality of the farmers' situation according to the findings.

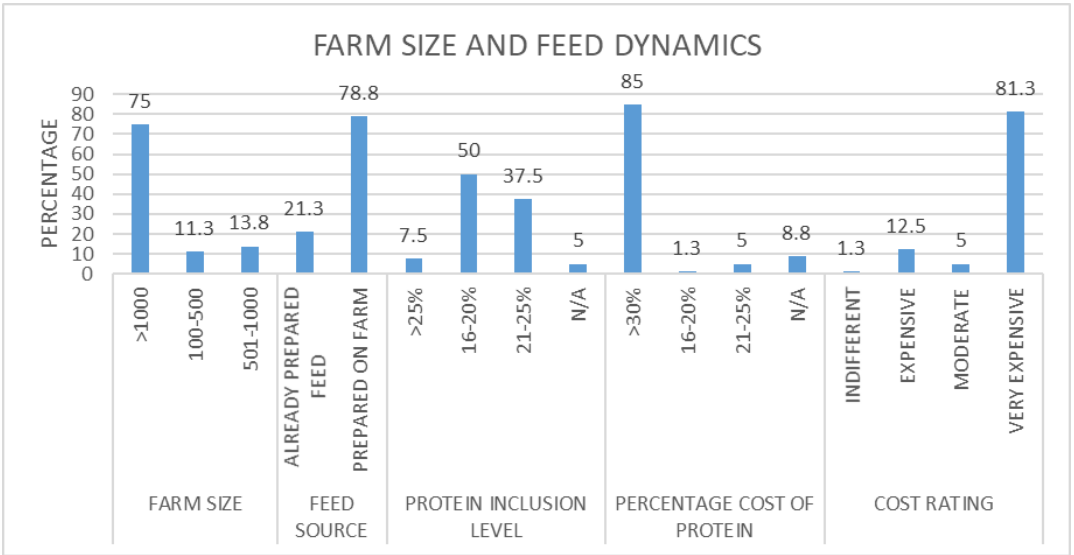


Fig. 3. Farm size and feed dynamics.

Soya bean meal and concentrates are the most highly utilized protein ingredients (93.8% and 81.3% respectively) by poultry farmers (Fig. 4). Fish meal utilization was admitted by only 48.8% of the farmers. Over the years, more and more farmers have managed to switch from the use of fish meal to the use of protein concentrates owing to a multiplicity of factors, including but not limited to; ease of use of the protein concentrates with grains and soya bean meal, simply by knowing the protein percentage concentration of the concentrate [22], the ever-increasing cost of fish meal, coupled with periodic shortages on the feed market, compelling farmers to switch brands, which often than not negatively affect production and productivity [23], proliferation and availability of varied brands of protein concentrates on the market [24] and challenges associated with the use of some fish meal, which relates to the traceability of the taste and smell of fish in the poultry product (meat and eggs) [23]. These and many other similar reasons have contributed to the steady but drastic decline in the use of fish meals for poultry feed by many commercial farmers. Farmers awareness and utilization of other protein sources exclusively or in combination with the conventional ones (Soyabean meal, Fish meal and Concentrates) was a fifty: fifty (50%: 50%) response. Awareness and utilization of other protein sources as admitted by almost 50% of the farmers were in proportions of 28.7%, 12.5% and 7.5% for cotton seed cake (CSC), palm kernel cake (PKC) and meat and bone meal (MnBM), respectively.

As the key objective of the survey, the study sought to investigate poultry farmers' awareness and readiness to adopt the novel practice of the use of insect protein as an alternative protein source in poultry feed (Fig. 5). When asked whether or not farmers knew about insect protein as an alternative protein source for birds, 52% admitted to having such knowledge. Termites and grasshoppers came tops with 35% and 7.5% respectively in the identification of known insects used as alternative proteins for birds. Forty-two percent (42%) of farmers gave no response by way of identifying specific insects used as alternative protein sources. This non-responsive percentage of farmers corroborates with the 47.5% who admitted not having any knowledge about the use of insects as an alternative protein source for poultry. Similar results have been reported by Bulinda *et al.* [25] when the knowledge and willingness of black soldier fly usage as a potential protein source in pig and poultry production in Kenya was investigated.

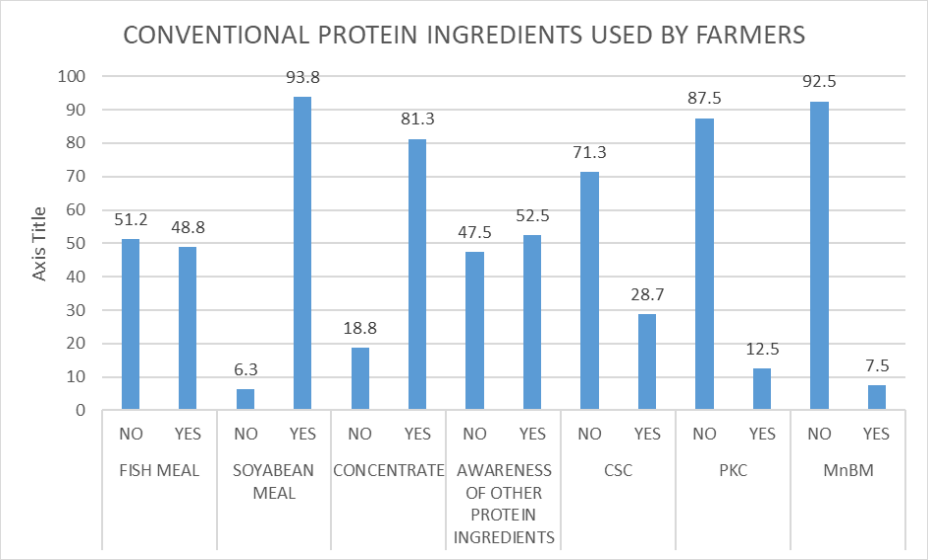


Fig. 4. Conventional protein ingredients used by farmers.

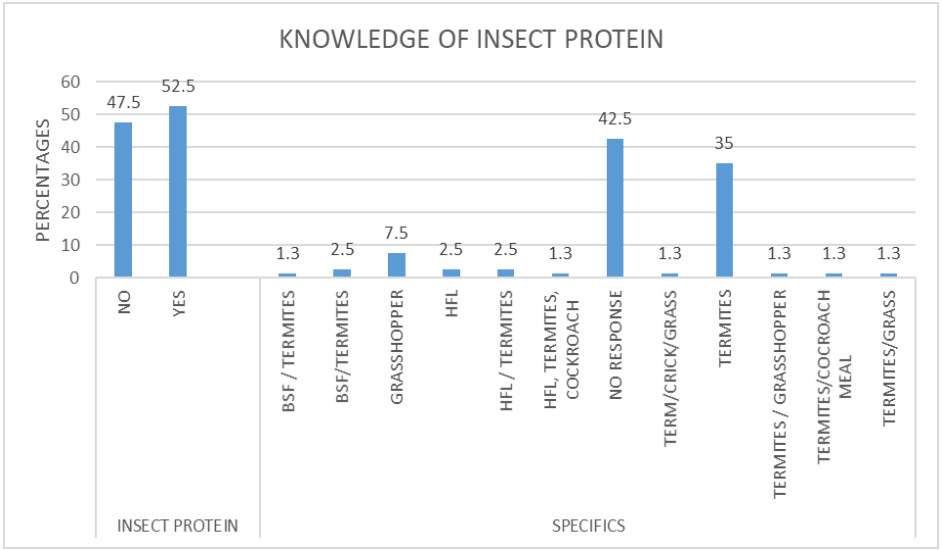


Fig. 5. Knowledge of insect protein.

Though 52.5% of poultry farmers admitted to having some form of knowledge about insects as an alternative protein source for poultry, it was rather disappointing to know that only 3.8% of respondents had ever attempted the adoption or use of insect protein, (specifically, Housefly larvae) as an alternative protein source, out of which only 2.5% found it to be desirable or promising (Fig. 6). This finding is quite significant, as it proves the traditional and conventional nature of Ghanaian poultry farmers in the exploration of novel technologies, practices and products directly related to their business. This bias could be fuelled by the farmers' understanding of how sensitive and responsive poultry birds are to rather unconventional feed ingredients and hence, they are extremely careful if not sceptical about trying novel practices, no matter how good or bad they may present. This informed the present study to investigate also what may influence the farmers' choice or decision to try insect protein as an alternative protein ingredient.

Even when the crude protein content of insect protein is admirable, only 15% of respondents would opt to give it a try (Fig. 7). Availability is a key factor of choice for farmers, and even when the availability of insect protein is assured, again, only 40% of farmers were willing to try insect protein as an alternative protein source to conventional protein sources. With good productivity being the ultimate aim of every farmer, half of the respondents (50%) were willing to try insect protein, given the opportunity. The cost of feeding is also a strong determinant of profit given productivity is at its peak. Should insect protein cost even the same as the conventional protein sources, only 8.8% of farmers would be willing to opt for it. Firstly, it can be said that the number one determining factor that may influence the farmers' choice for or against insect protein or any other ingredient is the impact the ingredient has on productivity. This is understandable since farmers believe that irrespective of the cost implication of an adopted practice if productivity is enhanced, profit maximization is inevitable [26]. But other determinants such as high protein content, similar cost and availability not being compelling enough for farmers to adopt the novel practice of using insect protein in poultry feeds, only demonstrates the non-conventional and conventional nature of the Ghanaian poultry farmer regarding the adoption of novel practices and technology. This begs for the urgent need to intensify education and extension services to farmers on some emerging trends and practices in the farming space, such as the use of insect protein as an alternative protein source. However, farmers must have trust, when it comes to education, sensitization and recommendations.

Quality, Price, Availability and other factors may be the direct determining factors that may influence the farmers' choice for or against the adoption of insect protein. Indirect factors such as market trends, peer influence and trust in the business systems can also influence consumer choices and decisions (in this case, the farmer). Based on this assumption, the study sought to determine which indirect factors, by way of some industry players, could influence farmers' choices and decisions regarding the adaptation of utilizing insect protein as an alternative protein source for poultry.

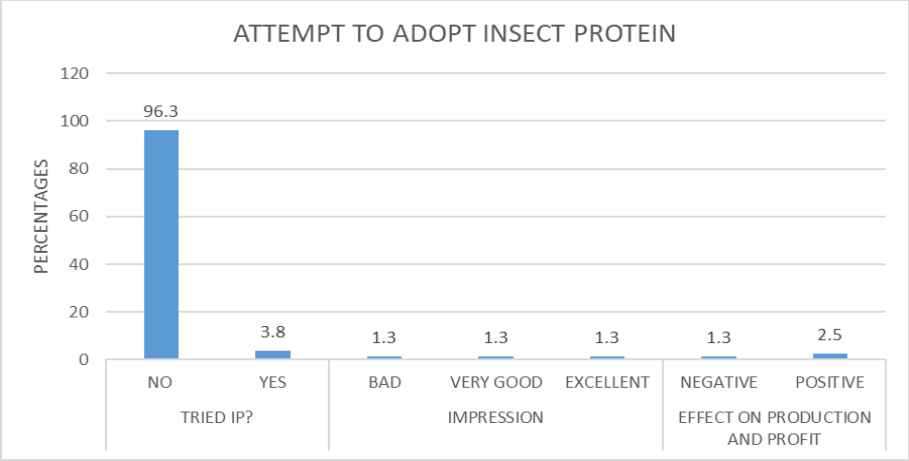


Fig. 6. Attempt to adopt the use of insect protein.

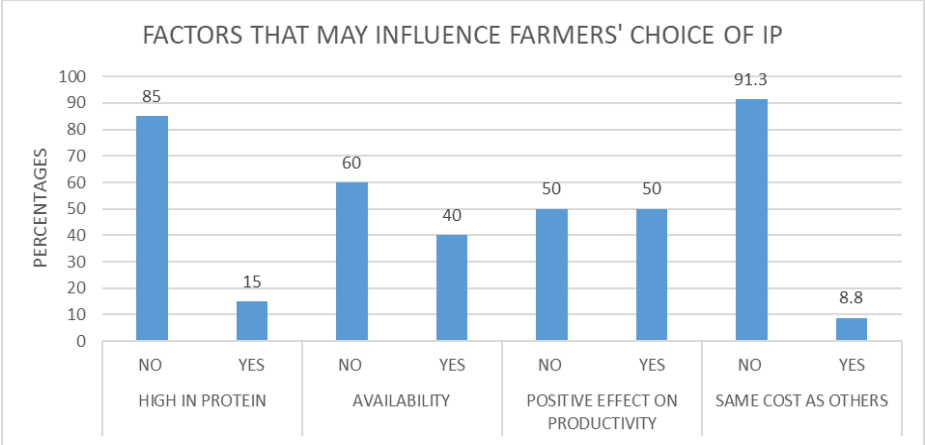


Fig. 7. Factors that may influence farmers' choice of insect protein.

As demonstrated in Fig. 8, poultry farmers are more likely to adopt the novel practice of utilizing insect protein if recommended to them by a veterinary or MOFA staff (91.3%), fellow poultry farmer (83.8%), agricultural extension officer (65%), input supplier (38.8%) and foreign company (36.3%).

Clearly, poultry farmers have trust and confidence in the Veterinary / MOFA officers, as well as their colleague farmers, more than any other person(s) or entity, due to the accessibility and contact time between these parties which has resulted in the development of trust and confidence over the years. It is an undeniable fact that these trusted parties are ranked more trustworthy to the farmer than a professional nutritionist, feed millers and feed experts, who ultimately, ought to be better positioned to give such important recommendations and advice due to their unavailability and inaccessibility to poultry farmers. Inaccessibility of professional nutritionists to farmers on the other hand may be due to the fact that unlike MOFA / Veterinary officers employed and paid by the government to attend to farmers, the farmer on his or her own, has the responsibility of engaging a professional nutritionist at a fee, relatively expensive to most farmers who may not even find the need to do so, even when recommended to them.

Farmers anticipation of the prospects of this novel practice could serve as an important tool in educating and convincing farmers to adopt the technology. Fortunately, 68.8% of farmers believe that the use of insect protein as an alternative in poultry feed in the near future is most likely and the determining factors are most likely to be (according to the farmers), availability (92.5%), quality (88.8%), price (82.5%) and shelf life (63.7%) (Fig. 9). Interestingly, the same factors which could be the determinants that give the prospect to the adoption of the use of insect protein, are the same factors that could pose a challenge to its adoption.

Only 15% and 21.3% of farmers feel that price and quality respectively could be a challenge in the future towards the adoption of the novel practice (Fig. 10). On the contrary, the majority of the farmers (60%) believe that availability could be the greatest challenge to embracing the use of insect protein as an alternative protein ingredient. Even though many of the farmers do not believe that price is / could be a major challenge, it is logical to reason along basic economic principles that, once availability proves to be a challenge, the science of demand and supply would make price a factor of great concern, should the demand be consistent. More so, farmers are justified to rate the availability of insect protein as the prime future challenge, given that it is a grey area yet to be explored fully in terms of its potential and also, they do not have enough information as to how production can be commercialized through technology and innovation to address the concern about availability [27] and [28]. All of this necessitates education and increased confidence on the side of farmers in order to assure the innovation's future viability.

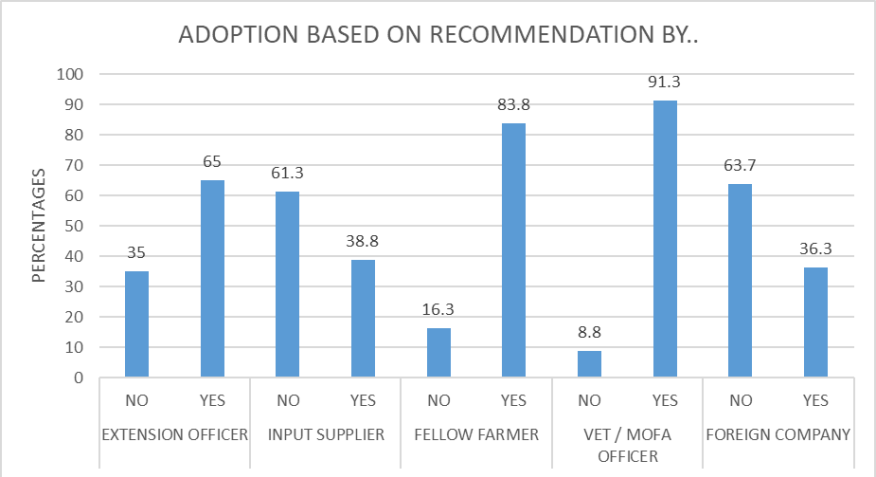


Fig. 8. Adoption based on recommendation.

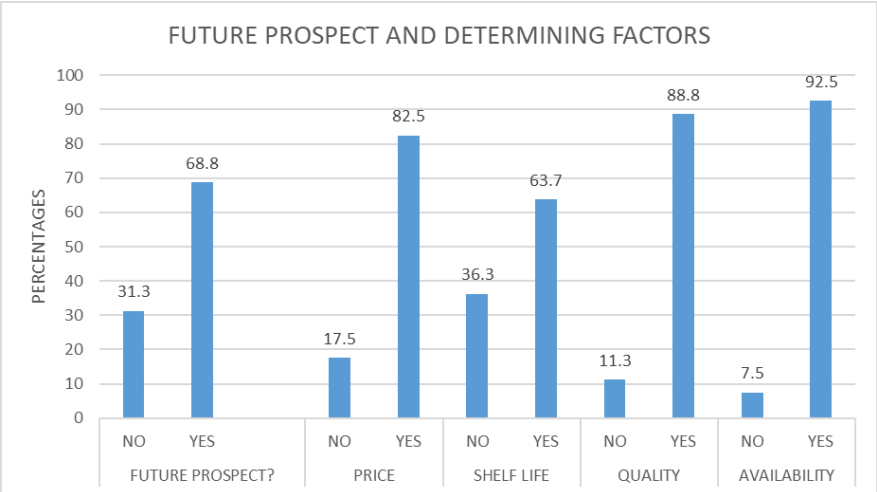


Fig. 9. Future Prospects.

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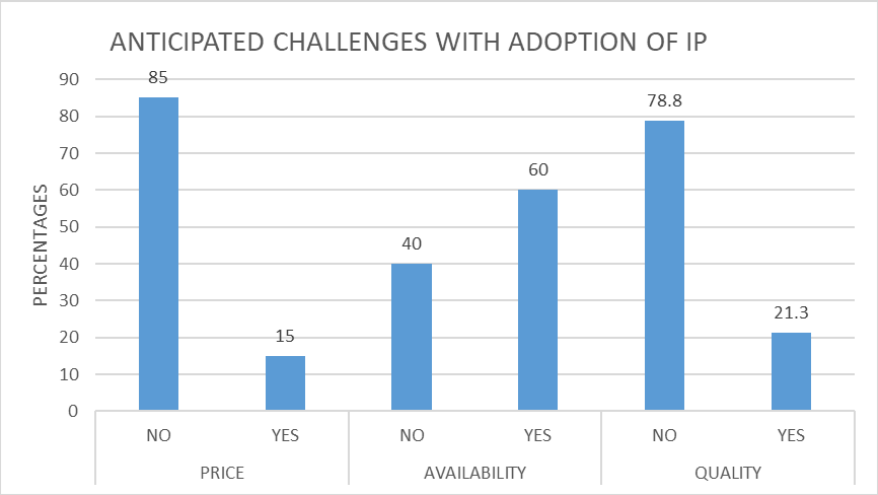


Fig. 10. Anticipated challenges.

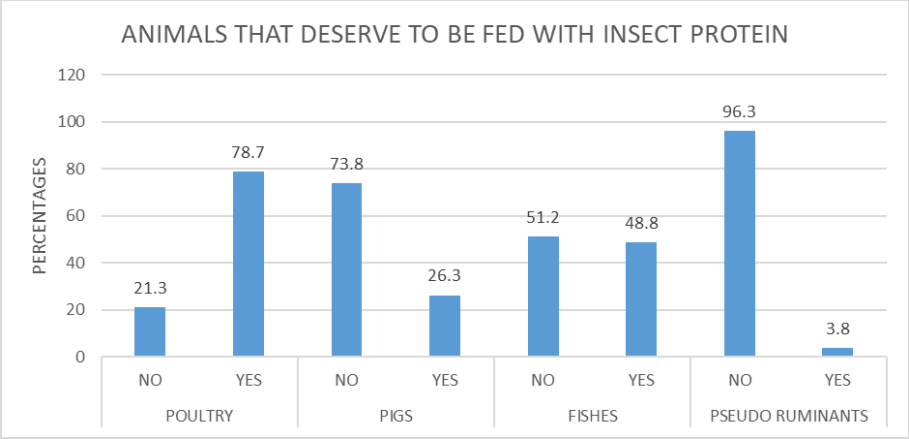


Fig. 11. Animals prudent to be fed with insect protein.

The response of farmers as depicted in Fig. 11 shows that poultry farmers are willing to embrace the practice. 78.7% agree that insect protein ought to be fed to poultry, while 48% also think it should be fed to fish, 26.3% going for pigs and 3.8% for feeding to Pseudo-ruminants.

Every ultimate production venture ought to have, in a clear perspective, the final consumer of the product of the production venture, in order to be able to tailor the production to yield products suitable and most preferred by the final consumer. The prime products of poultry farmers are ultimately eggs and poultry meat (Chicken) which are highly sought after by consumers at various levels of the value chain. Producing high-quality products that meet consumers' expectations and command premium prices, as it's the case of organically produced agro-products, ought to be the objective of every producer. This is why it was necessary to ascertain consumers' perceptions and expectations in the present study to know how the novel practice of utilising insect protein in poultry production could influence their behaviour patterns as consumers.

### *B. Consumers*

The demographic distribution of sampled consumers is demonstrated in Figure 12. Dominated by the male gender (63.9%) predominantly of the Christian faith (78.4%), all respondents had varying levels of education up to the tertiary level. A significant percentage had up to Secondary (34%) and Tertiary (41.2%) education. The modal age was 19-25 years (58.8%) which falls within the youth bracket amongst whom meat consumption is relatively high with a strong purchasing power. Also, by virtue of the geographical locations of the survey, Akans dominated with 73.2% of the respondents. In Fig. 12, the locations of respondents spanned from suburbs in Kumasi in the Ashanti region, Dormaa in the Bono Region and its environs.

Not every capable meat purchaser is a consumer. This is evident in Fig. 13, which shows 95.9% of the respondents as meat consumers and 4.1% as vegetarians. A person's decision to consume meat or otherwise may be influenced by a myriad of factors from health and animal welfare concerns to even culture [29]. Out of the 95% admitting to being meat consumers, 80.4% prefer or consume Chicken (poultry), 85.6% enjoy fish, 78.4% for ruminant species and 47.4% for pork. It is not surprising to see that pork recorded the least preferred consumption percentage. As much as it is a great delicacy among pork consumers, its dislike by those that shun it owes to various reasons such as health concerns, religious related beliefs, personal stereotypes, misconceptions and the like [30].

Consumers were asked whether or not what the animal feeds on or is fed with could influence their choice to consume their meat. It was interesting to find out that, majority (64.9%) of respondents responded in the affirmative, indicating their concern about what animals feed on or are fed with (Fig. 14). Regarding the awareness of the possibility of utilization of insect protein as an alternative protein ingredient to feed animals, 68% of respondents had no such knowledge or information. After a brief education on the

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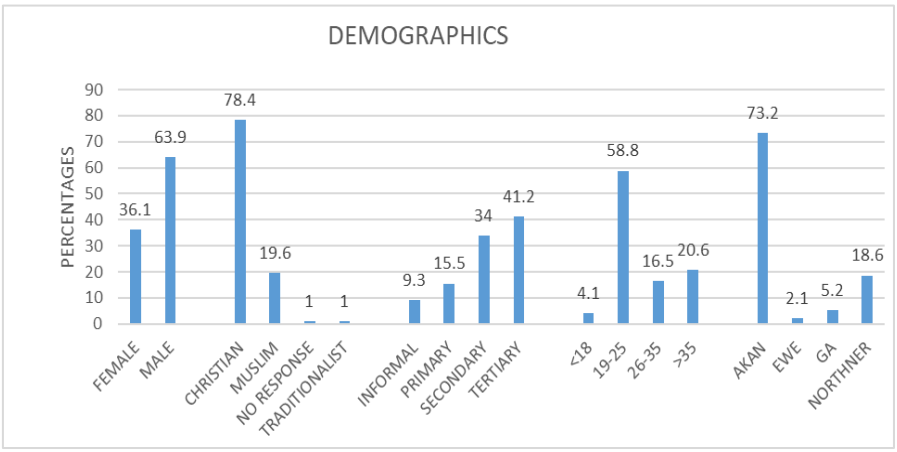


Fig. 12. Demographics of consumer respondents.

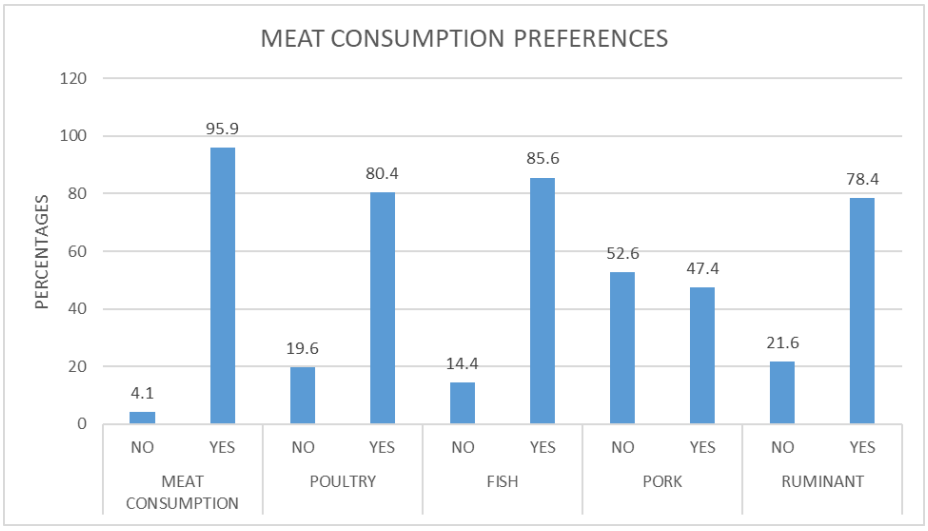


Fig. 13. Meat consumption patterns.

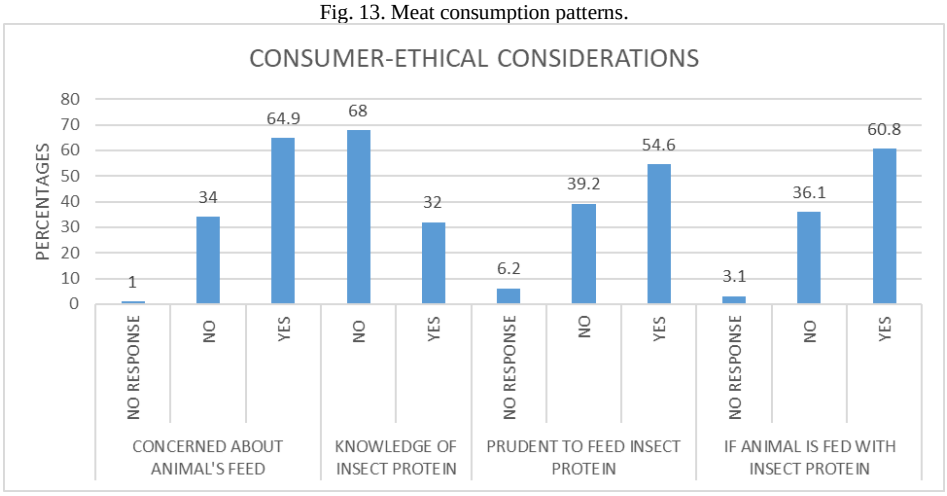


Fig. 14. Ethical considerations.

possibility of such novel practice, respondents were quizzed on whether or not it was prudent to feed animals with insect protein. Only 54.6% felt it was a prudent innovation and hence 60.8% of respondents indicated they would not mind consuming the meat of animals that had been fed with insect protein in their feed (Fig. 14). So then, what could be the deciding factors influencing respondents' choice of the resultant meat of animals raised with insect protein? 73.2% of respondents would opt for the meat of preferred animals raised with insect protein, given that the price of the resultant meat is cheaper, 57.7% if meat quality is improved, 82.5% if feeding of insect protein qualifies the meat of the said animals as being organically produced, 73.2% if insect protein can improve the taste of meat and 61.9% if it gives the meat an additional health benefit potential. It is therefore valid to conclude that meat consumers' appreciation and preference for organic meat production is on the rise and that all factors admitted to by respondents are significant influencers of one's choice for and subsequent consumption of a particular meat product.

Unique amongst reasons why respondents believed it is prudent to feed animals with insect protein or otherwise included but not limited to the possible nutrient-rich nature of selected insects (25.8%) for the practice, and the possibly

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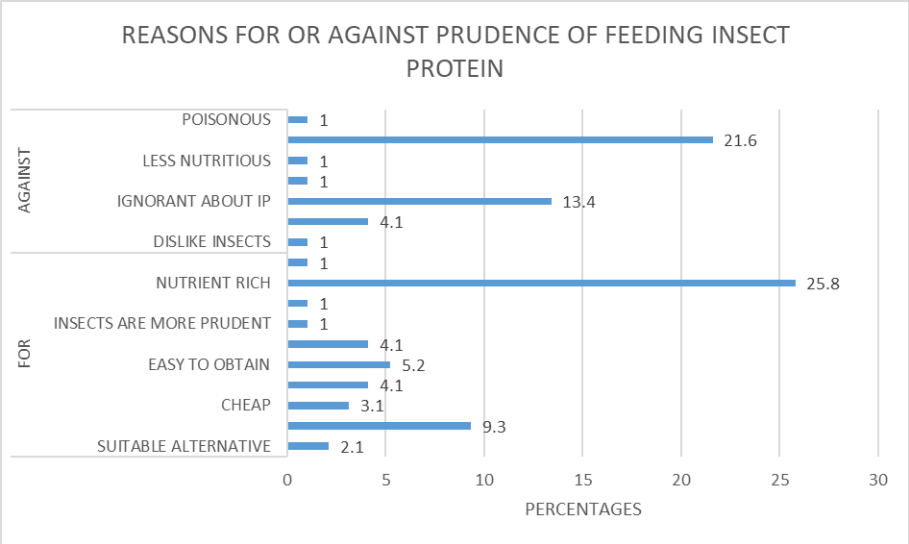


Fig. 15a. Reasons for or against prudence of feeding insect protein.

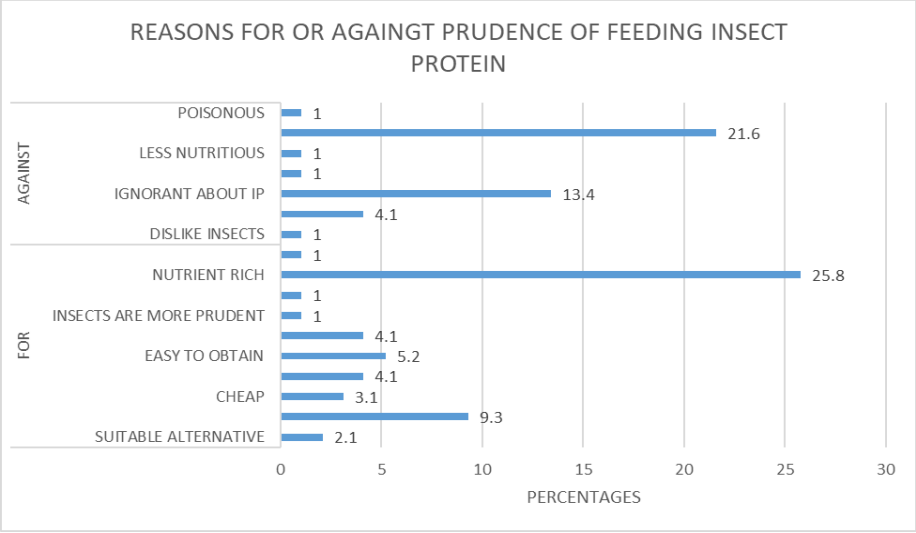


Fig. 15b. Reasons for or against prudence of feeding insect protein.

poisonous nature of insects (21.6%) against the practice (Fig. 15a and b).

## V. Conclusion

The findings indicate that many poultry farmers are not feeding their birds with balanced energy: protein ratio diet, which can lead to reduced productivity and profitability. The use of protein ingredients such as soya bean meal and concentrates are prevalent among farmers, while the use of fish meal is declining. Farmers' awareness and utilization of alternative protein sources, such as cotton seed cake, palm kernel cake, and meat and bone meal, are low. Furthermore, only a small percentage of farmers have knowledge of using insect protein as an alternative protein source for birds. The study also revealed that despite the low awareness of the possibility of utilizing insect protein as an alternative protein ingredient, a majority of respondents would not mind consuming meat from animals fed with insect protein if it met certain criteria. These findings provide valuable information for the meat industry and could inform the development of new strategies to meet consumers' changing preferences and concerns. This study underscores the importance of educating farmers on the benefits and proper use of alternative protein sources to improve the sustainability and profitability of Ghana's poultry industry.

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## Conflict of Interest

Authors declare that they do not have any conflict of interest.

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