RESEARCH ARTICLE

Potentials of Kunnu Waste as Dietary Supplement for African Catfish Fingerlings

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Potentials of Kunnu Waste as Dietary Supplement for African Catfish Fingerlings

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Abstract
A 72 days feeding trial was conducted on African catfish (*Clarias gariepinus*) fed on five diets (CP = 40%) in which maize was replaced with kunnu waste at 0%, 25%, 50%, 75% and 100% respectively. Fingerlings of *C. gariepinus* were assigned to the five diets in a completely randomized design at 36 fish per treatment in Hapa nets suspended in an outdoor concrete tank; experimental fish were fed at 5% biomass daily. Results on performance and feed utilization showed linear correlation between specific growth rate and body weight gain ($p > 0.05$). However, feed intake increased with increased dietary levels of kunnu waste ($p < 0.05$). The best feed conversion ratio (FCR) was obtained from the control group while the poorest was recorded at 100% replacement ($p > 0.05$). This finding indicated that *C. gariepinus* can tolerate kunnu waste as dietary replacement for maize without adverse effect on performance.

Keywords: *Clarias gariepinus*; kunnu waste; performance; fingerlings; replacement.

1. Introduction

The Food and Agriculture Organization [1] reported that about 2.0 billion people globally were suffering from chronic malnutrition especially protein intake which is manifested in diseases such as kwashiorkor, marasmus and other related metabolic problems. Out of this population, 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.

Also, some 40 million children suffer from vitamin A deficiency in which high percentage of them go blind while iodine deficiency disorders (IDD) also afflicts 200–300 million people with goitre [2]. 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 [3]. However, fishes 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 [4, 5].

Despite fishes being reported as the cheapest source of animal protein in Africa [6], aquaculture development in Sub-Saharan Africa including Nigeria has been insignificant compared to Europe and Asia [7] due to non-availability of quality feed at economic prices. Most of the orthodox feedstuffs such as cereals and oil bean seeds are staple food for Nigerians and raw-materials for agro-allied industry; hence, their prices have continued to soar in recent time. Attempts to reduce feed cost which is the primary determinant for viability and profitability of fish farming enter price have necessitated the search for non-conventional feed resources that are cheap and not in direct competition between humans and fish.

Kunnu is a traditional non-alcoholic fermented beverage made from cereals in Nigeria such as sorghum, maize, millet or rice [8, 9]. It is usually served as appetizer to entertain visitors mostly at the Northern states of Nigeria and other urban centres including social gatherings [10]. Nevertheless, kunnu waste refers to the residue or chaff that remains after wet sieving of the steeped and milled grains to produce the slurry called kunnu. It is often discarded at garbage dumps or used to feed livestock such as poultry especially those on extensive or semi-intensive pastoralism.

There is currently paucity of information on the use of this agro-processing waste as feedstuff in fish nutrition in Nigeria. This study is therefore aimed at determining the effect of feeding kunnu waste as replacement for maize in diets of African catfish (*Clarias gariepinus*) fingerlings.

2. Methods

2.1. Sampling collection and processing

The test ingredient (kunnu waste or chaff) used for this study was collected from a local processor of kunnu at Owerri, Southeastern Nigeria. The kunnu was made of composite grains from millet and sorghum fortified with clove (*Syzygium aromaticum*) and ginger (*Zingiber officinale*). The chaff was sundried for 48 hours and packaged in an air-tight polythene bag and kept in the refrigerator at –4°C prior to proximate analysis [11].

2.2. Feed formulation

The sundried kunnu waste was milled to facilitate pelleting. The kunnu meal was mixed thoroughly with other feedstuffs (Table 1) to produce five isoproteic (CP = 40%) diets such that maize was gradually replaced by kunnu waste at 0%, 25%, 50%, 75% and 100% respectively. The control diets (0%) contained no kunnu waste. Diets so produced were passed through a pelleting machine with die 2 mm to produce fish pellets, sundried for 4 days until crispy to prevent growth of mould on the feeds. The pelleted diets were packaged in water-proof nylon bags and were labeled accordingly prior to storage at room temperature. Samples of the diets produced were subjected to proximate analysis using standard methods as outlined by AOAC [11] and presented in Table 3.

Table 1: Percentage composition of kunnu based diets fed African catfish (C. *gariepinus*).

Ingredients	Dietary treatments				
	0%	25%	50%	75%	100%
Kunnu waste	–	6.5	13	19.5	26
Maize	26	19.5	13	6.5	–
Soya bean	42	42	42	42	42
Fish meal	26	26	26	26	26
Salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Oil	3	3	3	3	3
Bone meal	2	2	2	2	2
Total	**100**	**100**	**100**	**100**	**100**

2.3. Experimental fish and design

A total of 180 African catfish fingerlings with mean body weight 2.6 ± 0.1 g were purchased from Federal Polytechnic Nekede fish farm, Owerri, Imo State, Nigeria. They were acclimated for a week and fed the control diet in an outdoor cistern. Subsequently, experimental fish were randomly assigned to the five diets at 36 fish per treatment in a completely randomized design. Each treatment was replicated thrice making a total of twelve fish per replicate. Fish were fed the trial diets for a period of 72 days at 5% biomass shared between 7–8 am and 5–6 pm daily. The fish were reared in Hapa net measuring 1 m × 1 m × 1 m suspended in an outdoor concrete tank measuring 5 m × 4 m × 1.2 m.

2.4. Data collection and analysis

Fish in each Hapa were batch weighed at the commencement of the study and forthnightly thereafter with digital weighing balance. Fish were usually returned to their various Hapas after weighing while the feed intake

was adjusted to the new body weight accordingly. Data on performance such as body weight changes, specific growth rate, feed conversion ratio and feed intake were subjected to one-way analysis of variance [12] where significant difference occurred, means were separated by Duncan multiple range test.

3. Results and Discussion

The nutrients assay of kunnu waste (Table 2) showed that it contained about 12.20% crude protein, 12.39% crude fibre, 1.56% fat, 8.83% ash, 56.43% NFE and 8.59% moisture content respectively. The crude protein concentration is similar to the range 12%–13.73% recorded for plantain peel meal [13, 14] but higher than the value of 10% for maize [15] and 7%–9.7% for tigernut [16]. The value (12.39%) of crude fibre in kunnu waste/chaff that is slightly above the value of (9%–10%) recorded for composite ingredients of sorghum and maize used for the kunnu [16] is attributed to the action of microbes of [17, 18].

Table 2: Proximate composition of kunnu waste.

Nutrients	Chemical composition (%)
Moisture content	8.59
Ash	8.83
Crude protein	12.20
Fat	1.56
Crude fibre	12.39
Nitrogen free extract (NFE)	56.43

All the kunnu chaff based diets recorded higher but no significant crude protein concentration ($p > 0.05$) than the control diet (Table 3); while the control diet was superior in ash, crude fibre and nitrogen free extract respectively. The performance of *C. gariepinus* fed the test diets revealed that all the kunnu chaff based diets promoted relatively better body weight gain ($p < 0.05$) than the control diet while the best FCR was found in the group of fish fed the control diet ($p > 0.05$). Bichi and Ahmad [19] also reported better utilization of cassava leaves by Nile tilapia over maize diet.

Table 3: Proximate composition of experimental diets fed to African catfish.

	Dietary treatments (%)				
Parameters	0	25	50	75	100
Moisture content	5.94	7.65	7.68	8.06	7.27
Crude protein	40.08	40.95	40.18	40.65	40.41
Crude fibre	8.00	4.00	5.00	4.80	4.93
Ash	12.71	9.85	9.77	9.90	9.62
Crude fat	8.48	6.55	7.61	6.45	7.76
Nitrogen free extract	36.67	31.00	29.76	30.14	30.01

The improved growth response and utilization observed in fish fed kunnu waste diets may be due to the relatively lower fibre (Table 4) in those diets, perhaps due to the action of mycomycetes that might have weakened the cellulose cell wall of the fairly fibrous test ingredient (kunnu chaff) coupled with the action of the spices (i.e., clove and ginger fortification), which perhaps were responsible for the utilization of such diets. Spices have been reported to increase secretion of amylase and hexosamine including ptyalin which facilitates digestion of starch in the stomach, hence, rendering diets which are rich in carbohydrates more digestible [20]; ginger has also been reported to contain about 5.28% crude protein [21]. All these factors might have

been responsible for the better performance of fish fed kunnu based diet over the control. Nevertheless, the high feed intake is attributed to low NFE and consequently low calories in test diets compared to control. Animals feed intake has been reported to be inversely proportional to the energy value of the diets [22, 23]. Furthermore, fermentation usually increases the flavour/aroma of feedstuff hence promoting the attraction of diets containing such ingredients thereby increasing feed intake.

Table 4: Growth performance of African catfish fed with kunnu waste diets.

Parameters	Dietary treatments (%)				
	0	25	50	75	100
Initial mean weight (g)	2.62	2.6	2.7	2.6	2.7
Final mean weight (g)	19.65	22.13	20.52	18.94	24.29
Mean weight gain (g)	17.03[a]	19.59[a]	17.82[a]	16.34[a]	21.59[a]
Total feed intake (g)	20.13[a]	27.90[b]	29.87[b]	27.98[b]	32.65[b]
Specific growth rate (%/day)	1.22[a]	1.29[a]	1.22[a]	1.20[a]	1.33[a]
FCR	1.18[a]	1.42[a]	1.68[a]	1.71[a]	1.51[a]
Protein efficiency ratio	2.12[a]	1.71[a]	1.48[b]	1.44[b]	1.64[ab]
Mean growth rate (g)	0.24	0.27	0.25	0.23	0.30
Protein intake	8.07	11.42	12.00	11.37	13.19

[ab]Means within rows with same superscript are not significantly different ($p > 0.05$).

Nevertheless, some catfishes such as *Clarias isheriensis* was reported to have inherent amylase and cellulase which might also assist the fish to digest cellulose cell wall while the gridding of the diets between the vomerine teeth exposes the lignin and/or cell wall by increasing the surface area to digestion [24, 25]. Generally, all the experimental diets supported growth of *C. gariepinus*, indicating that diets met the nutritional requirement of the fish particularly the dietary protein. There was no significant ($p > 0.05$) differences among the treatment group for specific growth rate and FCR respectively.

4. Conclusion

Results of this study have indicated that kunnu waste meal can be tolerated by African catfish fingerlings up to 100% replacement without adverse effect on the growth and nutrient utilization. However, the non-competition between kunnu chaff and humans is another advantage due to almost "zero" cost of procurement which will reduce production cost and make fish protein readily available to rural populace.

Competing Interests

None declared.

Authors' Contributions

Both authors had read the final draft of the manuscript. LAA designed the experiment, carried out the feeding trial, laboratory and statistical analyses. CUM drafted the protocol and managed the literature search.

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