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# Performance of chufa tuber meal as a nutritional additive to the diet of *Cyprinus carpio* fingerlings

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**Abstract**
The investigation evaluated the nutritional effect of chufa tubers in the growth response of *Cyprinus carpio*. Chufa tuber was soaked in hot water to remove available phytotoxins, processed and stored in a cool dry place. It was substituted in five different diets at the rate of 0, 25, 50, 75, and 100% inclusion for maize formulated at 38% crude protein level. Each treatment was conducted in triplicate and fed twice daily at 5% body weight for ten weeks to 150 fingerlings of *C. carpio*. Among the different treatments, diet B (25% inclusion) was significantly different ($p$<0.05) and performed best in terms of survival rate, fish biomass (1127.7g), feed conversion ratio (0.40), protein efficiency ratio and maximum feed cost reduction of 7.15% higher than the basal diet (A). The study showed that diet B should be utilised for improved growth of common carp (*Cyprinus carpio*) for profit maximization.

**Keywords:** Chufa tuber, fish feed, nutrient, performance

## 1. Introduction
Chufa tubers are under-utilized due to lack of information on their nutritional potential [1, 2]. The quest for lesser-known and un-exploited crops, many of which are potentially valuable as human and animal foods has been on the high side to maintain the equilibrium between population growth and agricultural productivity, particularly in the tropical and sub-tropical areas of the world. Chufa tuber is a crop of the family *Cyperaceae*, commonly known as earth almond, tiger nut, chufa, yellow nutsedge and Zulu nuts. It is known in Nigeria as "Ayaya" in Hausa, 'Ofio" in Yoruba and "Akiausa" in Igbo; Cicoda or Cicada in Hindi, widely distributed in Punjab and Nilgiri hills, India [3, 4]. Owing to the high percentage of carbohydrates (mono- and di-), fibre, and oil (especially oleic acid) and its moderately high level of protein (7-9%), minerals (calcium, magnesium, iron and phosphorus), and vitamins C and E, it is a good source of food for animals [5].
About 2.0 billion people are suffering globally from chronic malnutrition especially protein intake, which is manifested in diseases such as kwashiorkor, marasmus and other related metabolic problems [6]. However, about 1.2 billion are from the developing countries of Asia, Africa and Latin America where the most prevalent cause of death in post weaned infants is protein malnutrition. In this regard, it has been found that fishes are excellent source of sulphur amino acids, B-vitamins, high quality unsaturated fatty acids and its mineral content is richer in iodine than other animals [7] and have been reported to be the source of hope towards solving global problem of malnutrition due to its richness in nutritive value above other animal sources of protein and also due to its cheaper value [8, 9]. It accounts for 80% of the total reported harvest from inland capture fisheries and over 90% of global inland capture fisheries production is used for human consumption [10].
The attempts to reduce the cost of feed which is the primary determinant for viability and profitability of fish farming enterprise have necessitated the search for non-conventional feed resources that are cheap and not in direct competition between humans and fish [11].
Considering the substantial contribution aquaculture makes towards socio-economic development in terms of income and employment through the use of unutilised and underutilised resources in several regions of the country, environmental friendly aquaculture has been accepted as a vehicle for rural development, food and nutritional security for the rural masses and also has immense potential as a foreign exchange earner [12].

Therefore, the present study was designed to explore the potential of chufa tuber meal as a growth additive feed ingredient for common carp.

## 2. Materials and Methods

The proximate analysis of Chufa tuber was studied for use in experimental feed formulation. Proximate analysis for the experimental diets, fish flesh, and water quality analysis during the experiment was carried out. The experimental feeds were formulated by the inclusion of graded levels of (0, 25, 50, 75 and 100%) chufa tuber meal into the basal diets containing different ingredients, vitamins and micro minerals (Table 1). The experiment was a complete randomized designed, carried out in semi-indoor with 60 litres capacity tubs in triplicate. Each diet was formulated at 38% crude protein. The aquaria were cleaned, partially filled with water for seven days before the stocking of fish and well ventilated with a netted material. Oxygen was provided by an aerator throughout the study period. Each aquarium was stocked with 10 fingerlings of *C. carpio* and fed with wheat offal for two weeks during acclimation.

The fish were fed experimental diets at 5% of their body weight at 0800 hours and 1600 hours respectively for 10 weeks. The feeding of fish was done after removing the waste materials and replenishing with clean water every morning during the study period to reduce pollution in the aquaria. Sampling was done every fortnightly to record the weight of fish, condition status and subsequent adjustment of feed in the experiment.

The *C. esculentus* was washed with clean water to remove dirt and boiled in hot water to remove available phytotoxins. The feed ingredients were ground to homogenous size with a Unitech hammer mill, mixed in an appropriate ratio, made into dough, pelleted into 1mm size and sun-dried for 24 hours. The dried feed was packaged in an air-tight polythene bags and stored in a container at room temperature. At the end of the study period, final sampling was done and three fish per replicate were randomly selected for carcass proximate evaluation.

**Table 1:** Gross composition of experimental diet (Dry matter)

| Ingredient | A (0%) Control | B (25% Chufa tuber meal) | C (50% Chufa tuber meal) | D (75% Chufa tuber meal) | E (100% Chufa tuber meal) |
|---|---|---|---|---|---|
| Chufa tuber meal | 0 | 5 | 10 | 15 | 20 |
| Maize | 20 | 15 | 10 | 5 | 0 |
| Soybean | 19.68 | 19.68 | 19.68 | 19.68 | 19.68 |
| Groundnut cake | 28 | 28 | 28 | 28 | 28 |
| Fish meal | 24 | 24 | 24 | 24 | 24 |
| Starch | 4 | 4 | 4 | 4 | 4 |
| Oil | 3 | 3 | 3 | 3 | 3 |
| Premix | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Methionine | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Vitamin B | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Vitamin C | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Total | 100 | 100 | 100 | 100 | 100 |

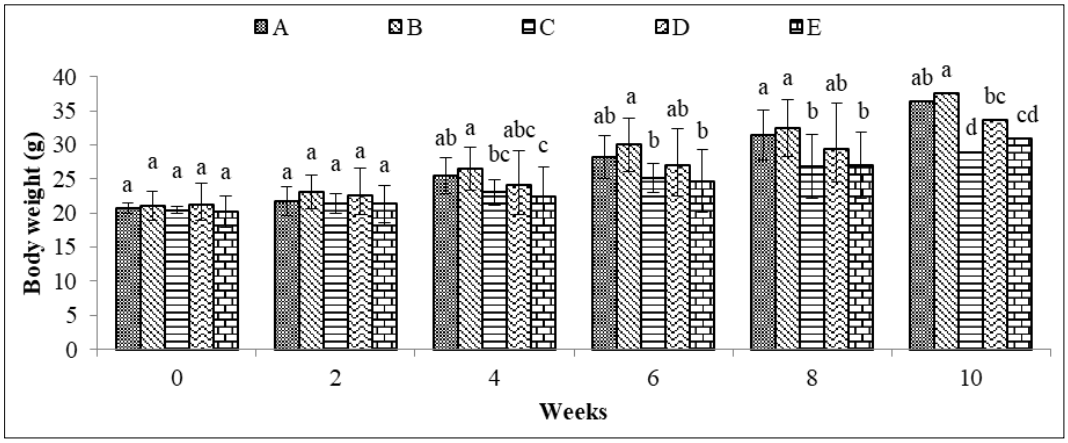
### Calculations and statistical analysis

Total protein of flesh was estimated according to the method of Lowry *et al.* [13], crude lipids was determined by method of [14] Folch *et al.*, [15] moisture by AOAC, [16] ash by AOAC, and total carbohydrate content in sample was determined by method of [17] Dubois *et al*. Parameters such as Weight gain = (Final weight – Initial weight); Apparent Feed consumed = (Estimated feed supplied during the experimental period); Feed conversion ratio (FCR) = (Apparent Feed intake/Weight gain); and Specific growth rate (SGR) = {(In Final weight – In Initial weight/ Experimental period) x 100%} were calculated for. The statistical analysis of the data was performed with a statistical package (SPSS 16.0 for Windows, SPSS Inc., Richmond, CA, USA). Data obtained were subjected to One-way ANOVA and Turkey's tests at $p<0.05$.

## 3. Results

The physicochemical analyses in terms of temperature, pH, dissolved oxygen and total hardness were within acceptable limits if fish culture without significant difference among the treatments. The temperature (°C**)** of water in different treatments ranged between 23 and 29°C, while the pH of water ranged between 8.05 and 8.40 during the experiment. The dissolved oxygen (DO) content of water ranged from 7.2 to 9.0 mg $l^{-1}$ and total hardness (CaCO3 mg $l^{-1}$) ranged from 140 - 177 in different treatments during the culture period.

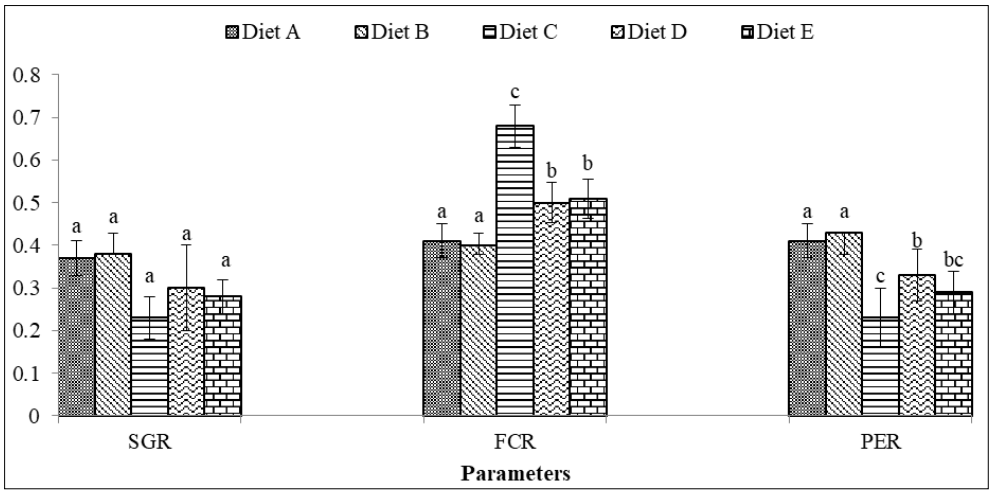
The morphometric analyses at the end of culture period showed that treatment B had the best result and significantly different ($p<0.05$) in final total body length, length gain and final body weight among other treatments.




Bars with different letters depict significant differences between treatments at ($p$<0.05).
Values are Mean ± S.D of three replicates.

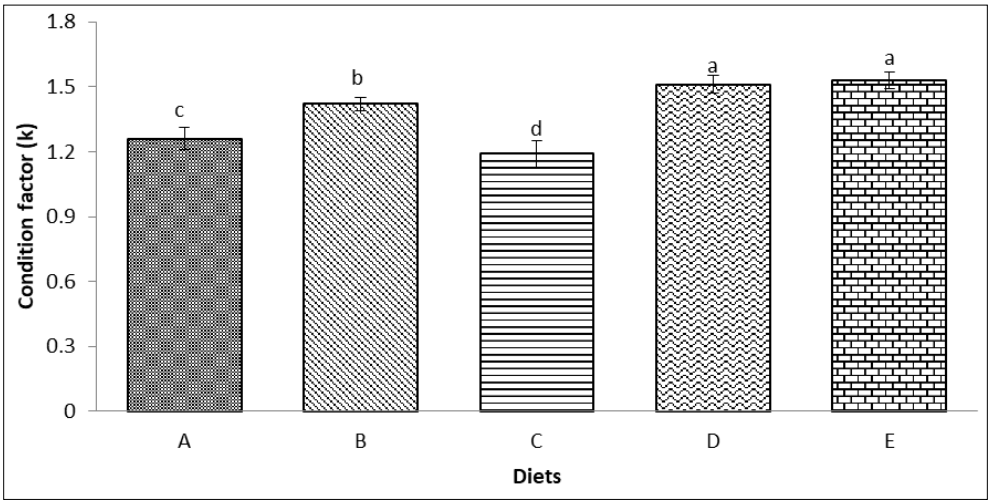
**Fig 1:** Variations in weight (g) of *C. carpio* in different treatments during the culture period

At the termination of the experiment, 100% survival of fish was recorded with diets supplemented with chufa tuber at 25% and 75% (B and D) while treatment C recorded the least survival rate. However, no significant difference ($p$>0.05) was recorded. Among other nutritive parameters recorded, treatment B (25% inclusion) recorded best result in terms of the percentage net weight gain (NWG), specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER), total biomass and total protein content of fish carcass with a significant difference at ($p$<0.05).




Bars with different letters depict significant differences between treatments at ($p$<0.05).
Values are Mean ± S.D of three replicates.

**Fig 2:** Specific growth rate, feed conversion ratio and protein efficiency ratio of *C. carpio* in different treatments during the culture period




Bars with different letters depict significant differences between treatments at ($p$<0.05).
Values are Mean ± S.D of three replicates.

**Fig 3:** Condition factor (k) of *C. carpio* in different treatments during the culture period

## 4. Discussion

Physico-chemical parameters of water play a significant role in the physiology and other metabolic activities of fish and hence are very important for the survival and growth of fish [18]. The act of supplementary feeding improves fish growth, but the composition, digestibility and physical characteristics of feed may have significant effects on water quality [19, 20]. The optimum pH range differs among species; however, the pH 6.5-9.0 range is generally accepted for the fish culture which correlates with the study [21]. Oxygen is one of the major limiting factors in aquatic respiration and metabolic reactions and as such, it is a significant water quality constituent that may limit production under aquaculture conditions, as low DO concentrations indicate eutrophication and biological overloading in aquaculture systems.

Other factors could be responsible for a high survival rate in control treatment as it contains no chufa tuber. Though treatments B and D recorded no casualties, the study shows sluggishness of fish in treatments C to E which may reflect and connotes the drop of survival in C and E due to the percentage of chufa inclusion. However, the study suggests a longer duration of feeding trials to ascertain prolong activity of chufa tuber to fish.

The present study revealed the acceptability of chufa tuber meal substituted with maize mostly in diet B which contained a 25% inclusion level of chufa tuber meal. It was also observed that the crude fibre content increased proportionally to the respective inclusion level of chufa tuber meal compared to diet A (control), thereby supporting digestibility and absorption of feed nutrients. This confirms the report of Belewu *et al.* in the study of feeding graded levels of *C. esculentus* meal on the performance characteristics of West African dwarf goat [22]. They further reported a better result in feed efficiency and weight gain with 20% inclusion level of chufa tuber meal which could be probably due to the excellent nutritional quality of the nut. However, Bamgbose *et al.* reported an increase in cockerel body weight with 33.3% chufa tuber meal substituted feed [23]. Consequently, in the study of Agbabiaka and Chukwuka on the effect of feeding different levels of chufa tuber meal on growth of broiler chicks, it was found that the group on 25% inclusion of chufa tuber meal recorded the highest average daily weight gain while with 100% inclusion level performed least [24] which agrees with the present study. However, this does not support the study of Oladele *et al.* for complete substitution of chufa tuber meal which was done on *Clarias gariepinus* fingerlings [25].

The study critically revealed the acceptance of chufa tuber meal (CTM) inclusion of all diets except diet E which had a 100% CTM inclusion. This conforms with the report of Agbabiaka and Chukwuka that fish were able to tolerate the CTM at an older age with better physiological adaptation compared to the juvenile stage.

Economically, the maximum net profit to total biomass harvested and feed cost reduction (3.21%) was recorded for diet B which has 7.15% higher than control (A), whereas it was lower for other diets. This may be attributed to the level of acceptability of chufa tuber meal by the fish species.

## 5. Conclusion

Thus, it can be concluded from the study that 25% inclusion of chufa tuber meal can be used as a substitute for maize in the diets of *C. carpio* fingerlings for better nutritional and economically viable diet and farmers can also utilise noxious weed (chufa tuber) in feed formulation for low-cost carp culture, thereby harnessing resource wastage in the eradication of chufa weed into carp productivity.

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