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ASSESSMENT OF GROWTH PERFORMANCE OF AFRICAN CATFISH (*Clariasgariepinus*) FED WITH FEED PRODUCED FROM BLEND OF PIGEON PEA (*Cajanuscajan*) BAMBARA GROUNDNUT (*Vignasubterranea*) AND FISH MEAL

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ABSTRACT

A 3-factor -factorial experiment (2^K) was designed to produce fish feeds from mixture of pigeon pea, bambara groundnut and fish meal as major ingredients, while maize, red palm oil, salt and micro nutrient pre-mix were added as minor ingredients. The raw materials were processed into flours. The ingredients were weighed out in various ratios and mixed. The mixture was extruded; sun-dried and packaged and labeled F1-F8 and a commercial feed labeled F9 served as control. The feeds were feed to juvenile *Clariasgariepinus* kept in 9 separate plastic bowels and fed for 42 days. The forty-five fish of uniform weight and age were grouped into 9 and stocked in the nine artificial ponds, each pond contained five fish. The feeds were analyzed for proximate composition, while the growth performance of the fish was evaluated at the end of the feeding period. Result showed that F3 (20g pigeon pea, 20g Bambara ground nut and 16g fish meal) contains the highest protein (33.14 %) and F1(20g pigeon pea, 30g bambara ground nut and 16g fish meal) the least (23.13 %). F3 exhibited the highest specific growth rate (1.14 %) followed by the F9 (control) which contains 1.09%. The highest weight gain (16 g) was observed in the fish fed the control feed. However, F3 and F4 (20g pigeon pea, 30g bambara ground nut and 18g fish meal) ranked next to the control with respect to growth performance. It is therefore possible to produce quality catfish feed from bend of pigeon pea, Bambara ground nut and fish meal.

KEYWORDS: Catfish, fish feed, bambara groundnut, pigeon pea, fish meal

INTRODUCTION

Fish and fish products are known worldwide as very important diet to humans because of their high nutrient quality and significance in improving human health (Amao *et al.,* 2006). Fish is a high-protein, low-fat food that provides a range of health benefits. Fish is lower in fat than any other source of animal protein and oily fish are high in omega-3-fatty acids commonly called “the good fats”. Since the human body cannot make significant amount of these essential nutrients, fish consumption becomes an important part of the human diet (Edwin *et al*., 2001; Oyewole and Amosu, 2012; Uchechukwu *et al.,* 2014). However, in Nigeria the production of catfish looks relatively low compared with the growing population and demand for fish and catfishes of the family *Clariidae* are the most commonly cultivated fishes(Chris *et al.,* 2011; Adewumi and Oluleye, 2011).It has been reported that the annual fish production in Nigeria is 0.6 million metric tons with a fish demand of 2.66 million metric tons (Adetunji *et al.,*2009) This implies that fish produced in Nigeria does not meet the demand and that most of the fish consumed in Nigeria are imported. High cost of fish feed, which is also imported has been reported by many researchers to be a major limiting factor in the production of catfish in Nigeria (Ohen and Abang, 2009; Shitote *et al.,* 2011; Nwosu and Onyeneke, 2013),

Researchers have attempted to study the type of feed mostly consumed by *Clariasgariepinus*. In its range, *Clariasgariepinus* was found to be omnivorous feeding on plant materials, plankton, anthropods, molluscs,

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fishes, reptiles and amphibians (Vitule *et al.,* 2006).
Fishmeal is an excellent protein source in fish feed due to its balanced amino acid profile and high digestibility by fish. Traditionally, fishmeal is the main dietary protein source in fish feed formulation
Pigeon pea (*Cajanuscajan*) seed is one of the tropical legumes that have been scarcely used in fish feed production in spite of its crude protein and energy profile. Like other leguminous seeds, its nutritive value is masked by the occurrence of anti-nutritional factors,
example trypsin inhibitors haemoglutinin and saponin (Francis *et al.,* 2001). According to Adeparusi (1994), Pigeon pea has low human food preference in Nigeria possibly because this pea requires a longer cooking period than cowpea. Pigeon pea is a leguminous plant, it is an annual crop, and it is hardy, widely adaptable and more tolerant of drought and high temperatures than most other crops (Akande *et al.,* 2010). Locally in Nigeria, pigeon pea is called fio-fio by the Igbos, Otili by the Yorubas, Ohete by the Benin and Aduwa or Dan Mata by the Hausas. Pigeon pea is grown extensively in Nigeria but it is still one of the lesser utilized and unexploited legume (Oguntunde, 1985; Enwere, 1998; Nwanna *et al.,* 2008; Alegbeleye *et al.,* 2001l; Ani and Okeke, 2011; Hammed *et al.,* 2013; Orire *et al.,* 2015)

Bambara groundnut (*Vignasubterranea*) is another underutilized leguminous grain. Its name is derived from the name of a Mali tube called "Bambara". This bean is related to cowpea and it is botanically known as *Vignasubterranean* (*L.*) *verde,* a member of the *Fabaceae* family (Denis *et al.,* 2015).
In the formulating of fish feed with plant protein sources, caution needs to be observed in their inclusion levels in fish feeds as well as ensuring their proper processing for effective utilization (Francis *et al.,* 2001; Madu *et al.,*2003). Various treatments such as boiling, toasting and soaking have been used as an effective method of destroying or reducing these antinutritional factors (Salunkhe *et al.,* 1985; Ogunji *et al.,* 2005; Balogun, 2013)
Past works carried out on the use of plant protein as a substitute for fishmeal in fish feed production have been based on the use of a single legume grain combined with fish meal. A few published works that combined various plant raw materials have not tried to determine the main effect of each of the ingredients or the effect of the combined ingredients on the growth performance of the fish.
This present work produced fish feed using two locally sourced legume grains combined with fish meal as major ingredients, while molases, red palm oil, sodium chloride and micro nutrient pre-mix were added as minor ingredients. The produced feeds were evaluated for proximate composition and the growth performance on juvenile catfish (*Clariasgariepinus*)

MATERIALS AND METHODS

Source of Raw Materials

The ingredients used to formulate the eight (8) experimental feeds that was used in this experiment includes: commercial fishmeal (Danish fish meal), pigeon pea seeds, bambara groundnut seeds, maize seeds, molasses, palm-oil, table salt and vitamin-mineral premix (which consists of 20,000iu, vitamin A, 200 i.u, α-tocopherol acetate 400mg, Ascorbic acid 100mg, Vitamin D3, 200mg, Vitamin E, 8mg Vitamin K3, 20mg, Vitamin B1, 30mg, Vitamin B2, 12mg Vitamin B6, 50 mg, Pantothenic acid, 0.8 mg, Biotin, 150 mg, Niacin, 0.05mg, Niacin, 0.05mg, Vitamin B12, 4.0mg, Cobalt, 40mg, Iron, 5.0mg Iodine, 30mg, Manganese, 4mg Copper, 40 mg, Zinc, 0.2 mg Selenium, 100mg, Lysine, 100mg, Methionine, 100mg, Anti-oxidant were purchased from Nnobi Market, Anambara state. In order to study the performance of the formulated feed, forty five (45) juvenile African catfish (*Clariasgariepinus*) were stocked in nine plastic bowls (5fish in each). Commercial fish feed was used as the control feed.

Equipment

Nineartificial pond were constructed. The ponds consisted of nine (9) plastic bowls of equal sizes (50 litres each) which were labeled F1 to F8 and the 9th as control (F9). Water regulatory tap was connected to each bowl to serve as water outlet facility. Mosquito net nailed to planks was used to cover each bowl to prevent foreign matters from entering the pond.

Experimental Design

The experimental design is a Factorial Design ($\mathbf{2^K}$), where k is the No of the factors (Feed ingredients) and 2 = levels of each factor. This was designed using statistical software (MINITAB version 16.0) as shown in Tables 1a and 1b for the design and the ingredient combinations in the runs respectively

Table 1a: Experimental design (2^K)

	-1	+1
Pigeon pea (g)	2030	
Bambara ground nut (g)	20	30
Fish meal (g)	16	18

Table 1b: The runs with their actual values of the ingredients (g)

Feed	Pigeon pea (x_1)	Bambara groundnut (x_2)	Fish meal (x_3)
1	20	30	16
2	30	20	16
3	20	20	16
4	20	30	18
5	30	30	18
6	30	30	16
7	20	20	18
8	30	20	18

Feed Preparation

The pigeon pea and bambara groundnut seeds were washed and then soaked separately in water at room temperature (28^0C±1) for 3 days while changing the water every 24 h in order to avoid fermentation and to reduce the anti-nutrients present in the seeds. After soaking, the seeds were sun dried. The maize grains were cleaned and boiled for 5 minutes to achieve partial gelatinization of the starch which helped the pellet (extruded feed) float on water during the feeding of the fish. All the pre-treated raw materials above were sun dried and milled into very fine particles size (0.6 mm)using a locally fabricated milling machine. The feed ingredient were weighed out following the combinations in Table 1b and each sample was separately prepared by first mixing the dry feed ingredients together, and then separately mixing the wet ingredients (2g molasses, 5g red palm oil, 1g sodium chloride and 1g micro nutrients premix) before combining and mixing all the ingredients together. After mixing, hot water (5%) weight of the feed was added to the mixture to form dough. The dough was extruded into feed sizes (4mm) using a locally fabricated extruder. The extrudate were sun dried in order to reduce the moisture content for prolonged shelf-life. The dried feeds were packed in bags and labeled as F1, F2, F3, F4, F5, F6, F7 and F8. The control was labeled F9. All the feeds including the control were stored in a dry and airy environment to prevent spoilage. During the feed preparation, the weight of molasses, palm oil, salt and premix were constant in the eight formulated feed samples, while the weight of maize was varied in order to maintain a constant weight for each feed sample at 100 g

Method of Feeding

The fish were fed two times daily (8am in the morning and 3pm in the afternoon). Broadcasting method of feeding was used to feed the fish. At every feeding, the fish were fed to satiation and caution was taken not to administer excess feed as this could lead to pollution of the pond which possibly could depletes the dissolved oxygen level of the pond and also wastage of the feed. The pond water was changed every two days or earlier if the pond water became too cloudy. Dirty pond water might lead to suffocation of the fishes and possibly death of the fish

Plate 1: Artificial pond used for the experiment

Proximate Analysis on the formulated feed

The proximate parameters were analyzed using the Official Methods of Analysis of the Association of Analytical Chemists (AOAC, 2005).

The carbohydrate content of the samples was obtained as the difference between the total summations of percentage moisture, fat, fibre, protein, ash and 100

% Carbohydrate= 100 - (% moisture + % fat + % protein + % fibre + % ash)

Weight Measurement

The weight of the individual fish was determined on weekly basis using a digital sensitive weighing balance. A small plastic sieve with handle was used to bring out the fishes singly from the artificial pond for weighing. The fish was starved for 16 hours prior to weighing in order to empty its gut to ascertain the actual weight.

Weight Gain

The Weight Gain is defined as the average increase in weight of the fish throughout the period of the experiment.

Weight gain = Final weight of the fish at the end of feeding – initial mean weight of the fish before feeding commenced

Specific Growth Rate (SGR)

Specific Growth Rate is another parameter used in calculating the growth of the fish. It indicates the actual growth of the fishes during the period of the experiment.

Specific Growth Rate (SGR) = $\frac{(W_2 - W_1)}{\text{Period of feeding (days)}} \times \frac{100}{1}$

Where: W_2= mean final weight and W_1= mean initial weight

Survival Rate

Survival Rate (SR) = final number of fishes x 100
Initial number of fish1

Statistical Analysis

Data generated from the experiment were subjected to statistical analysis using statistical package for Social Sciences (SPSS Version 17.0). Significant differences between means were determined at P<0.05. Also SPSS was used to analyse if significant differences exists between the formulated feeds and the control feed. SPSS was also used to determine the significant differences in the weights of fishes fed the different feeds and the control feed.

RESULTS AND DISCUSSIONS

Proximate Composition

The proximate composition of the feeds is shown in figures 5 and 6. Significant differences (P < 0.05) were observed in the proximate composition of the eight formulated feeds and the control. The control contained the smallest amount of moisture (8.00 ± 0.00%) when compared to the other feeds and the difference was significant (P < 0.05). This difference could be attributed to the fact that control is a company's product and must have been adequately dried using a dryer instead of sun drying. Feed 8 had the second lowest moisture content (16.27 ± 0.38%) and this value differed significantly (P < 0.05) from the other feeds. Excess moisture could encourage the growth of mould in the stored feed and could result to off flavor development leading to rejection of the feed by the fish. It was also observed that the moisture content of the formulated feeds were high when compared with the control feed. However, the feeds were continuously sun-dried during the experiment to avoid spoilage.

Protein has been reported by earlier researchers to be the most important nutrient in the feed of African catfish. The protein content of a typical fish feed should contain about 25-50 % protein(Edwin *et al.,* 2001; Hammed *et al.,* 2013).The proximate of some of the formulated feeds fall within the range. Hammed *et al.* (2013) recommended 25 % inclusion of pigeon pea in fish feed due to its lower protein content when compared to soy bean. Table 3 showed that the formulated feeds had lower protein contents when compared with the control feed. The control feed contained the highest (40.00 ± 2.00 %) which was significantly different (P < 0.05) from the other feeds. F1 was observed to have the lowest protein content (23.13 ± 0.18%) The highest protein content recorded among the eight formulated feeds was found in F3 (33.14 %)

The fat contents of the experimental feeds closely compared with earlier report on fat content of locally produce fish feed (Uchechukwu *et al.,* 2014). It was also observed that feed containing high moisture content had low fat content. The highest fat content (15.27 ± 0.31%) was observed in F8. The fat content of the control feed (11.33 ± 2.00%) differed significantly (P < 0.05) with the fat content of other feeds. Even though fat is an essential nutrient however, excessive consumption of it could lead to satiety and less feed intake by the fish and this phenomenon could negatively affect the growth and development of the fish. High fat feed if not adequately preserved with antioxidants could easily spoil due to rancidity and consequently the diet would be rejected by the fish when it is administered.

The control feed had the lowest ash content (10.00 ± 1.00%) and this value differed significantly (P < 0.05) with the ash content of the other feeds. Ash content is an index of the mineral content. This increased ash content suggested that there could be high inclusion of minerals (premix) in the formulated feeds.

The carbohydrates content of the feed ranged between 22.47 and 31.53%.The feed samples showed significant differences in their carbohydrate content (p < 0.05) From the feed formulation recipe (Table 3.2), feed 3 had the highest maize content (35%) this could be responsible for its exhibited higher weight gain and specific growth rate than the other feed counterparts despite its low pigeon pea, bambara nut and fish meal inclusion (16: 20 : 20). This observation corroborates the report of the earlier researcher that high carbohydrate inclusion in catfish feed increased its growth performance even though protein content stands as the most important nutrient in fish feed (Edwin *et al.,* 2001)

The control exhibited the highest crude fiber content (5.00 ± 1.00 %) which differed significantly (P < 0.05) with the other feeds. Fibre plays important role in animal nutrition even though it does not have calorific value when consumed

Specific Growth Rate (SGR)

Figure 1 shows that feed 3 had the highest specific growth rate (1.14) followed by the control feed (1.09). Specific growth rate is one of the parameters used in evaluating the growth performance of the fish. It reveals the actual growth of the fishes during the period of the experiment. Feeds 3 and 4 favourably competed with the control in specific growth rate

Weight gain

Data on the performance of the experimental fishes in terms of their weight gain was presented infigure2. After week one of feeding the fish with the experimental feed, it was observed that there was no significant difference (P > 0.05) in the current and initial weights of the fish. This could be that the fishes were not yet fully adapted

to the new feed or that they consumed less quantity of the feed since they had not been used to the new feed. However, significant increase in weight was achieved in the fishes at the end of the feeding trail. The control exhibited highest weight gain (16 g) possibly because it is a commercial feed whose quality ought to have been improved over the years through research and development. However, feed 3 (15.8 g) ranked next to the control with respect to weight gain

Regression output

Weight gain versus Pigeon pea, Bambara ground nut, Fish meal

Wt. gain = - 6.5 + 6.10 Pigeon pea + 3.70 Bambara ground nut + 4.60 Fish meal…… Eq.1

From the regression equation the three major components of the feed (pigeon pea, bambaranut and fish meal) had positive effect on the weight of the fish fed the feed since their regression coefficients were positive. From the regression equation (1) and figure 3, pigeon pea exhibited the highest main effect on the weight gain of the fish followed by fish meal and bambara ground nut showed the least main effect. The main effect of the three major components of the fish feed is presented in figure 3. The main effect of the feed components (independent variables) are represented by different lines and the length of the line is directly proportional to the main effect that very component had on a given response variable. An ingredient that exhibited longer line has greater effect on the response variable (weight gain) than a component that had a shorter line (Ishiwu et. al., 2015)

From figure 4, it was observed that there was interaction effect between pigeon pea and fish meal on weight gain of the fish, but bambara ground nut has no significant interaction effect with either pigeon pea or fish meal on weight gain of the fish. This suggests that bambara ground nut could be substituted with pigeon pea in the feed recipe without adversely affecting the weight gain of the fish.

Survival Rate (SR)

The Survival Rate (SR) of the entire fishes during the experimental period of six weeks was 86.67%. The difference (13.33 %) was mortality rate.

CONCLUSION

This research has succeeded in producing fish feed from cheap and locally sourced legume grains (pigeon pea and bambara ground nut) and the feed was highly acceptable to juvenile *Clariasgariepinus*. The feed produced competed favourably well with the most popular commercial fish feed patronized by fish farmers in South East geopolitical zone of Nigeria in proximate composition and growth rate of the fish. Blend of Pigeon pea and fish meal showed interaction effect on weight gain of the fish, while blend of bambara ground nut and fish meal; blend of bambara ground nut and pigeon pea showed no significant interaction effect on weight gain of the fish. The main effect of pigeon pea showed the greatest positive effect on weight gain, followed by fish meal and bambara ground nut. Producers of fish feed are encouraged to utilize both pigeon pea and bambara ground nut in producing fish feed. This practice would promote the use of these locally available but underutilized legume grains.

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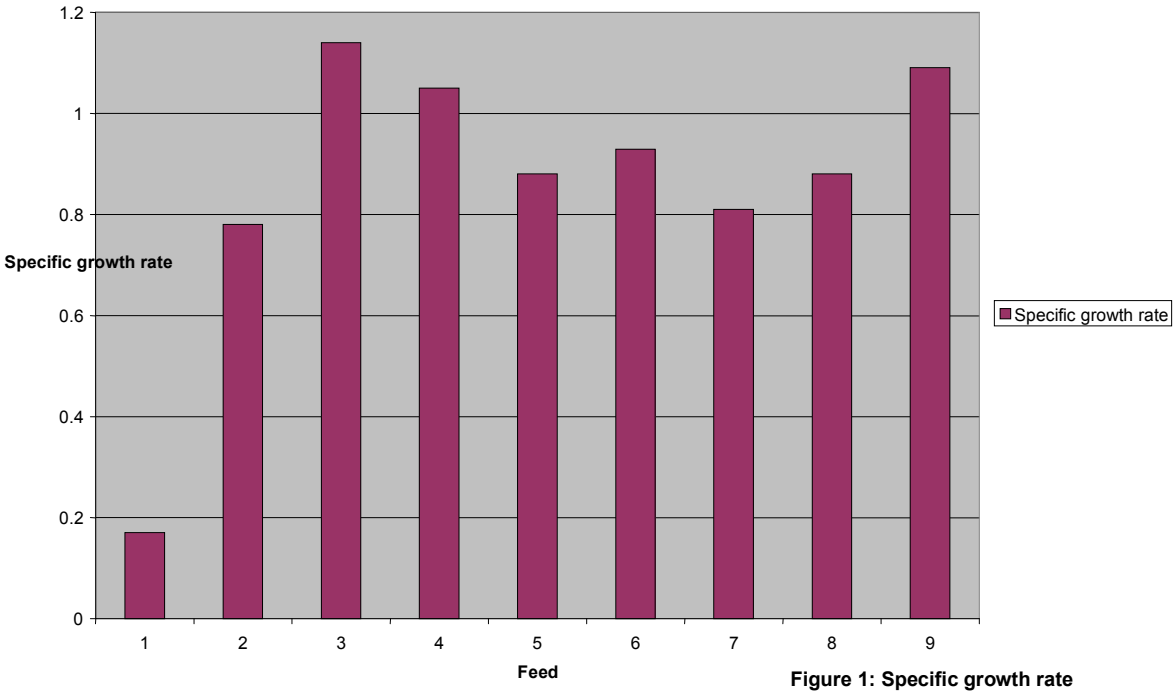

Figure 1: Specific growth rate

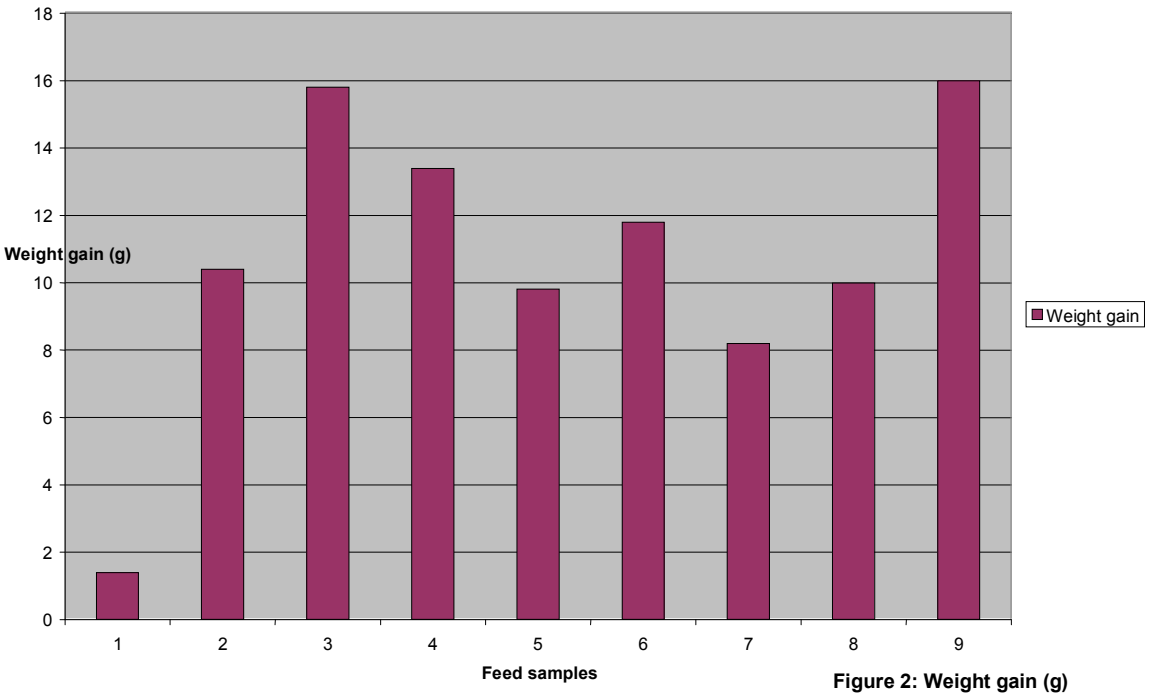

Figure 2: Weight gain (g)

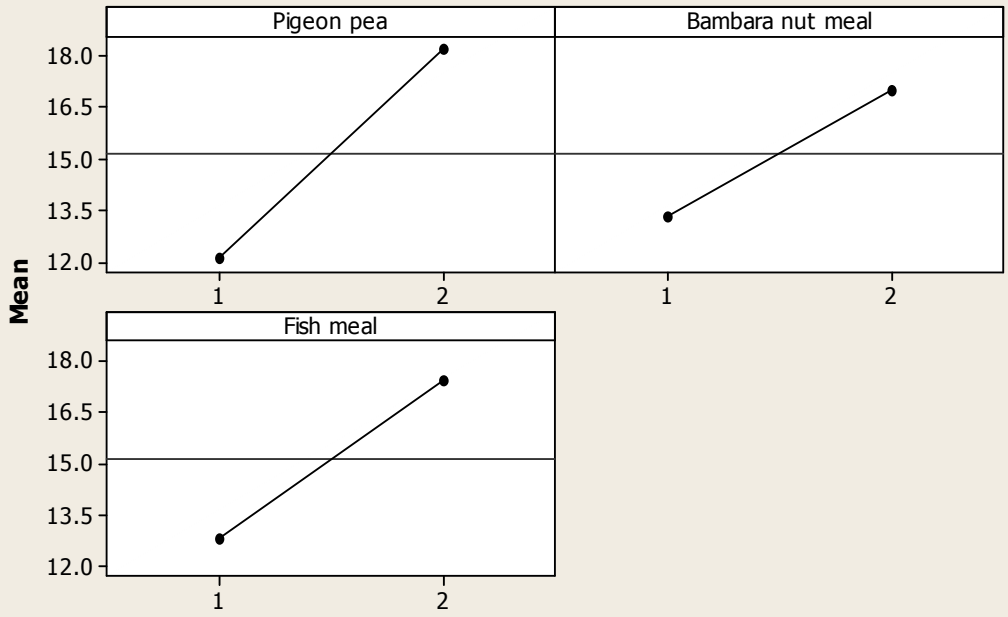

Fig. 3: Main effect of the 3 major ingredients on weight gain

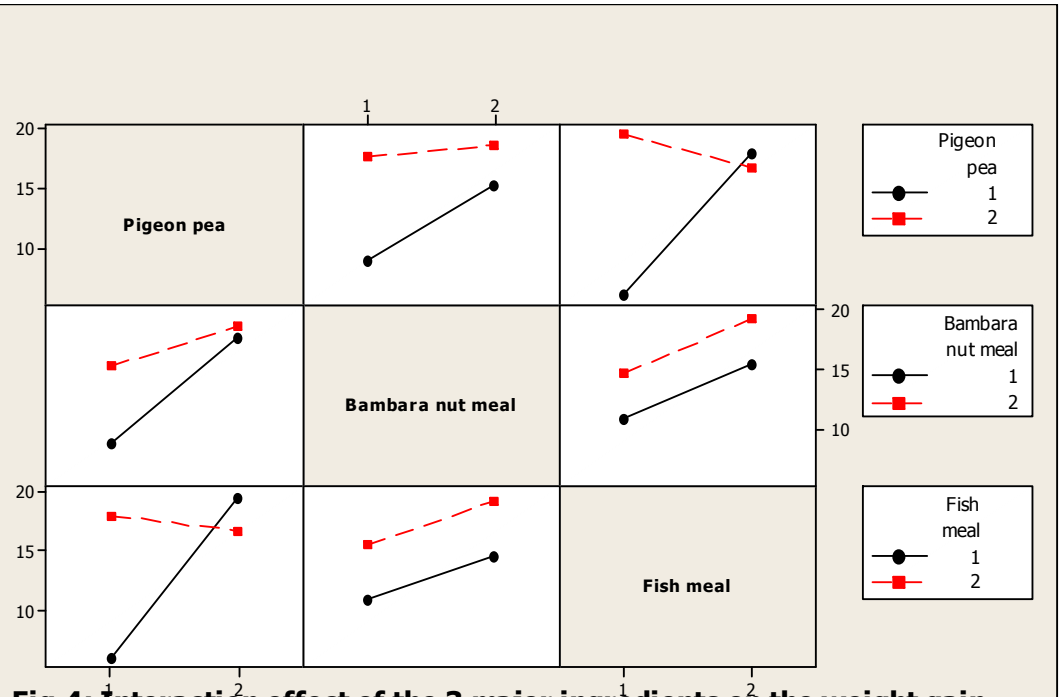

Fig.4: Interaction effect of the 3 major ingredients on the weight gain

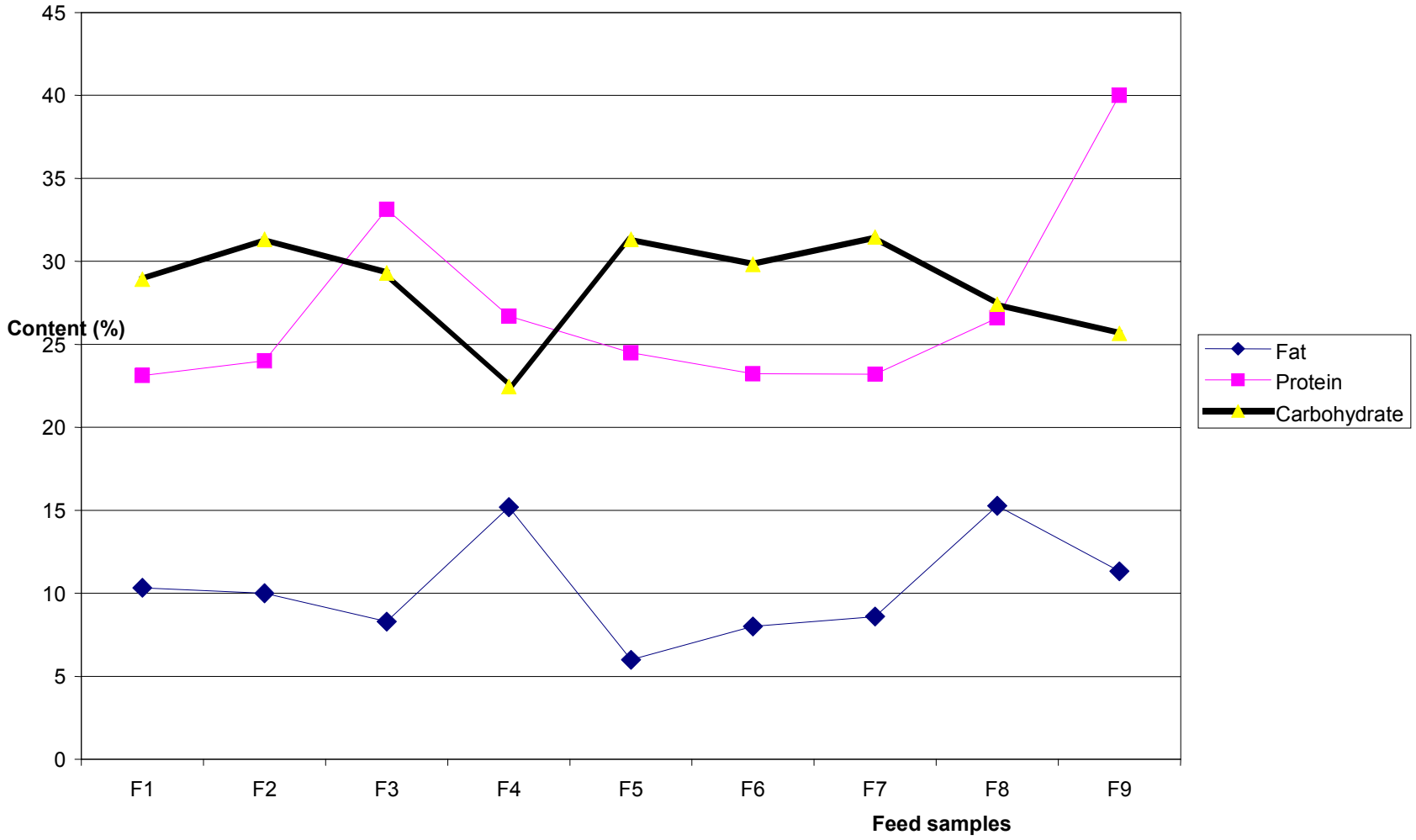

Fig.5: Fat, Protein and Carbohydrate content of the feeds

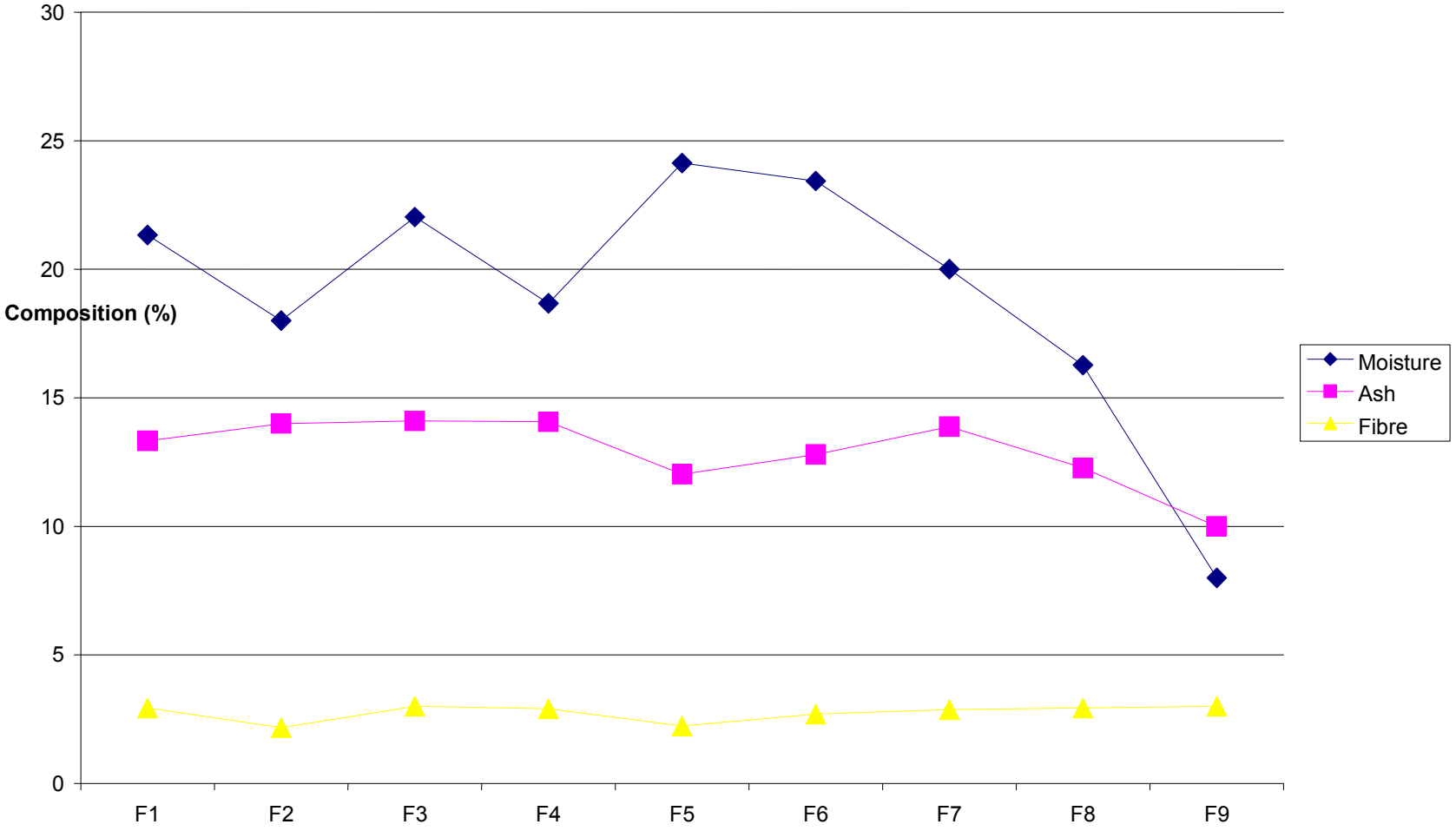

Fig. 6: Moisture, Ash and Fibre content of the feeds