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NUTRIENT COMPOSITION OF MALE AND FEMALE NILE TILAPIA *OREOCHROMIS NILOTICUS* (LINNAEUS, 1758) FROM CAPTURED AND CULTURED SOURCES

The demand of fish-derived proteins is growing globally and this poses a huge challenge to the aquaculture sector. As Earlier research has focused mostly on the nutrient requirements and metabolic processes of cultured species, recent findings has also acknowledged that there is a need to understand how the compositions of diets influence physiological responses in farmed fish. This study assessed the proximate nutrient composition of wild and cultured male and female Nile tilapia (*Oreochromis niloticus*, Linnaeus, 1758). Forty Nile tilapia were sampled with twenty from both sources and equal distribution of sexes. Condition factor assessment showed that both sexes for cultured fish are in better condition compared to their wild counterparts. Proximate analyses comprised moisture, lipid, ash, crude protein, dry matter, crude fiber, and nitrogen-free extract. The means of the data were presented using means and standard error and t-tests were used to determine the differences between the groups. In most of the parameters, there were no statistically significant differences; there was no difference in dry matter, ash, or crude fiber values in the sexes and in origins. However, minimal variations were observed: male tilapia had more crude protein and lipids, and females contained more nitrogen-free extract. This finding offers useful information about the nutrient profile and condition status of *O. niloticus* and provide information that can support sustainable aquaculture practices, fish processing decisions, and feed formulation.

Keywords: Nile tilapia, proximate composition, aquaculture nutrition, nutrient interaction, sustainable fish production.

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Табиғи жағдайда ауланған және өсірілген еркек және ұрғашы Ніл тиляпиясының Oreochromis niloticus (Linnaeus, 1758) қоректік құрамы

Бүкіл әлемде балық тектес ақуыздарға деген сұраныс артып келеді, бұл аквакультура саласына елеулі сын-қатерлер туғызуда. Бұрынғы зерттеулер негізінен өсірілетін балық түрлерінің қоректік қажеттіліктері мен метаболизмдік үдерістеріне бағытталса, соңғы ғылыми еңбектер рацион құрамының ферма жағдайында өсірілетін балықтардың физиологиялық жауаптарына қалай әсер ететінін түсінудің маңыздылығын көрсетеді. Осы зерттеуде жабайы және өсірілетін Ніл тилапиясының (Oreochromis niloticus, Linnaeus, 1758) аталық және аналық дараларының проксиматтық (негізгі) қоректік құрамы бағаланды. Барлығы қырық Ніл тилапиясы алынды: олардың жиырмасы жабайы ортадан, жиырмасы өсірілетін шаруашылықтан, жыныстары тең үлесте таңдалды. Уақытша күй-жай коэффициентін бағалау нәтижелері бойынша өсірілетін тилапиялардың екі жынысы да жабайы даралармен салыстырғанда жақсы күйде екені анықталды. Проксиматтық талдау ылғал, липидтер, күл, шикі протеин, құрғақ зат, шикі талшық және азотсыз экстрактивті заттардың мөлшерін анықтауды қамтыды. Нәтижелер орташа мәндер мен стандарттық қателік түрінде ұсынылды, ал топтар арасындағы айырмашылықтарды анықтау үшін t-тест қолданылды. Көптеген көрсеткіштер бойынша статистикалық тұрғыдан маңызды айырмашылықтар байқалмады: құрғақ зат, күл және шикі талшық мөлшері жыныска да, шығу тегіне де байланысты өзгермеді. Дегенмен, шамалы айырмашылықтар анықталды: аталық тилапияларда шикі протеин мен липидтер мөлшері жоғары болды, ал аналықтарында азотсыз экстрактивті заттардың үлесі көбірек болды. Алынған нәтижелер O. niloticus түрінің қоректік профилі мен физиологиялық күйі туралы құнды мәлімет береді және тұрақты аквакультура

тәжірибелерін дамытуға, балықты өңдеу шешімдерін қабылдауға және жемшөп құрамын оңтайландыруға негіз бола алады.

Түйін сөздер: Ніл тилапиясы, проксиматтық құрам, аквакультурадағы қоректену, қоректік заттардың өзара әрекеттесуі, балықты тұрақты өндіру.

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Питательный состав самцов и самок нильской тилапии *Oreochromis niloticus* (Linnaeus, 1758), выловленных в природных условиях и выращенных в аквакультуре

Спрос на белки рыбного происхождения во всём мире растёт, что создаёт серьёзные вызовы для сектора аквакультуры. Если ранее исследования в основном были сосредоточены на питательных потребностях и метаболических процессах культивируемых видов, то последние работы также подчёркивают необходимость понимания того, как состав рационов влияет на физиологические реакции выращиваемой рыбы. В данном исследовании была оценена проксиматная (основная) питательная композиция дикой и культивируемой нильской тилапии (*Oreochromis niloticus*, Linnaeus, 1758) самцов и самок. Было отобрано сорок особей нильской тилапии: по двадцать из каждой группы (дикая и культивируемая рыба) с равным соотношением полов. Оценка коэффициента упитанности показала, что особи обоих полов из культивируемых условий находятся в лучшем состоянии по сравнению с дикими. Проксиматный анализ включал определение содержания влаги, липидов, золы, сырого протеина, сухого вещества, сырой клетчатки и безазотистых экстрактивных веществ. Результаты представлены в виде средних значений и стандартной ошибки; для определения различий между группами использовались t-критерии. По большинству показателей статистически значимых различий выявлено не было: не обнаружено различий в содержании сухого вещества, золы и сырой клетчатки между полами и по происхождению рыбы. Однако отмечены незначительные вариации: у самцов тилапии было больше сырого протеина и липидов, тогда как у самок – более высокое содержание безазотистых экстрактивных веществ. Полученные результаты дают полезную информацию о питательном профиле и состоянии *O. niloticus* и могут быть использованы для поддержки устойчивых практик аквакультуры, принятия решений в переработке рыбы и разработки кормов.

Ключевые слова: нильская тилапия, проксиматный состав, питание в аквакультуре, взаимодействие питательных веществ, устойчивое производство рыбы.

Introduction

Fish has always been a potential source of animal protein and essential nutrients in Africa and the world over, it is needed for the maintenance of a healthy body (Albashr, et al*.,* 2024). Fish of various species don't provide the same nutrient profile to their consumer and the nutritive value of a fish varies with season (Pyz-Łukasik et al., 2020). Nile Tilapia (*Oreochromis niloticus*) is one cichlid widely distributed in the inland water bodies in Nigeria. Although, they are mainly fresh water fish *O. niloticus* has been described as euryhaline and can disperse along brackish coastlines between rivers (Stauffer et al., 2022). Tilapia species is esteemed as food; affordable and supporting both small scale subsistence and commercial fisheries in Nigeria (Ifedayo et al., 2020). It grows to a maximum length of 62 cm, weighing 3.65 kg at an estimated 9 years of age (Dwivedi et al., 2016). The average size (total length) of *O. niloticus* is 20 cm (Langi et al., 2024). Proximate composition of fish involves the determination of moisture, lipid, protein and ash content. Carbohydrate is determined by difference (Bland et al., 2021). The proximate composition of fish is affected by a diversity of factors such as: size, sexual maturation, temperature, salinity, exercise, ration, time and feeding frequency, starvation, type and amount of dietary ingredients (Raposo et al., 2023). Protein and ash contents do not vary as often as lipid, since it is not impacted by diet, but mainly is determined by the species type, genetic characteristics and size (Islam et al., 2021; Raposo et al., 2023). Furthermore, environmental stressors and water quality can also influence the proximate composition, affecting nutrient accumulation and overall fish health (Canosa & Bertucci, 2023).

The condition factor of fishes is the most important biological parameter which provides information on condition of fish species and the entire com-

munity and is of high significance for management and conservation of natural populations (Tibihika et al., 2023). It is also a parameter of the state of well-being of the fish that determines present and future population success because of its influence on growth, reproduction and survival (Ngodhe & Owuor, 2019). Condition factor has been used as an index of growth and feeding intensity (Kamble et al., 2024). It decreases with increase in length (Famoofo & Abdul, 2020); and also influences the reproductive cycle in fish (La Rosa et al., 2025). It also serves as an integrative indicator of fish energy reserves and capacity to withstand environmental stressors such as pollution or poor water quality (Akintade, Edwin, & Simon, 2016). Moreover, condition factor is useful in fisheries biology for comparing fish populations across different habitats or time periods, helping detect environmental degradation or resource limitation (Li et al., 2023). In aquaculture practice, a consistently high condition factor among stocked fish may indicate effective feeding regimes and good overall welfare, which can support better survival and yield outcomes (Azrita, Syandri, & Aryani, 2024). This study aimed to evaluate the proximate nutrient composition and condition factor of male and female Nile tilapia (*Oreochromis niloticus*) from captured and cultured sources to provide insights for sustainable aquaculture management, feed formulation, and fish processing practices.

Materials and methods

Sample collection

Forty samples of Nile Tilapia (*Oreochromis niloticus)* were obtained from Zobe dam and Ni'ima fish farm located along Dutsi-ma/Kankara Road, Katsina State, Nigeria. The samples comprises of 20 captured and 20 cultured fish, having 10 males and 10 females each.

Length-Weight Measurement of Fishes

Length and weight of the 40 fish samples were determined immediately before chilling them with ice. Length was measured using measuring board while the weight was measured using sensitive weighing balance**.** The length and weight obtained were used to estimate the condition factor using Fulton's index which was calculated using Htun-Han (1978) equation with formula given below:

$$K=100W/L^3$$

Where W= Weight of the Fishes
L= Length of the fishes
K= Condition Factor

Preparation of fish sample

Fish samples were packaged separately in a labeled polythene bags containing ice chips at a low temperature (3^{o}C), the fishes were gutted and thoroughly washed with clean water. Sample were pooled together to form composite samples. Each fish sample was cleaned and dried in a hot-air oven at 105 °C to constant weight. The dried muscles were then ground into powder using a mortar and pestle and labelled for proximate composition analysis.

Proximate Analysis

Analysis such as determination of dry matter, ash content, lipid content, crude protein content etc. was carried out in the university's biochemistry laboratory by using the 2012 AOAC standard.

Statistical analysis

The data were presented using mean and standard error. T-test was used to test for significance difference between the treatments. All analysis was done using SPSS version 22.

Results and discussion

The results obtained after the statistical analysis were interpreted and presented in the tables below.

Condition factor

Male

Table 1 shows the length, weight and condition factor of the male fishes from both captured and cultured sources. The length was significantly higher ($P<0.05$) in captured (19.58±0.38cm) compared to cultured fishes (16.64±0.81cm). The weight was also higher in captured (133.80±7.32) but the difference was not significant from that of culture (113.60±5.40). However, the condition factor was significantly different between the two sources, with cultured having higher value of 2.56±0.27 compared to 1.78±0.04 in captured.

Table 1 – Condition factor of male O. niloticus from capture and culture sources

Parameters	Captured	Cultured
Length (cm)	19.58±0.38^a	16.64±0.81^b
Weight (g)	133.80±7.32^a	113.60±5.40^a
Condition Factor (K)	1.78±0.04^b	2.56±0.27^a

Note: values are expressed as mean ± SE (standard error)
Means with different superscript across rows are significantly different ($p<0.05$).

Female

In table 2, the mean length, weight and condition factor of the female fishes from captured and cultured sources are shown. The Length was significantly higher (P<0.05) in captured (18.72 ± 0.37cm) compared to cultured fishes (17.04±0.38cm). The mean weight 129.40±6.04g and 114.40±1.83g was obtained for both captured and cultured sources respectively, the captured fishes possessed slightly higher value than the cultured fishes but there was no significant difference. The condition factor (1.97±0.04 and 2.34±0.15) for both sources, the cultured fishes contained slightly higher value than the captured and also not significantly different.

Table 2 – Condition factor of female *O. niloticus* from capture and culture sources

Parameters	Captured	Cultured
Length(cm)	18.72±0.37[a]	17.04±0.38[b]
Weight(g)	129.40±6.04[a]	114.40±1.83[a]
Condition Factor (K)	1.97±0.04[a]	2.34±0.15[a]

Note: values are expressed as mean ± SE (standard error)
Means with different superscript across rows are significantly different (p<0.05).

Proximate Composition (Sources)

From the table 3, the ash content for the cultured fishes (25.70±0.01%) recorded significantly higher mean value (P<0.05) than the captured fishes (18.32±0.04%). The dry matter content for captured and cultured (95.97±1.39% and 97.13±1.26%), crude protein (48.00±2.00% and 50.09±7.85%) and oil (3.57±0.11% and 4.09±0.03%) all possessed slightly higher values for the cultured than the captured. However, the crude fiber (1.71±0.02% and 1.65±0.04%) and the nitrogen free extract (28.41±2.09% and 18.42±7.81%) for captured and cultured sources respectively possessed slightly higher value in the captured source than the cultured.

Table 3 – Proximate Parameters for Captured and Cultured *O. niloticus*

Parameters	Captured	Cultured
D.M	95.97±1.39[a]	97.13±1.26[a]
CP	48.00±2.00[a]	50.09±7.85[a]
CF	1.71±0.02[a]	1.65±0.04[a]
Oil	3.57±0.11[a]	4.09±0.03[a]
Ash	18.32±0.04[b]	25.70±0.01[a]
NFE	28.41±2.09[a]	18.42±7.81[a]

Note: values are expressed as mean ± SE (standard error)
Means with different superscripts across rows are significantly different (p<0.05).
Key: D.M= Dry matter, Ash= ash content, Oil= Oil content, CP = crude protein content, CF= Crude Fiber, NFE= Nitrogen Free extract.

Proximate Composition (Sex)

The proximate parameters for male and female *O. niloticus* are shown in Table 4 below.

Table 4 – Proximate Parameters for Male and Female *O. niloticus*

Parameters	Male	Female
D.M	96.49±1.9[a]	96.61±0.74[a]
CP	53.97±3.97[a]	44.12±1.89[a]
CF	1.67±0.06[a]	1.69±0.01[a]
OIL	3.87±0.12[a]	3.79±0.33[a]
ASH	22.03±3.75[a]	22.06±3.71[a]
NFE	18.47±7.86[a]	28.36±2.14[a]

Note: values are expressed as mean ± SE (standard error)
Means with different superscripts across rows are significantly different (p<0.05).
Key: D.M= Dry matter, Ash= ash content, Oil= Oil content, CP = crude protein content, CF= Crude Fiber, NFE= Nitrogen Free extract.

All the parameters in the table for both male and female were not significantly different (P>0.05). Although the dry matter for male and female fishes (96.49±1.91% and 96.61±0.74% respectively),

Ash (22.03±3.75% and 22.06±3.71%), and crude fiber (1.67±0.06% and 1.69±0.01%) all possessed similar value for both. However crude protein for male (53.97±3.97%) shows slightly higher value than the female fishes (44.12±1.89%). The oil content for male (3.87±0.12%) also had slightly higher values than that of female (3.79±0.33%). Nitrogen free extract value for female (28.36±2.14%) showed slight difference compared to the male fishes (18.47±7.86%).

In this study, relationship between male and female *O. niloticus* from the wild and cultured source in terms of their proximate composition, length, weight and condition factor were investigated.

Condition Factor

The condition factor is an indicator for well-being of the fish and reflects how the fish gained weight in relation to length. These results showed that the different environments (wild and culture) of study were suitable for Nile tilapia growth but the male fishes had a higher and better values. This showed that the males were doing better than the female in terms of weight and length. Results obtained for the wild male and female fishes (1.78 and 1.97 respectively) are similar with the finding of Makeche et al. (2023) who reported the condition factor of male and female *Oreochromis niloticus* from capture fisheries as 1.41 and 1.95 respectively. However, Ahmadi (2024) reported values of male and female Nile tilapia cultured in fish pond as 1.80 and 1.82 respectively, which are in partial agreement with the current study with 2.56 and 2.34. The differences between the condition factors calculated in the present study and the earlier ones may be due to age, environmental influences, feed scarcity in the wild, feed quality and feeding systems. Sumaoy et al. (2025) found insignificant difference in length or weight growth rate between the sexes of fish in the pond and also the condition factor showed no changes. Makeche et al. (2023) reported that results of growth analysis and measurements of nutritional status (condition factor) showed only minor differences between wild and pond reared and condition factor is the most commonly used as indicator for nutritional status.

Proximate Composition

In this study, relationship between male and female *O. niloticus* from the wild and cultured source in terms of their proximate composition. The dry matter of the captured and cultured fishes was observed to have a percentage mean value of 95.97% and 97.13% respectively. The male and female fish species on the other hand was also observed to have a mean value of 96.49% and 96.61% respectively. The result is similar to work done by Kirimi et al. (2022) with mean value of 92% for cultured fishes and also Hammed et al. (2022) with mean value of 87.28% for wild fishes. The crude protein of the captured and cultured fishes was observed to have no significant difference. The male and female fishes on the other hand also had no significant difference. The result is in contrary to work done by Al-Taee et al. (2022) with protein mean value of 16.88% and 15.26% for wild and cultured fishes respectively. The higher value for cultured fishes from the present study may be as a result of age variation, quality of food and feeds and the feeding systems on the farm. However, the male fishes possessed the higher mean value because the female fishes are mouth brooders and they fed less during this process and they may also have less access to quality proteinous feeds compared to the male fishes. The result agrees with the work reported by Hammed et al. (2022). The percentage mean value of crude fat contained in wild and cultured fishes were 3.57% and 4.09% respectively. This result agrees with then work done by Al-Taee et al. (2022) with fat percentage mean value of 7.67% for captured *O. niloticus*. Hammed et al. (2022) reported a mean percentage of fat for cultured *O. niloticus* which is not similar to the present study. However, Yagoub et al. (2025) recorded 11.11% for cultured *O. niloticus* which is higher than the current study with mean values of 3.87% and 3.79%. The cultured fishes had higher value from the present study which may be due to factors such as age, nature of the environment, feeding systems and composition of feeds fed to them on the farm. The male also possessed the higher mean value because the female fishes are mouth brooders. The ash content of the captured and cultured fishes was observed to have a value of 18.32% and 25.7% respectively. The male and female fish species on the other hand was also observed to have a mean value of 22.03% and 22.06% respectively. The result is in line with the work done by Al-Taee et al. (2022) with mean value of 1.57% for wild *O. niloticus* and 1.86% for cultured fishes respectively. However, Yagoub et al. (2025) reported the percentage mean values of 19.39% for cultured *O. niloticus* which are different from the current study as stated above.

Conclusion

As shown in the current research, the proximate composition of the cultured *O. niloticus* was signifi-

cantly higher than their wild-caught counterparts, hence highlighting their nutritive superiority, with protein and lipid contents being higher. Moreover, the cultured *O. niloticus* showed higher condition factor indices in both sexes, indicating an excellent overall well-being and physiological stability compared with their wild fishes. male fish from both sources were found to have higher protein and fat content, while females had higher nitrogen-free extract. All of these findings provide an essential information for sustainable aquaculture and suggests that cultured male *O. niloticus* can provide enhanced nutritional advantages, and that the adoption of management tools that focus on enhancing condition factor can result in improved growth, health, and production outcomes.

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