

DETERMINATION OF INCLUSIVE LEVEL OF BASAL FEED TO FEED FORMULATION FOR PIGS OF DIFFERENT AGES TO PRODUCE QUALITY LEAN PORK WITH MINIMAL FAT

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Abstract

The study determined the best inclusive level of basal feed to feed compounded for pigs at different ages to produce minimal fat and quality lean meat. The study employed true experimental design with complete randomized design (CRD). Two specific objectives, two research questions and two hypotheses guided the study. The population was 10 weaner piglets randomly selected and assigned to four treatments. Four different experimental diets were formulated with varying levels of basal feed (yellow maize) at 45%, 35%, 25% and 15% inclusive levels respectively. The control group piglets were fed with the conventional feed with 55% basal feed in their formulated feed. Pork obtained from pigs in the control and experimental groups were subjected to proximate analysis. Results showed that experimental pigs with feed containing 15% basal feed had the lowest fat content (cholesterol). In conclusion, the findings of the study showed that the best inclusion level for basal feed in pig feed formulation to obtain minimal fat, high quality lean meat is 15%. It is recommended that feed millers and pig farmers both at peasant and commercial levels adopt the formula used to compound the feed that produced the pork with the lowest fat content in order to produce high quality healthy lean pork for human consumption.

Key Words: Feed, Fat content, Pig, Pork, Lean meat, Compound

INTRODUCTION

Pigs are well known for their ability to grow fast and high prolificacy. They possess the ability to accumulate both lean meat and fatty tissue. Pigs are majorly reared for their meat also referred to as pork in many parts of the world. Pork is largely consumed in most parts of the world. It provides a good source of protein, some vitamins and minerals. However, its consumption is limited by some individuals because of its high fat content. This has led to the evolution of modern pork industries towards high meat and low fat percentage pigs (Barton-Grade in Jong-Hyun, Kwan-Seob, Chog-Sam & Ho-Sung 2015). Too much fat in the human diet has been proved to be detrimental as it is associated with the cause of some health problems such as blocked blood vessels, high blood pressure and obesity among others. The quality of any meat is determined by how much meat with minimum fat it contains. Pork quality can be improved by mapping out strategies to determine the best optimal feed formulation that will produce highest quality pork with more lean meat and less but adequate fat. The enormous capacity of pigs for growth of both lean and adipose tissue depends largely on the quantity of carbohydrate consumed. Majority of the pig's caloric needs are supplied by carbohydrates and fats present in the feed. (Velayudhan, Kim & Nyachoti 2015). Carbohydrates are broken down into simpler molecular forms such as glucose before absorption while excess is stored in the pig's body as fat which makes up the adipose tissues or fat deposit in the pig's body. In the opinion of Schumacher, DelCurto-Wyffels, Thomson & Boles (2022), 'the deposition of fat occurs when the energy consumed is greater than the requirements of the animal'. This indicates that fat deposition can increase in pigs with increase of carbohydrates or basal feed in pig feed. The extent of deposition however, varies based on such factors as species, genetics, or breed, sex, age, live weight and environmental factors can influence fat development at various points of an animal's life.

This research aims at determining this optimal or best feed formulation formula that will be used in compounding pig feed such that will enable them produce high quality pork with high lean meat and minimal but adequate fat. In compounding feed for pigs, carbohydrate feed ingredients and lipids (fat) are good energy sources. However, lipids are concentrated energy source and their inclusion in pig feeds are known to affect growth rate, feed efficiency, diet palatability, feed dustiness and pellet quality. Brian, Trey & Gerald (2015) stated that in addition to energy production, carbohydrate and fat feed ingredients contribute to weight gain and fat content in pork.

Fat is a term used to describe a class of macronutrients used in metabolism called triglycerides. These make up one of the three classes of macronutrients including proteins and carbohydrates (biologydictionary.net 2022). Fats are saturated fatty acids and are strong forms of storing energy in pigs. The quantity of fat accumulated in pigs is a function of the quantity of carbohydrate and fat source added to the feed. Liu, Kil, Mendoza, Song & Pettigrew (2018) opined that adding 5% or 10% fat to diets for grow-finishing pigs has been shown to increase feed efficiency but, in some cases, reduce carcass leanness. According to the authors, fats from animal sources are normally considered to have lower digestibility than those from plant sources and hence, lower energy value than fats from vegetable origin. Fats from vegetable origin was used for this experimental study. Fats from vegetable origin include, palm oil, vegetable oil (soya bean oil), cotton seed oil, palm kernel oil, among others. For this study, the oil in the palm kernel cake and soya bean meal which were part of the feed ingredients were used as the only fat sources. These fat sources are preferred because of their high digestibility, ability to improve palatability, reduce dustiness and supply vitamins.

Nutritional guidelines suggest that dietary fat should not exceed 30% of total calories, and saturated fats should less than 10% of calorie intake. (WHO 2020). Feeding strategy is the most commonly used management factor for quality control in the

production of meat and for improvement or control of performance, animal welfare, safety, nutritional value, and eating and technological quality (Andersen, Henriksen, Gibbs & Hrycyna 2005). Fat supplementation is important for growing-finishing pigs because of the high energy value of the diet. Physiologically, pigs produce heat as a result of their production and maintenance functions. However, their body development and production efficiency are possible if this body heat production is minimal. (Tavares S.I.S, Donzele J.I, Oliveira R.F.M., Ferreira A.S,(2002) in Wolp R.C., Rodrigues N.E.B., Zangeronimo M.G., Cantarelli V.S., Fialho E.T., Philomeno R., Avarenga R.R & Rocha L.F. (2012). Therefore, though fats are needed to an extent in the body and diets of pigs of all ages because they increase the palatability of meat (pork) to an extent, excess fat in pigs leads to excessive heat generation and discomforts and makes its consumption detrimental to health. Fat content in pork is a function of various feed ingredients that make up the feed. Fats (lipids) and maize constitute the major source of fat deposit in pigs. Fat deposition increases faster than lean deposition with increasing body weight (BW). Lebreton in Lebreton, Candek-Potokar (2021). Fat content in pigs should, therefore, be controlled if high quality lean meat is to be obtained.

Fat contents are known as triglycerides that are esters of three fatty acid chains and the alcohol glycerol. Fat content in meat functions as energy deposits, protective padding in the skin and around organs especially heart and kidney as well as provides insulation against body temperature losses. Fat content in animal carcass varies from 8% to 20%, fat content is 20% only in pork. This is on the high side for healthy human consumption hence the study will seek nutrition-based ways to reduce the percentage of fat content in pork for healthy consumption. In the context of this study, fat content is the amount of fatty tissues found within the skin and the meat tissues of the mature pig due for slaughter. Fat content in pork has many health implications for humans and so, should be controlled intelligently to obtain pork with minimal fat best

for healthy human consumption. The lower the fat content in pork, the higher the quality of the lean meat. The quality of pork can be improved to obtain quality lean meat for healthy consumption by leveraging on innovative ways of compounding or formulating feed to determine the best optimal feed formulation to produce high quality lean meat with minimal fat content. This study sought to determine the best level of fat-producing feed ingredients (basal feed) to include in feed formulated for pigs to obtain high quality, low-content fat.

Purpose of the Study

The major focus of the study was to determine the best inclusive level of basal feed to be added to feed compounded for pigs at different ages to produce quality less fat lean meat. Specifically, the study sought to determine the:

1. Correct/adequate quantity/percentage of carbohydrate (basal feed) to be added to feed compounded for piglets at different ages.
2. Amount/quantity of fat deposited in pigs fed with feed containing the varying percentages of basal feed.
3. Compounded feed that produced the pork with the lowest/minimal fat.

Research Questions

1. What is the percentage of basal feed to be included in feed compounded for pigs at different ages?
2. What quantity of fat was deposited in the pigs fed with feed containing the varying percentages of basal feed?
3. Which of the feed produced pork with the lowest/minimal fat?

Hypotheses

1. There is no significant difference in the mean basal feed added to the different experimental feed.
2. There is no significant difference in the mean quantity of fat content produced in pigs by each of the experimental feed compounded.

Materials and Methods

The study adopted a true experimental ~~research~~ and a completely randomized design with equal replication in order to establish a cause-effect relationship between the independent and dependent variables. Rogers & Révész (2020) opined that experimental research design examines whether there is a causal relationship between independent and dependent variables. The independent variable is the variable of influence while the dependent variable is the variable being influenced as established by Loewen & Plonsky (2016). The independent variable in this study is the different compounded feeds while the dependent variable is the outcome of influence of the different treatment feeds which is the levels of fat deposits in the pork from the control and treatment pigs.

The study was carried out at Isiuja in Nsukka, Enugu State. The area is situated off the road leading to alor-uno and is characterized with a lot of shades due to the presence of many trees such as oil palm, mango and oil bean among others. Nsukka is also noted for its cool weather as well as adequate rainfall for about 8 - 9 months in the year which makes the environment is conducive for pig farming. Pigs thrive better in cool environments because it helps to cool their body from the excessive heat they produce due to their natural tendency to accumulate fat within the body. The location was chosen for its peculiar conducive climatic conditions that favor pig production and

also to ward off the prevalent swine flu outbreak at the time of the commencement of the study.

The population for this study was 10 piglets farrowed the same day by the same sow. The sow was purchased from the department of Animal Production Piggery Unit of the University of Nigeria Nsukka. Eleven (11) was farrowed by the sow. No sampling was done in selecting the piglets because of the limited number of piglets farrowed. Ten piglets were selected and randomly assigned to five pens in replicates of two each.

Materials and Preparation of Diets for the Experiment

The materials used in formulating the various feed treatments include:

- i) **Basal feed (carbohydrate) or energy source:** yellow maize and cassava peel
- ii) **Protein feed ingredient:** Bambara offal and soya mean meal
- iii) **Vitamins and mineral feed ingredients:** bone meal and limestone
- iv) **Fat and oil feed ingredients:** palm kernel cake and soya bean meal
- v) **Fibre:** spent grain, rice bran and cassava peel
- vi) **Additive:** mineral premix and salt

Preparation of Control and Treatment Feeds for the Pigs: The feed ingredients were all purchased from orba market, from the feed meal and other. The researchers ensured that the yellow maize still had high energy content by purchasing weevil-free well bagged maize. Feed ingredients were compounded at the king-size feed meal located along onuiyi link road. The formulation of feed was done in line with the guidelines provided by the National Research Council (NRC, 2012) which provides estimates of the amounts of these nutrients for various classes of swine under average conditions. Based on this guideline, the feed was formulated at 45%, 35%, 25%, and 15% inclusion level of basal feed respectively. The control feed contained the conventional quantity of basal feed of 55% inclusion level.

Certification of Experimental Piglets

The piglets used for the experiments were farrowed by a sow purchased from the Animal Science Piggery Unit in the University of Nigeria, Nsukka. The health status and prolificacy of the sow was certified by a pig expert in charge of the piggery. The piglets were obtained from the same sow, farrowed the same day to take care of some extraneous variables by establishing homogeneity among the piglets.

Experimental Procedure and Data Collection

Prior to the assignment of experimental pigs to the pens, there was thorough cleaning and washing of the pens with water and detergent. The pens were newly constructed to further ensure minimal possible cases of infections. The pens were constructed with feed and water troughs and the flooring was done to have a rough surface to enable piglets' hoof have a firm grip on the floor to avoid falling that could cause injuries. Ten pigs were randomly assigned to five treatment groups with two replicates each in a completely randomized design. Five pens were used each containing two pigs. One contained the control piglets while four contained the experimental or treatment piglets. The pens were labelled C, T1, T2, T3 and T4 for ease of analyses. Control feed for C contained 55% basal feed while T1, T2, T3 and T4 contained 45%, 35%, 25% and 15% inclusion levels of basal feed respectively. The piglets used were weaned at eight weeks and trial fed using the conventional compounding feed formula for pig weaners for four weeks to allow for physiological adjustments. The various feed treatments and the control feed were introduced to the piglets gradually until they stabilized. The piglets were given a daily ration based on body weight and were fed once daily. Piglets were weighed on weakly basis and weight gain recorded in order to determine the quantity of feed to serve them. Water was supplied ad libitum, wastes were removed and the pen washed thoroughly with water daily to avoid build up pathogenic organism. At eight

months, the pigs were slaughtered and the flesh collected from the loins were taken for proximate analysis. Data showing the varying levels of fat in each sample were obtained.

Results

Results are presented in tables 1 – 3

Table 1: Inclusive Levels of Basal Feed in Feed Formulated for Pigs

Control & Treatment Groups	Percentage of Basal Feed included in Feed
C	55%
T1	45%
T2	35%
T3	25%
T4	15%

The results in Table 1 indicates that T1 received the highest basal feed treatment diet of 45%, T2, T3, T4 and T4 received the lower treatments of 35%, 25% and 15% respectively. The control feed had the conventional inclusion level of 55% of basal feed. content of basal feed treatment had the lowest fat content in pork with the value of 13.85%.

Table 2: *Amount/quantity of fat deposited in pigs fed with feed containing the varying percentages of basal feed.*

Control & Treatment Groups	Percentage of Basal Feed	Quantity of Fat Deposited(%)
C	55	23.47
T1	44	15.71
T2	35	15.42
T3	25	14.50
T4	15	13.85

The results in table 2 reveals that treatment 1 (T1) pigs fed with feed containing 45% basal feed had a value of 15.71% of fat deposited, T2 pigs fed with 35% feed containing 35% basal feed had fat deposit of 15.42, T3 had 14.50% and T4 had 13.85%. This means that treatment pigs fed with the highest percentage of basal feed of 45% had the highest fat deposit descending decreasingly to T4 fed with the least percentage of basal feed with the fat deposit of 13.85%. This shows a decrease in fat content as the percentage of basal feed decreases. Control pigs fed with the conventional feed formulation formula containing the basal feed of 55% had the highest fat content deposit above all the treatment pigs.

Table 3: Proximate analysis showing corresponding varying levels of protein and fat deposited with different inclusion levels of basal feed

Treatments	Basal feed (%)	Protein (%)	Fats(%)
C	55	25.36	23.47
T1	45	17.26	15.71
T2	35	21.63	15.42
T3	25	25.93	14,50
T4	15	23.14	13.85

Results in table 2 shows varying levels of protein and fat deposited with corresponding varying levels of basal feed inclusion in compounded pig feed. Among the treatment pigs, T1 had the highest fat deposit while T4 had the lowest fat deposit. Also, results showed that T3 had the highest protein content while T1 had the lowest protein content. T1 produced the poorest lean meat among the treatment pigs in terms of fat content level and protein content, T3 produced the best pork in terms of protein

content and T4 produced the best quality lean meat in terms of level of fat and protein content.

Key:

T1- Treatment 1 (average value)

T2- Treatment 2 (average value)

T3- Treatment 3 (average value)

T4- Treatment 4 (average value)

For hypothesis 1, the Results show that there is a significant difference in the levels of basal feed added to formulated feed to produce varying contents of fat in pigs. Therefore, the hypothesis of no significant different was rejected and the alternate hypothesis (H_A) was upheld.

Results also showed that there is a significant difference in the mean quantity of fat produced by experimental pigs as a result of varying levels of basal feed added to the pig feed. And so the alternative hypothesis H_A, of significant difference was upheld.

Discussion

Pigs in T1 were fed with experimental diet containing 45% inclusion level of basal feed while T2, T3 and T4 had inclusion levels of 35%, 25% and 15% respectively. The percentage of basal feed content in the feed treatments was decreased from T1 to T4 in order to determine the relative levels of fat deposition. Result of the study showed that fat deposits in the pork decreased with decreased basal feed. This is in line with the opinion of Schumacher, DelCurto-Wyffels, Thomson & Boles (2022), that the deposition of fat occurs when the energy consumed is greater than the requirements of the animal. The more basal (energy) feed added to pig feed, the more tendency of fat deposition in the pig. Basal feeds are high in carbohydrates (energy) and the end product after digestion in the pig's body is glucose. Glucose is not stored in the body tissues but is converted to fat before deposition. This shows the relationship between

basal/carbohydrate feed and amount of starch deposited which is what the researcher leveraged on in this study.

For hypotheses 1 & 2 results show there is a significant difference in the amount of basal feed added to the feed as well as the fat content produced in pork. Increase in the basal feed caused an increase in the fat content in the pork produced. This agrees with the opinion of Brian, Trey & Gerald (2015) that in addition to energy production, carbohydrate and fat feed ingredients contribute to weight gain and fat content in pork.

Fat content in the samples of pork from the experimental pigs decreased as the basal feed content decreased. Also, the protein content increased accordingly except in T3 where we have the highest protein content. This implies that to produce high quality lean pork, good and healthy for human consumption, the pig breeder and pork producer should decrease the level of basal feed or energy product in the feed.

Conclusion

Based on the findings of the study, it was concluded that the best inclusion level for basal feed in pig feed formulation to obtain minimal fat, high quality lean meat is 15%.

Recommendation

Based on the findings and conclusion of the study, It was recommended that feed millers and pig farmers both at the peasant or subsistence and commercial levels should adopt the feed diet formulation in this study to produce healthier pork for more consumption by humans.

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