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Effect of Papaya Seed Inclusion on Growth and Carcass Quality of African Catfish (Clarias Gariepinus) Fed Maggot Meal

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ABSTRACT

Sixty (60) catfish juveniles of ten weeks old were used for the study with the objective of determining the effect of papaya seed inclusion on growth and carcass quality of African catfish fed Maggot Meal (MGM). House fly maggots were collected fresh, washed, sundried, then crushed to obtain the MGM. Papaya seed were also obtained from papaya fruits purchased from the open market. The seeds were washed, sundried and crushed to obtain the Papaya Seed Meal (PSM). The fish were randomly assigned to four dietary treatments identified as T_0, T_1, T_2, and T_3. T_0 was a pure popular foreign feed known as AllerAqua^R which was not treated with any maggot meal or papaya meal. Its purpose (AllerAqua^R) was only to compare the performance of the locally compounded maggot meal based feeds with the popular foreign feed. Diets T_1, T_2, and T_3 contained MGM at 30% inclusion level at the expense of fish meal. In addition to MGM, Papaya Seed Meal (PSM) was also included as additives to the three diets (T_1,T_2 and T_3) at 0%, 1%, and 2% inclusion levels respectively. Fish were fed at 5% body weight daily for 12 weeks. Water was changed after every three days. Data was obtained for Weekly Feed Intake, Weekly Weight Gain, Final Body Weight and Feed Efficiency. Analysis of data reveal no discrepancies (P>0.05) in Weight gain and feed intake among the three maggot meal based diets. The results of carcass analysis also reveal no discrepancies (P>0.05) in the moisture content, crude protein, crude fat, crude fibre and ash contents of fish fed papaya seed treated maggot meal. Hence, the incorporation of papaya seed in maggot meal based diets has no adverse effect on growth performance and carcass quality of fish.

I. INTRODUCTION

The rising cost of feed has been attributed to the rising cost of fish meal which is the major source of animal protein in livestock feeds. Fish meal also provides energy, essential fatty acids, vitamins and minerals in animal dietary formulations (Okah and Onwujiariri, 2012). However, the high cost of fish meal has forced researchers to look for its substitutes or alternatives (Tacon and Jackson, 1985, Wester et al. 1992). Fish meal accounts for 45% - 65% of total cost of fish feeds and therefore, any effort to substitute it with cheaper raw materials will significantly reduce the cost of production (Okah, 2004.). As a consequence, nutritionists have been experimenting on the possibility of replacing fish meal with cheaper and more readily available alternatives that have comparable energy and crude protein contents. One of such raw material is Maggot Meal (Ogunji et al. 2006). These authors have shown that Maggot Meal (MGM) has a great benefit and potentials as protein source in animal nutrition.

The reported crude protein value of MGM range from 43 to 64% (Awoniyi et al., 2003; Fasakin et al..2003: Nwangbo et al.. 2009; Odesanya et al., 2011). Adesulu and Mustapha (2000) also reported superior levels of some essential amino acids including cystine, histidine, phenylalanine, tryptophan and tyrosine in MGM than in fish meal or soy bean meal. MGM is rich also in phosphorus, trace elements and B complex vitamins (Aniebo et al, 2009).There have been studies on the use of maggots in the diets of African catfish, mostly Clarias gariepinus. The results are generally impressive, though the inclusion of MGM should be limited to 25-30% as performance tends to decrease when higher inclusion levels are used. Odusanya et al (2011) however, reported the crude fat of maggot to be over 30%. Thus, Jiang et al., (1992) opined that maintaining the oxidative stability of Poly Unsaturated Fatty Acid (PUFA)-enriched foods such as fish fed MGM diets have always been a challenge. Higher levels of PUFA increase the rate of fatty acid unsaturation, leading to oxidative deterioration of lipids (rancidity). Lipid oxidation

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affects flavor, taste, aroma, after taste, and the general nutritional value and shelf life of foods (Jiang et al., 1992).

This off-flavor brought about by oxidation has been the major pitfall of MGM feeding strategy (Bhal et al, 2011). Hayat et al, (2009) maintain that lipid oxidation is a major factor that determines quality and shelf-life of fish. Synthetic antioxidants such as Butylated Hydroxyanisole (BHA) and Butylaled Hydroxyloluene (BITT) have effectively been used for the stabilization of foods against lipid oxidation (Cherian, 2012). However, growing concerns regarding their role in the cause of diseases like cancer have restricted their use in food products (Thomas et al, 2006). Sampaio et al. (2012) and Kasapidou et al, (2012) suggested that the alternatives for the synthetic antioxidants are natural antioxidants which are safer, economical and capable of preventing oxidative deterioration of food products. Thus, there is growing interest and advocacy in the use of natural antioxidants such as papaya seed, rosemary, oregano, green tea, grape seed etc to prevent lipid oxidation in food products and also in the alleviation some metabolic diseases at the same time (Dashti et al, 2015). Tunda and Aytunga, (2011) in consonance assert that the use of natural food preservatives can also provide protection from both spoilage and pathogenic microorganisms. Thus, food supplementation with antioxidants such as papaya seeds is being advocated. The aim of this study is to evaluate the effect of papaya seed inclusion on the growth and carcass qualities of African catfish fed Maggot Meal (MGM).

Objectives of the Study:

The objectives of the study were to:

i. Evaluate the growth performance traits of Catfish fed maggot meal (MGM).

Ii Evaluate the effect of papaya seed inclusion on the utilization of maggot meal (MGM) fed to catfish.

iii. Evaluate the effects papaya seed inclusion on carcass qualities of catfish fed Maggot Meal (MGM).

iv. Determine the economy of production in using the treatment diets.

Justification:

The scarcity of feeding stuffs especially fish meal which is the main source of protein in animal feedshave made it necessary to look for substitutes or alternatives, hence the introduction of non-conventional feeding stuffs such as maggot meal (MGM) in animal feed and dietary formulation. However, high crude fat content of MGM is a major pitfall in MGM feeding strategy. High level of fatty acid leads to high rate of lipid oxidation and rancidity with consequent short shelf life of meat obtained from animals fed MGM based diets. There is therefore the need for closer studies on how to improve the nutritional values of this newly discovered alternative protein source. The study of the effects of a natural antioxidant such as papaya seed on growth and carcass qualities of catfish fed maggot meal based diets becomes imperative. .

II. REVIEW OF RELATED LITERATURE

The ever increasing world population has placed intense pressure on food sources, particularly protein, which is already at very critical levels. All classes of livestock particularly poultry and fish need high quality protein in their diets for optimum performance. These animals are fed mainly with fish meal based protein concentrates. Fish meal is derived from fish and other smaller aquatic creatures. However, to produce 1kg of fishmeal needs about 4kg of the smaller aquatic creatures. That is, four times the amount by weight of protein going in as coming out of the system. Thus, the efficiency of this process is poor and unsustainable since livestock feeds contain about 20% protein. As a consequence, overfishing of seas is now inevitable. The fishing industry is introducing host of control measures like how much fish that can be caught within a period or even total ban on fishing in some areas. To avoid more serious effects on marine life and ecosystems, more efficient ways of getting the protein we need must be developed.

Maggots, unlike Fishmeal, are very new as a source of protein for animals. They are very rich in proteins and contain a wide range of amino acids and minerals that provide the necessary nutrition for livestock growth. Maggot production doesn't come with the adverse environmental consequences like producing other animal protein. Unlike the prices of soybean and fishmeal which are currently going through the roof, maggots are abundant and readily available. As long as there are organic wastes, maggots can comfortably be 'farmed' in the backyard.

Maggot Production

In South Africa, AgriProtein is breeding billions of flies on a farm to mate lay eggs and produce maggots. These maggots are fed on organic waste material which is also a nutrient-rich

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fertilizer. The maggots are harvested and dried into a natural and sustainable animal feed. Maggot-based animal feed is more than 15 percent cheaper than other alternatives and has been proven to be highly nutritious for livestock, especially chickens (poultry), fish and pigs. Maggot Meal /MagMeal™ consists of the ground up, dried larvae that contains the nine essential amino acids, meaning it is a complete animal protein. In the study conducted by Ogunji et al.(2008) to evaluate the growth and nutrient utilization of Nile tilapia fed MagMeal™ instead of a commercial fish feed. The results of the study showed that the fish gained good growth and health, and that it did not produce any stress on their systems. The study also showed a better performance in the growth of the fingerlings when fed with MagMeal™, than when they were led with other commercial fish food. Thus, for Nile tilapia and other species of fish, MagMeal™ can work as a replacement to commercial fish feed. Therefore, serving an affordable option to the rising cost of imported fish feeds.

MGM in Feed Formulations

The non significant differences of the evaluated growth and nutrient utilization indices among the three treatments imply that maggot meal can successfully replace the entire fishmeal portion of the fish diet. Other authors have observed a better performance of fish fed diets containing maggot meal over those solely fed on fish meal diets (Ogunji et al., 2006). This is a reflection of the nutritive quality and acceptance of this biomatcrial. The result also corroborates previous observation that maggot meal, like other animal protein sources was well accepted and utilized by fish (Alegbeleye et al. 1991; Idowu et al. 2003). It has been suggested that the good growth and nutrient utilization capacity offish fed maggot-based diets stem from the high biological value ie nutrient composition and digestibility, of the ingredient (Sogbesan el al., 2006). Jhingrarn (1983) reported that maggots are easily digested by fish and this has been attributed to its relatively high crude fibre content, which according to Fagbenro and Arowosoge (1991) plays a significant role in feed digestion. The non significant difference in the values of FCR of the treatment diets is possibly indicative-that both protein sources compared favourably in feed to flesh conversion. It has been reported that the biological value of maggot meal is equivalent to that of whole fish meal (Ajani et al. 2004).

Sheppard and Newton (1999) have also reported that maggot oil is high in desirable medium chain and mono unsaturated fatly acids, and rich in phosphorus trace elements and B-complex vitamins (Teolia and Miller. 2003). Ogunji et al, (2006) postulated that several other ingredients of animal origin such as feather meal, poultry by-product meal, and also plant protein sources may not successfully replace fish meal in aquafeeds due to their inferior amino acid profile, and nutrient inhibition factors found in the latter class. Utilization of maggot meal will thus pave way for cheaper and nutritionally rich aqua feeds.

Table 3 Amino acid profile of housefly maggot meal compared with that of fish meal

Amino acid	maggot meal	Fishmeal
Histidine	3.09	1.36
Arginin	5.80	3.99
Aspartic acid	8.25	Not given
Threonine	2.03	2.60
Serine	3.23	Not given
Glutamicacid	15.3	Not given
Proline	2.85	. Not given
Glycine	4.1 1	Not given

Alanine	2.86	Not given
Cystine	0.52	0.82
Valine	3.61	3.09
Isoleucine	3.06	2.97
Leucine	6.35	4.45
Lysine	6.04	4.55
Tyro sine	2.91	1 .98
Phenylalanine	3.96	2.35
Melhionine	2.28	1.68
Tryptophan	0.69	Not given

Source; N.R.C. (1977)

Maggot meal is of high biological value. According to Akpodiete and Ologhobo (1999), maggot meal contains the ten essential amino acids and this is comparable to fish meal (Fetuga, 1977), thus, it has high nutritive value. The percentage of crude protein of 39.55%, lipid 12.5-21% and crude fiber 5.8-8.2% were reported by Ogunji et al. (2008a). Ogunji et al. (2008b) reported that the biological value of maggot meal was equivalent to that of whole fish meal and that the larvae contained no anti-nutritional or toxic factors sometimes found in alternative protein sources of vegetable origin. Fasakin et al. (2003) reported that crude protein content of maggot meals ranged between 43.3% and 46.7% in full -fat sun dried and hydrolyzed /defatted oven dried maggot meals respectively. 'Thus similar crude protein and lipid values were obtained in processing methods involving sun drying and oven drying either hydrolyzed or defatted maggot meals (Fasakin et al. 2003).

Oxidative Rancidity of Foods and MGM

The most common form of chemical deterioration is oxidative rancidity. Oxidative rancidity in fish can vary greatly, ranging from extensive flavor changes, color losses and structural damage to proteins to a more subtle "loss of freshness" which discourages repeat purchases by consumers (Skrivan et al, 2011). The latter is probably the most important to food processors since it is not apparent, but yet results in consumer dissatisfaction. Oxidative stability is a central parameter in the estimation of food or fish quality because of the susceptibility of fish or fish products to oxidative degeneration, which is one of the main causes of spoilage in fish products. Oxidative reactions are affected by several factors, among which are lipid composition and processing, and could be delayed by endogenous or exogenous antioxidants (Skrivan et al, 2011) . Biological antioxidants are molecules which, when present at low concentrations compared to those of an oxidizable substrate, significantly delays or prevents oxidation of that substrate (Jiang and Xiong, 2016).

Lipid oxidation is one of the most important problems encountered in animal products rich in polyunsaturated fatly acids such as Maggot Meal (Jiang and Xiong, 2016). Lipid oxidation is one of the most major factors affecting the quality and shelf life of fish. It causes undesirable changes in taste, odor, texture, flavor, and appearance of foods, and also destroys fat-soluble vitamins. Furthermore, the oxidative degradation of lipids can damage biological membranes, enzymes and proteins, which may pose a direct threat to human health (Liu, (2007), (Parker et al, 1995). Natural antioxidants of plant origin have been introduced to improve the lipid stability and enhance the sensory properties of food. The antioxidant properties of natural antioxidants of plant origin are mainly attributed to their phenolic contents, thus, their antioxidant action is similar to synthetic phenolic antioxidants (Elgasim and Al-Wesali, 2000). Microbial control in foods could be assured by suppressing one or more essential factors for microbial survival (Horace, 1982). There has been a constant search for alternative and efficient compounds for food conservation, aiming a partial or total replacement of antimicrobial chemical additives. Spices and herbs have been used for thousands of centuries by many cultures to enhance the flavor and aroma of foods. Scientific experiments since the late 19th century have documented the antimicrobial properties of some spices, herbs, and their components. Inhibitory activity of spices and derivatives on the growth of bacteria, yeasts, fungi and microbial toxins synthesis has been well reported, so they could be used in food conservation as main or as adjuvant antimicrobial compounds in order to assure the production of microbiologically stable foods.

Papaya Seed

Papaya seed is now being used for both medicinal as well as culinary purpose, it is a broad spectrum antibiotic killing a very wide variety of microorganism. Besides having potent antioxidant and antimicrobial action, it is now one of the most commonly used ingredients as a flavor enhancer in fish and meat products (Liu et al, 2010). In addition to its flavoring properties, papaya also possesses a wide range of medicinal attributes. These include antibacterial, antiviral, antifungal and antiprotozoan activities (Ankri and Mirelman, 1999) and beneficial effects on the liver, kidneys, cardiovascular and immune systems. There are a lot of reports concerning the antibacterial and antioxidant effects of papaya seed on fish and meat products (Kourounakis and Rekka. 1991 ; Lin et al., 1991; LI-Khateib and El-Rahman, 1987; Ismaiel and Pierson, 1-990).

The antioxidant activities of the ethanol, petroleum ether, ethyl acetate, n-butanol and water extract fractions from the seeds of papaya were evaluated and it was found that the ethyl acetate fraction showed the strongest DPPH and hydroxyl free radical scavenging activities, and its activities were stronger than those of ascorbic acid and sodium benzoate, respectively Elgasim and Al-Wesali, 2000). The n-butanol fraction demonstrated the greatest ABTS+ radicals scavenging activity. The ethyl acetate fraction and the n-butanol fraction not only showed higher antioxidant activities than the petroleum ether fraction, water fraction and ethanol fraction, but also showed higher superoxide union and hydrogen peroxide radicals scavenging activities than those of the other extract fractions. The high amount of total phenolics and total flavonoids in the ethyl acetate and n-bulanol fractions contributed to their antioxidant activities Elgasim and Al-Wesali, 2000). The ethyl acetate fraction was subjected to column chromatography, to yield two phenolic compounds, p-hydroxybenzoic acid and vanillic acid, which possessed significant antioxidant activities (Sampaioni 2012). Therefore, the seeds of papaya might be used as natural antioxidants.

Gap in Literature

In recent times, the use maggot as fish feed and poultry feed has been studied extensively. Even in Nigeria, there have been numerous experiments on the use of maggots in the diets of African catfish. The results are generally positive though the inclusion of MGM should be limited to 25-30% following its high contents in poly unsaturated fatty acids (Odusanya et al, 2011). Thus, there is growing interest and advocacy in the use of natural antioxidants such as papaya seed, rosemary, oregano, green tea, grape seed etc to prevent lipid oxidation in food products and also in the alleviation some metabolic diseases at the same time (Dashti et al, 2015). Food, supplementation with antioxidants such as papaya seeds is being advocated. However, not much is known on the use of a natural antioxidant such as papaya seed to counter the effects of lipid oxidation associated with maggot meal fed to catfish. The aim of this study is to evaluate the effect of papaya seed inclusion on growth and carcass qualities of catfish fed Maggot Meal (MGM).

III. MATERIALS AND METHODS

Experimental Site:

The experiment was conducted at the Fishery Unit of the Enugu State Polytechnic, Iwollo. Ezeagu Local Government Area of Enugu State.

Management of Experimental Fish:

Sixty (60) catfish juveniles of ten weeks old were used for the experiment. The fish were purchased from a reputable farm in Enugu. The ponds to be used measured 1m by 1m in dimensions with inlet and outlet facilities. The pond bottom and walls were thoroughly washed, disinfected and flooded with water three days before the arrival of fish. The fish were starved for the first twenty four hours before being placed on the treatment diets after randomly assigned to the four dietary treatments. They were fed two times daily based on 3 percent of body weight while water was changed after every three days.

Maggot Meal for the experiment was collected from a reputable poultry farm in Enugu State Nigeria. The maggots were collected fresh, washed, sun-dried and crushed in a hammer mill to obtain the Maggot Meal (MGM). The four treatment diets formulated were Iso-nitrogenous with 45% crude protein and metabolizable energy range of 2578-3000 kcal/kg. The papaya seed for the experiment were obtained from papaya fruits purchased from the market. The seeds were sundried and crushed to fine powder.

Experimental Diets

Three experimental diets were formulated with maggot meal at 30% inclusion level at the expense of fish meal. In addition, papaya seed meal was included as additives at 0%, 1%, and 2% inclusion levels corresponding to T_1 T_2, and T_3, respectively. A popular foreign commercial feed (AllerAqua^R) was a fourth diet (T_0) used only for the purpose of comparing its quality with the quality of the locally formulated maggot meal based diets. Each treatment was replicated three times giving a total of 12 observations (3x4). There were five (5) fish per observation which will give a total of 5x12 = 60 fish used for the study.

Table 3.1; Showing the Percentage Composition of the Experimental Diets.

Ingredients.	**T_1.**	**T_2.**	**T_3**
Maize	22.0	21.0	20.0
MGM	30.0	30.0	30.0
Papaya Seed	0.0	1.0	2.0
Soya meal	30.0	30.0	30.0
Groundnut cake	15.0	15.0	15.0
Bone meal	2.0	2.0	2.0
Lysine	0.25	0.25	0.25
Methionine	0.25	0.25	0.25
Premix	0.5	0.5	0.5
Calculated Analysis			
CP(%)	41.9	41.9	41.9
Energy(kcal/kg)	2900	2900.	2900

Data Collected: The data collected include the following:

1. **Initial Body Weight (IBW)**: After randomly assigning the fish to the various treatments, all fish in each treatment were weighed to determine their Initial Body Weights (IBW) before the experiment. The average IBW for each replicate and treatment was recorded.

2. **Weekly Feed Intake (WFI):** The Weekly Feed Intake (WFI) for each replicate was determined from the total feed fed for the week which was based on 3% body weight of the fish.

4. **Weekly Weight Gain (WWG):** The fish shall were weighed every week to determine their increase in weight for the week. This can also be divided by seven (7) to determine the daily weight gain. The feed intake and weight gain were also used to compute the weekly feed efficiency.

5. **Total Feed Intake (TFI);** The total feed consumed by each fish throughout the experimental period was determined by summing up the daily feed intake from the day one (1) of the experiment to the last day of the experiment.

6. **Final Body Weight (FBW):** Each fish was weighed at the end of the experiment to determine their final body weight.

7. **Total Weight Gain (TWG):** This was determined by subtracting the initial body weight from the fina! body weight.

8. **Weekly Feed Efficiency (WFE):** This was determined by dividing the weekly weight gain by the weekly feed intake.

Analysis of Data

The data on average weekly feed intake, body weight gain, feed efficiency and final body weight were analyzed using a one way Analysis of Variance (ANOVA) in a Completely Randomized Design (CRD)

Economic Analysis: A cost benefit (gross margin) analysis was carried out to obtain the economic benefit or shortfall on the dietary treatments

i. **Cost benefit ratio** = $\dfrac{\text{Total cost of feed}}{\text{Body weight gain}}$

ii. **Total Revenue** = Final body weight x cost/kg live weight

iii. **Total cost of production**: This includes the cost of procuring the fish, water, feeds and drugs.

iv**. Net Returns: Total Revenue** - Total cost of production

v. Total weight gain = final body weight - initial body weight

vi. **Feed efficiency** = $\dfrac{\text{Daily Weight Gain}}{\text{Daily Feed Intake.}}$

vii. **Feed cost/kg** = $\dfrac{\text{Total cost of feed (N)}}{\text{Total feed consume}}$

Proximate Analysis of Carcass:

Fish samples shall be subjected to Proximate Analysis in the laboratory to determine the carcass composition. The carcass parameters to be determined include: Moisture Content, Crude Fibre (CFIBRE), Crude Protein (CP), Crude Fat (CF) and Ash Content. .

IV. RESULTS AND DISCUSSION

Results

4.1; **Results of Crude Protein Analysis of Major Feed Ingredients using the AOAC Official Method of 988.05**

Table 4.1 presents the results of Crude Protein (CP) analysis of the major feed ingredients. This was determined using the AOAC Official Method of Routine Semi-Micro Kjeldahl, Procedure/Technique, which consists of three techniques of analysis namely Digestion, Distillation and Titration. The results were carried out in duplicates giving the mean CP values of Maize, Soybean and MGM as 10.6, 43.7 and 35.1 (%) respectively.

Table 4.1; Showing Crude Protein (CP) Analysis of the Major Feed Ingredients

Sample	**CP1**	**CP2**	**Mean**
Maize Meal	10.67	10.58	10.62
Soybean Meal	43.69	43.77	43.72
MGM	35.18	35.07	35.12

4.2; Antioxidant Analysis of Papaya Seed;

Table 4.2 presents the results of antioxidant analysis of papaya seed. Samples were analyzed chemically according to the official methods of analysis described by the Association of Official Analytical Chemist (AOAC., 18th Edition, 2005). All analyses were also carried out in duplicates. The mean values for the Total Antioxidant Activity, Total Phenolics and Ferric Reducing Ability of Plasma (FRAP) were shown as 77.9, 33.8 and 28.8 (ug/100g) respectively.

Table 4.2; showing the antioxidant Compounds in papaya seed

Parameters	**Value 1**	**Value 2**	**Mean**
Total Antioxidant Activity (Ug/G Or Umol Tocopherol Eq/G)	77.89	77.92	77.91
Total Phenolic(mg gallic acid Uq/100g)	33.78	33.76	33.77
Ferric Reducing Ability of Plasma (FRAP Ug/100g)	28.79	28.84	28.82

4.3; Results of Proximate Analysis of Feed;

Table 4.3 presents the results of proximate analysis of feed using the AOAC Official Methods. All Analyses were carried out in duplicates. The results present the mean values of the moisture content (M), Crude Protein (CP), Crude Fat (CFAT), Crude Fibre (CFIBRE) and ASH (Total Inorganic Minerals) as 5.34, 29..93, 6.98, 2.64, and 8.15 (%) respectively.

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Table 4.4; Showing the results of Proximate Analysis of feeds (in duplicates)

Sample Parameters	**A Value 1**	**A Value 2**	**A Mean**	**B Value 1**	**B Value 2**	**B Mean**	**G. Mean**
%M	5.26	5.24	5.25	5.45	5.42	5.43	5.34
%CP	29.78	29.89	29.83	30.07	29.98	30.03	29.93
%CFAT	7.86	7.83	7.84	6.12	6.15	6.13	6.98
%CFIBRE	2.57	2.59	2.58	2.72	2.69	2.70	2.64
%ASH	8.76	8.74	8.75	7.57	7.54	7.55	8.15
%NFE							
%DM							

%NFE = 100 – (%CP+%CFAT+%CFIBRE+%ASH+%M); %DM = (100 - %M)

Sample Parameters	**C Value 1**	**C Value 2**	**C Mean**	**D Value 1**	**D Value 2**	**D Mean**	**G. Mean**
%M	5.37	5.33	5.35	5.21	5.18	5.19	5.27
%CP	29.89	30.04	29.96	30.18	30.29	30.24	30.10
%CFAT	6.25	6.29	6.27	6.51	6.47	6.49	6.33
%CFIBRE	2.85	2.81	2.83	2.94	2.91	2.92	2.88
%ASH	7.69	7.63	7.66	7.47	7.44	7.46	7.56
%NFE							
%DM							

%NFE = 100 – (%CP+%CFAT+%CFIBRE+%ASH+%M); %DM = (100 - %M)

4.4. Growth Performance Traits;

Table 4.4; presents the ANOVA Summary of the main effect of maggot meal treated with three different levels of papaya seed (P_0, P_1 and P_2. Corresponding to 0%, 1% and 2% inclusion levels) on the growth performance traits of catfish. Data analyzed include; Weekly Feed Intake (WFI), Weekly Weight Gain (WWG), Final Body Weight (FBW), Total Feed Intake (TFI) and Weekly Feed Efficiency (WFE). The results show no discrepancies (p>0.05) in Feed Intake Weight Gain, Final Body Weight and Feed Efficiency among the treatment diets. Such similarities (p>0.05) were also observed in the Final Body Weight and Feed Efficiency. The foreign feed (T_0) however had superior (p<0.05) parameters to the locally formulated feed.

Table 4.4; Showing the ANOVA Summary of the main effect of maggot meal treated with papaya seed on the growth perform ance traits of catfish.

Papaya Levels	WFI	WWG	FBW	TFI	WFE
Control	10.52 ± 1.21^a	35.68 ± 2.06^a	213.78 ± 1.36^a	126.72 ± 12.31^a	3.39 ± 0.78^a
P_0	4.7 ± 91^b	16.24 ± 1.19^b	$97.44\pm.32^b$	$56.32\pm.19^b$	3.36 ± 0.11^a
P_1	4.61±.12b	$14.72\pm.22^b$	$87.73\pm.17^b$	$55.35\pm.33^b$	3.24 ± 0.24^a
P_2	$4.59\pm.17^b$	$14.45\pm.09^b$	76.71 ± 1.22^b	$55.04\pm.11^b$	3.28 ± 0.33^a

[abcd]means on the same column followed by different superscripts are statistically different (P<0.05)

4.5. Economic Analysis;

The results of Cost Benefit (Gross Margin) Analysis carried out to obtain the economic benefit or shortfall of the dietary treatments were presented in table 4.5. The parameters include; Cost of 1g of feed, Total Feed Intake, Total Cost of Feeding, final Body Weight, Cost Benefit Ratio, Total Cost of Production, Total Revenue and Net Returns. The cost of 1kg live weight of fish was estimated at #4000 while the cost of 1kg feed was estimated at #2500.

Table 4.5.; Showing the Main Effect of Papaya Seed on the Economic Parameters;

Parameter	Control	P_0	P_1	P_2
Cost of 1g of Feed (#)	2.5	0.8	0.76	0.72
Total Feed Intake (g)	126.72	56.32	55.35	55.04
Total Cost of feed (#)	316.8	45.06	42.07	39.63
Total Weight Gain (g)	213.78	97.44	70.33	62.71

Cost Benefit Ratio	1.48	0.46	0.60	0.63
Total Revenue (#)	855.12	389.76	281.32	250.84
Net Returns (#)	538.32	344.7	239.25	211.21

From the table above, it could be observed that increase in papaya seed levels reduced the cost of production and the cost benefit ratio. However, the total weight gain and the net returns decreased numerically as the papaya seed levels increased. The final body weights were also numerically different.

4.6; Proximate Analysis of Carcass;

Table 4.6 presents proximate composition of fish carcasses using the AOAC Ofiicial Methods. Analyses were carried out in duplicates. The results show the mean values of the moisture content (M), Crude Protein (CP), Crude Fat (CFAT), Crude Fibre (CFIBRE) and ASH (Total Inorganic Minerals) of about 7.24, 62.74, 7.67, 0.00, and 9.44 (%) respectively.

Table 4.6; Showing the Carcass Proximate Analysis Result in Duplicates

Sample	**A**	**A**	**A**	**B**	**B**	**B**	
Parameters	**Value 1**	**Value 2**	**Mean**	**Value 1**	**Value 2**	**Mean**	**G Mean**
%M	7.67	7.63	7..65	6.84	6.81	6.83	7.24
%CP	61.89	61.97	61.93	63.58	63.52	63.55	62.74
%CFAT	8.59	8.56	8.57	6.77	6.79	6.78	7.67
%CFIBRE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%ASH	9.67	9.62	9.64	9.25	9.23	9.24	9.44
%NFE							
%DM							

%NFE = 100 – (%CP+%CFAT+%CFIBRE+%ASH+%M); %DM = (100 - %M)

Sample	**C**	**C**	**C**	**D**	**D**	**D**	
Parameters	**Value 1**	**Value 2**	**Mean**	**Value 1**	**Value 2**	**Mean**	**G. Mean**
%M	6.96	6.92	6.94	6.89	6.84	6.87	6.91
%CP	62.17	62.28	62.25	63.38	63.29	63.25	62.75
%CFAT	6.85	6.89	6.87	6.93	6.91	6.92	6.89
%CFIBRE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%ASH	9.61	9.58	9.6	9.16	9.11	9.13	9.37
%NFE							
%DM							

%NFE = 100 – (%CP+%CFAT+%CFIBRE+%ASH+%M); %DM = (100 - %M)

Discussion

Crude Protein Analysis of Major feed Ingredients:

Results of Crude Protein (CP) analysis of maize, soybean and Maggot Meal as presented in table 4.1 show that these ingredients were of good quality. Maize with CP of over 10% is should be of a very good variety. The soil must have been rich in Nitrogen fertilizers. Olowookere et al, (2017), reports that soil nitrogen is a critical component of protein synthesis in maize. These authors found that increasing nitrogen fertilizers increased crude protein content of maize with the highest content of 17.45% recorded for SUSUMA (Quality Protein Maize) and 15.72% for SAMMAZ 11 (Normal Maize). Shamsedin et al, (2023) and Bhaumik et al, (2023) had similar reports.

The Crude Protein (CP) content of soybean as shown by the results of the analysis is over 43%. The soil quality and soil nitrogen may also have been high. Jin et al, (2023), Cerrudo et al, (2023) add that genetic variation and environmental conditions such climate and water availability can impact protein contents. The table also presents MGM used for the study with a Crude Protein (CP) of 35.12 %. This is in disagreement with the reports of Fatuga et al, (1977) who reported a Crude Protein of 39%. Fasakin et al (2003) also reported a Crude Protein of 46.7% for Maggot Meal. These discrepancies could be attributed to several factors which according to Newton et al, (2005) include handling and processing methods which can result in protein degradation.. Awoniyi et al, (2003) also note that the type of substrate used for maggot rearing can impact protein content. Diener et al, (2009) had the same view. Furthermore, the species of flies used for maggot production can yield maggots of varying protein content (Ogunji et al, 2008). The analytical methods or laboratory procedures may also lead to variations in reported protein contents (Makkar et al, 2014). The lower protein content of MGM used for this study may have impacted the overall crude protein of the experimental diets which on analysis were shown to contain crude protein of about 35% as against the 41% obtained from calculation. The low protein in the local diets also affected the growth performance of the fish fed the experimental diets in relation to those fed the foreign feed.

Antioxidant Analysis of Papaya Seed;

Antioxidant analysis of Papaya seed show that the Papaya seed used for the study contains about 77.91Ug/g of Total Antioxidant Activities/Tocopherols, Total Phenolics of 33.77Ug/100g and total Ferric Reducing Ability of Plasma (FRAP) of 28.82Ug/100g. The antioxidant profile of the papaya seed is within the range reported by previous researchers such as Martins et al, (2019), Nile et al, (2018), Rodriguez-Concepcion et al (2018), Silver et al, (2020) and Kummar et al, (2022). These authors obtained similar results in their several analytic studies of the antioxidant properties of different parts of papaya and other plants and herbs. The highest Total Antioxidant of 82Ug/g was reported for rosemary herb, while Total Phenolic Property (TCP) for berries and citrus ranged between 10 - 50ug/g. hence, the laboratory result of 33. 77Ug/g for the Papaya seed used in this study was still within range. The FRAP content of 28.88Ug/g of the Papaya seed was also high enough considering the amounts reported for other plants with potent antioxidant properties..

Growth Performance Traits;

From table 4.5, it could be observed that apart from the foreign commercial diet (AllerAqua), Feed Intake (WFI) in all the maggot meal based diets were statistically similar (p>0.05). Such similarities (P>0.05) reflected on the Total Feed Intake (TFI). The table reveals only some numerical decreases in weight gain as the level of papaya seed increased. This is in agreement with the reports of Issa, and Omar, (2012) who reported that natural antioxidants used as feed additives show no adverse results as regards to weight gain, feed efficiency, mortality or livability in livestock. Oleforuh-Okoleh, (2014) also observed no adverse effect on the weight gain and feed efficiency when natural antioxidants are incorporated in animal feeds.

The numerical differences in weight gain may suggest that papaya seed contains no anti-nutritional compounds or that the level is perhaps too low to cause any significant difference in weight gain. The significant (p<0.05) differences observed between the locally formulated feeds and the foreign feed (T0) could be as a result of the poor protein content of the local feeds as revealed by the results of the proximate analysis which showed that the locally formulated feeds have crude protein of only about 35%, while the foreign feed has CP of 45%

Also revealed in table 4.5, are similarities (P>0.05) in the growth parameters of the maggot meal based diets with the control diet (T_0). This similarity (P>0.05) is an indication that maggot meal based diets did not differ with the control diet in terms of nutritional quality and ability to promote growth. This is in agreement with the previous studies on maggot meal such as the reports of Ogunji et al.(2009) who reported impressive growth response by catfish fed maggot meal based diets. As can be seen from the Table above, maggot meal also gave impressive results in feed conversion efficiency. This impressive growth response may be due to the high level of crude protein in maggot meal. Aniebo et al. (2009) reported a CP of 40.59 to 40.74% for maggot meal. Ogunji et al.(,2009) also observed a better performance of diets containing maggot meal over those fed 100% fish meal. maggot meal has therefore been proven to be a possible replacement for fish Meal in fish diets.

Results of Proximate Analysis of Carcass;

The results of proximate composition of the dry fish carcasses as presented in table 4.6 show the values for the moisture content (M), Crude Protein (CP), Crude Fat (CFAT), Crude Fibre (CFIBRE) and ASH as 7.24, 62.74, 7.67, 0.00, and 9.44 (%) respectively These values were in agreement with the reports of Ajai et al, (2000) who reported the moisture content of dry fish to be between 2-9% depending on the species. These authors also report the crude protein of dry fish to be between 39 and 69%. This in agreement with the 62 % obtained in this study. The crude fat of 7.67 obtained in this study is in consonance with the reports of Azam et al, (2007). These authors report the crude fat content of dry fish to be between 2.9% and 26% depending on the species.

The reports of Ajai et al (2019) also agreed with this result.

Hence, the close relationships between the carcass composition obtained in this study with the reports of previous authors show that papaya seed fed to fish has no adverse effect on the carcass composition.

V. CONCLUSION

It has been established in this study through the laboratory analysis that the antioxidant profile of papaya used in the study was satisfactory in relation to the previous reports. Thus indicating strong antioxidant influence of papaya seed powder in the maggot meal based diets with consequent improvement on the carcass composition of fish fed MGM treated with papaya seed. The results of this study also showed that the incorporation of papaya seed in fish feed has no adverse effect on the growth and the nutritional quality of the cooked fish.

VI. RECOMMENDATIONS;

Papaya seed and other natural antioxidants when added to fish or meat have multiple functions. They may play an antioxidant, antimicrobial and preservative role during processing and storage, since plants and plant materials are rich in bioactive compounds which have the potential to inhibit or delay oxidation. This property can be widely used by the culinary and food industry to confer good protection capacity of the products and as well improve the consumer acceptance of food products.

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