GROWTH PERFORMANCE OF RABBITFISH (*Siganus sutor*) REARED IN INTERTIDAL BRACKISH WATER EARTHEN PONDS USING HAPA NETS

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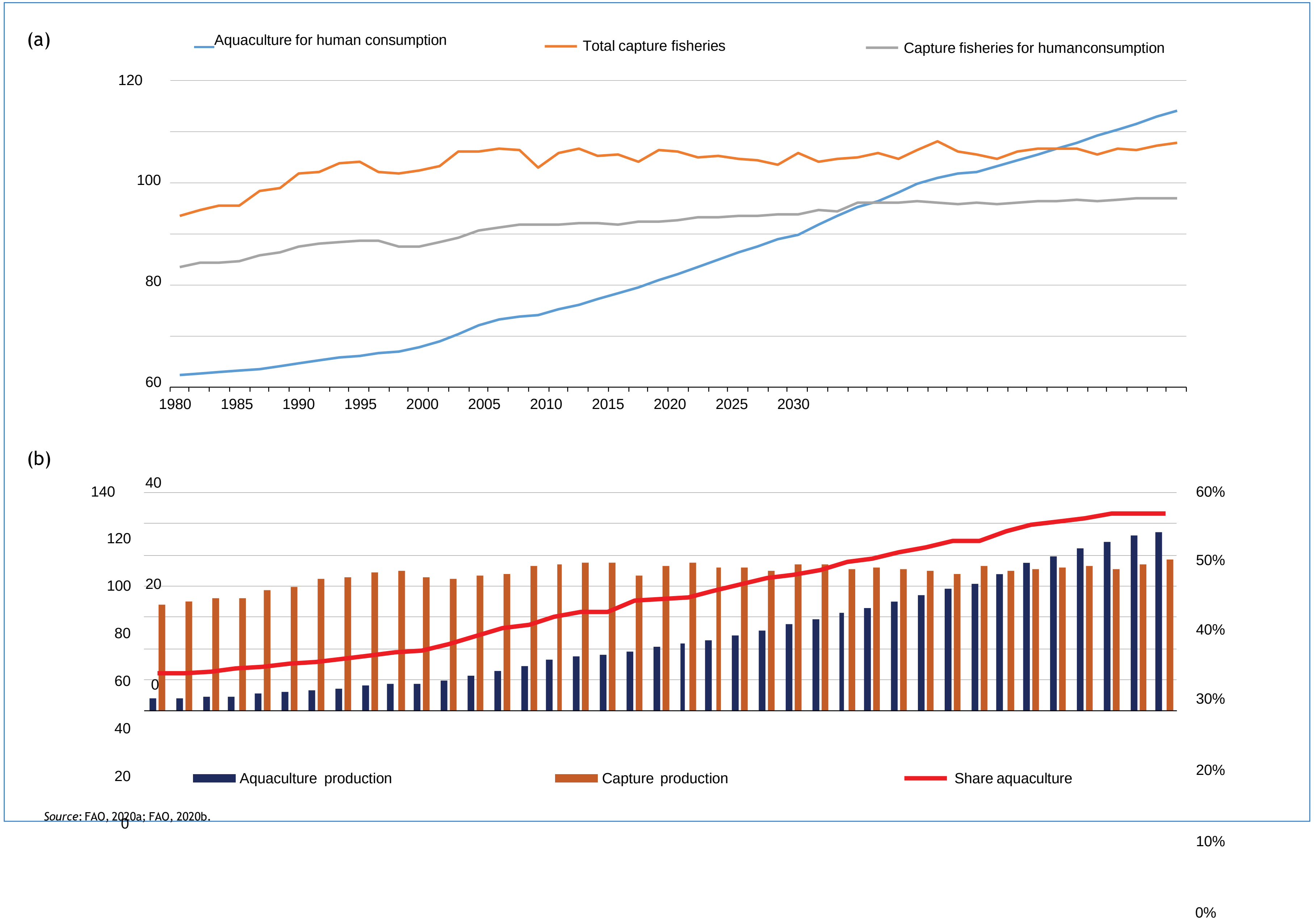
Introduction

- Globally fish consumption is **increasing** (Ahmad, Siddiqui, Nabi, Khan & Zamiret, 2020; Khalid, Habib, Mohammad, Momin & Abdel-Aziz, 2020).
- **Asia** is the leading aquaculture production than **Africa** (FAO, 2016c; 2016; 2018).
- Aquaculture production in **Kenya** has **improved** greatly (Gok, 2015)
- **Mariculture** has remained **low** with low value finfish farmed (Mirera & Ngugi, 2009).
- There is need for farming **high value fish** such as Rabbitfish (*Siganus sutor*),
- The fish grows well in **brackish water** ponds (Rachmansyah & Triyanto, 1997).
- The fish has a **high demand** due to its taste, flesh quality, market price and high nutrition (FAO, 2020).
- There is need to find **replacer** for fishmeal in aquaculture without affecting the growth performance of fish (Tacon & Metian, 2009).

Global capture fisheries and aquaculture production



Source: FAO, 2020a; FAO, 2020b.

Siganus sutor

Black soldier fly Larvae

Black soldier fly

WHY *Siganus sutor?*

- Fish prices are rising drastically as a result of; **climate change, lack of new technologies** and **overfishing**

- There is need for rapid growth of the aquaculture sector as a safer ground for **food security**.

- The **mariculture** sector presents the biggest opportunity, as it is yet to be fully exploited.

- Fish considered to be a high **market value** fish

Why *Siganus sutor* ?

- The fish is sold in South Pacific @ USD 14-18/kg) and in Kenya @USD 5
- Aquaculture has much potential to meet the demand for fishery products
- The rate of fish consumption currently in Kenya is **4.5 kg/person per year.**
- Capture from fisheries has been on a decline yielding 170,000 metric tonnes in 2014 and 120,000 metric tonnes in 2017
- For better **mariculture** growth, we need **quality**, **availability, and cheap** feeds
- **Insects** can be used to manage waste and produce useful protein sources for aquaculture

Areas of concern……,

- Growth performance and survival rate

- The proximate composition

Study objectives

The general Objective

- To assess **growth performance** of rabbitfish (*Siganus sutor)* fed on locally formulated black soldier fly larvae meal (*Hermetia illucens*) diet and reared in brackish water earthen ponds in Kenya

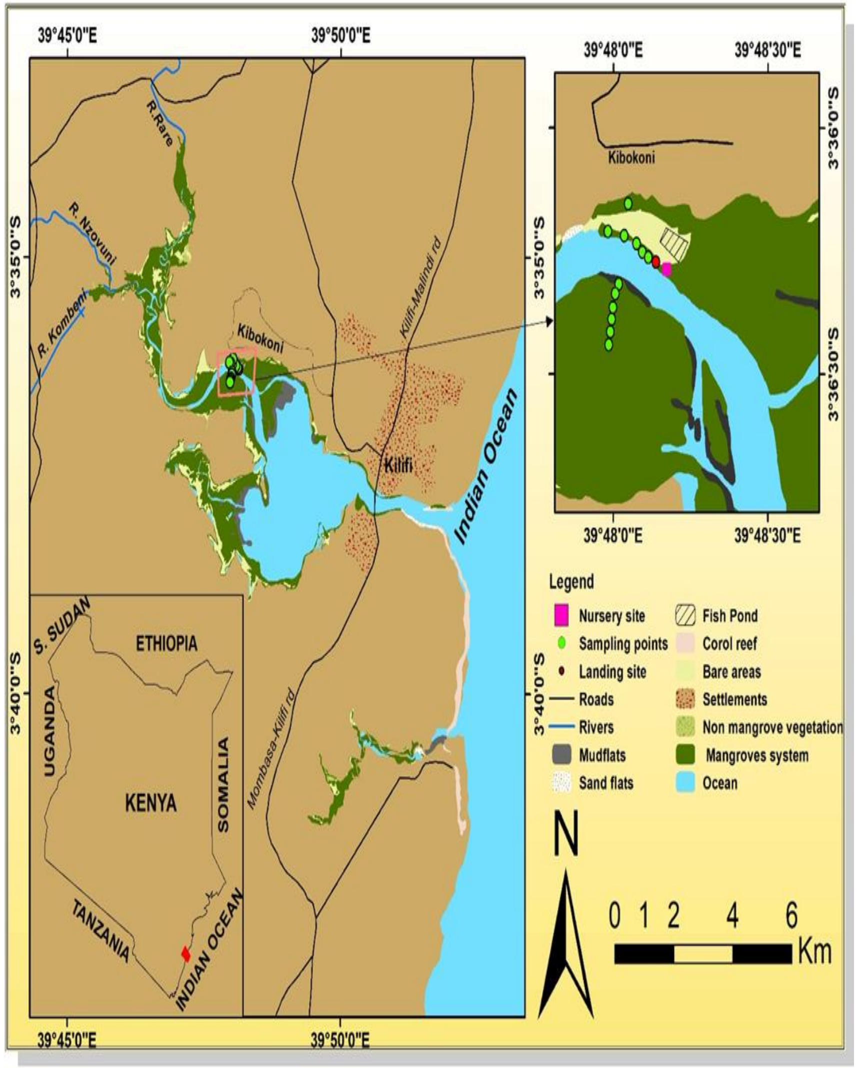
Specific Objectives

- To assess the growth performance of rabbitfish offered black soldier fly larvae meal and fish meal in brackish water.
- To compare the **nutritional composition** of locally formulated black soldier fly larvae and fish meal used in the formulation of rabbitfish diets.

Materials and methods

The study was carried out at Kilifi County

Study site



Experimental design

- The study had complete block randomized design (CBRD) with four treatments.

- T1 (0% FM, 100% BSFL)
- T2 (25% FM, 75%BSFL)
- T3 (50% FM, 50%BSFL)
- T4 (40 % CTRL)

Pond repair

- The experimental pond measured 20m x 40m x 1m (800m^2)
- The pond was repaired and inlets and outlets pipes installed
- The pond was drained, limed and dried for a week
- The pond was fertilized with organic manure

Experimental fingerlings

- Experimental fish were sourced from the wild along Kilifi creek by artisanal fishers
- Fish were transported to experimental site
- Fish were acclimatized fortnightly

Feed Preparations

- Black soldier fly larvae was cultured
- Other ingredients were obtained from open-air market
- Individual ingredients were grinded, sieved and weighed.
- Quantities were computed with the Pearson’s Square Method.
- Prepared feed was dried under shade and packaged.
- A sample was taken from each treatment for proximate analysis

Feed preparation cont.…

Stocking and feeding regime

- 180 fish (average stocking weight and length, 11.64±0.96 and 9.90±0.91cm /fish respectively).
- Fish were randomly allocated into 12 hapas at a density of 15 fish/m^2 /hapa.
- Each hapa was randomly assigned to one of three replicates of the four dietary treatments
- All fish were weighed and measured individually at the beginning, every month and the end of the study period.
- The fish were fed on 5% body weight
- Feeding was done twice a day at 0900HRS and 01600HRS.

Proximate analysis

Proximate analysis was done on;

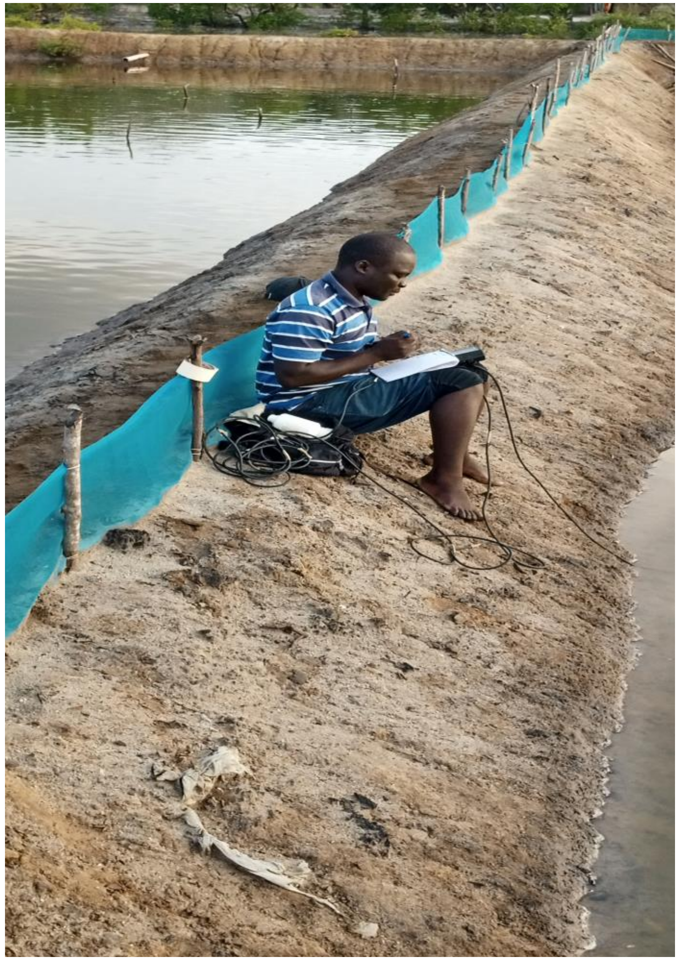
- Moisture content
- Lipids
- Crude protein
- Fats
- Ash
- Carbohydrates

- Analysis was done on dry matter basis using standard methods of the Association of Official Analytical Chemists (AOAC, 2003).

Water quality monitoring

Water quality parameters were monitored for;

- Temperature
- Dissolved oxygen
- pH
- Ammonium
- Nitrites-nitrogen (NO_2-N)



water quality parameters data collection

Fish gutting

Objective

- To check for *diet acceptability*
- One fish per hapa per treatments was dissected
- The intestinal organs were observed for any traces of pelleted diets.

Fish gutting to monitor acceptability of formulated diets

Fish sampling

- Fish were sampled under mangrove shade
- Water was aerated using 12 Volt aquarium aerators to ensure adequate dissolved oxygen concentrations.
- All the 15 fish were sampled from each hapa

Data analysis

- All the data were recorded in sampling book later to Microsoft Excel 2000 version 7.0.
- Descriptive analysis
- Data was subjected to two-way analysis of variance (ANOVA), followed by a comparison of means (Tukey's HSD test) to test the effects of the growth performance on fish.
- At $P<0.05$ was regarded as statistically significant.
- Growth performance curves were generated using excel.
- Length-weight relationship (LWR) was performed to monitor the isometric growth of fish

RESULTS

Water quality parameters

Parameters	Mean and StDev	Min	Max
Temperature(^{0}C)	29.45±0.58	27.8	29.9
DO (mg/L)	0.63±0.03	0.08	2.32
Transparency (cm)	31.50±0.12	30.23	44.2
PH	7.78±0.08	7.57	7.88
Salinity(mg/L)	41.56±1.23	39.27	44.67
PO4(mg/L)	0.44±0.01	0.45	0.45
NO2(mg/L)	2.19±0.03	1.20	2.20
NO3(mg/L)	1.50±0.01	0.93	1.50
NH3(mg/L)	3.72±0.05	2.12	3.73
Chl-*a* (mg m-3)	0.11±0.00	0.09	0.11

Proximate composition

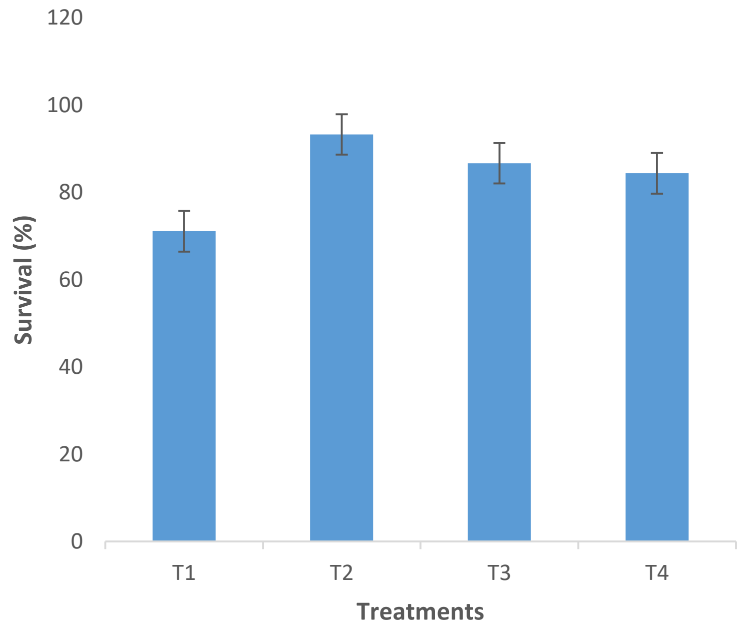
- Proximate analysis

Treatments	T1(100% BSFL)	T2(25% FM, 75% BSFL)	T3(50% FM, 50% BSFL)	T4(40%Commercial diet)
Moisture (%)	8.55 ±0.23	9.96 ±0.46	10.23±0.43	9.47 ±0.23
Lipid (%)	14.41±0.22	10.39±0.12	6.1 ±0.31	6.03±0.34
C. protein (%)	27.38 ±0.11	24.59 ±0.09	25.28 ±0.15	24.87 ±0.01
Ash (%)	4.67±0.22	8.0 ±0.32	8.64±0.40	8.2 ±0.11
Crude fiber (%)	18.43±0.24	16.77 ±0.21	14.27 ± 0.21	18.30 ± 0.12
Carbohydrates (%)	36.56 ±0.34	35.48 ±0.09	35.48 ±0.21	33.13 ±0.10

Growth rate Performance parameters

Survival rate (%)

- Fish survival ranged between **71.1** and **93.3%** for all treatments



Growth rate Performance parameters

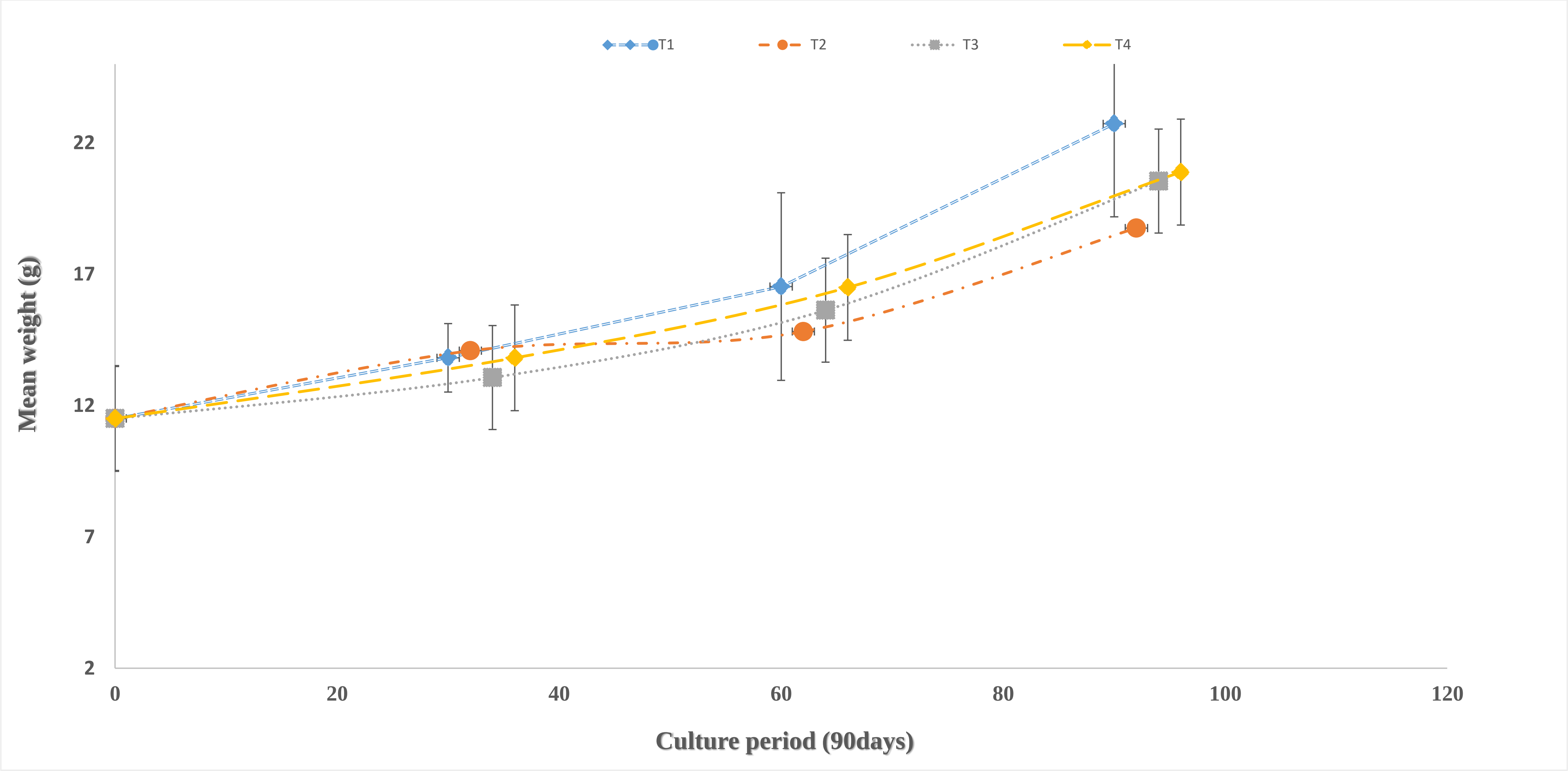
- There was no significant difference for the mean length and weight of fish (p = 0.86 and p = 0.42, respectively).

Parameter	T1 100% BSFL (*n=180*)	T 2 75% BSFL (*n=180*)	T3 50% BSFL (*n=180*)	T4 40% Control (*n=180*)
Initial BW(g)	11.5± 0.99	11.5±0.78	11.5±0.78	11.5 ± 0.68
Final BW (g)	64.59±0.42	59.17±0.33	61.02±0.42	62.47±0.41
Initial length (cm)	8.7± 0.13	8.7 ± 0.16	8.7 ± 0.07	8.7 ± 0.21
Final Length (cm)	27.3±0.15	28.4±0.24	28.7±0.19	28.6±0.89
BWG (g)	53.08±4.05	47.66±3.89	49.51±1.81	50.96±0.14
DWG	0.58±0.09	0.53±0.03	0.53±0.03	0.57±0.05
ADL	0.07±0.02	0.05±0.02	0.05±0.05	0.05±0.05
ADG	0.359±0.05	0.253±0.03	0.293±0.02	0.321±0.04
SGR	3.68±0.09	3.88±0.08	3.74±0.09	3.65±0.02
FCR	1.48±0.24	3.41±0.22	0.91±0.30	2.98±0.31

RESULTS CONT…,

- All fish showed a steady **increase in weight** following exposure to their respective diets throughout the 90 days’ culture period.
- **Exponential growth** curves was observed as the weight gain increased gradually.
- T2 and T3 curves displayed **overlap,** by the middle of 30^{th} day
- At the 60^{th} day **separation** of curves was observed between the diets.
- At the 90^{th} day T3 and T4 **overlapped**.
- Diet T1 showed the **highest** weight.
- T2 had the **lowest** growth weight.
- Their was no significance different ($p<0.05$) among the treatments.

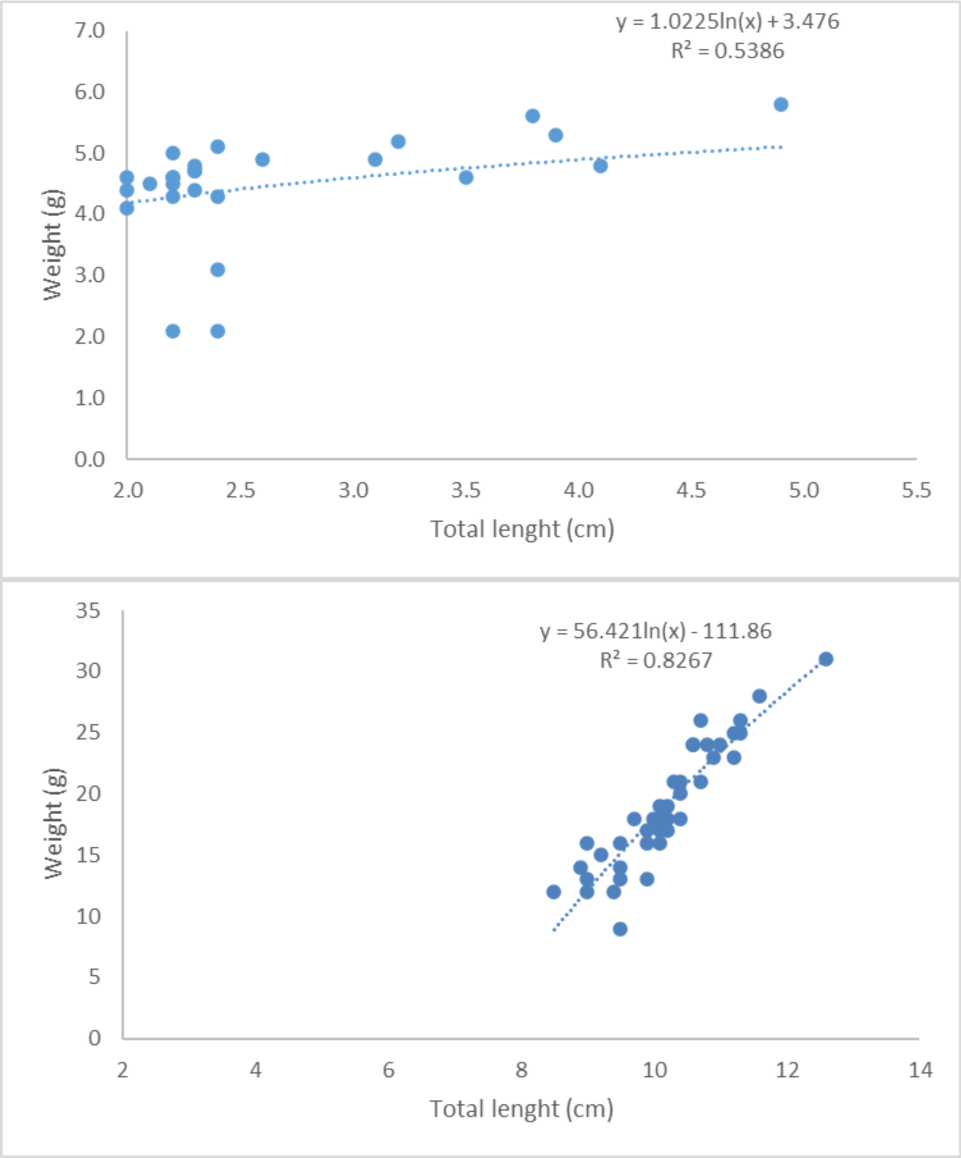
RESULTS CONT…

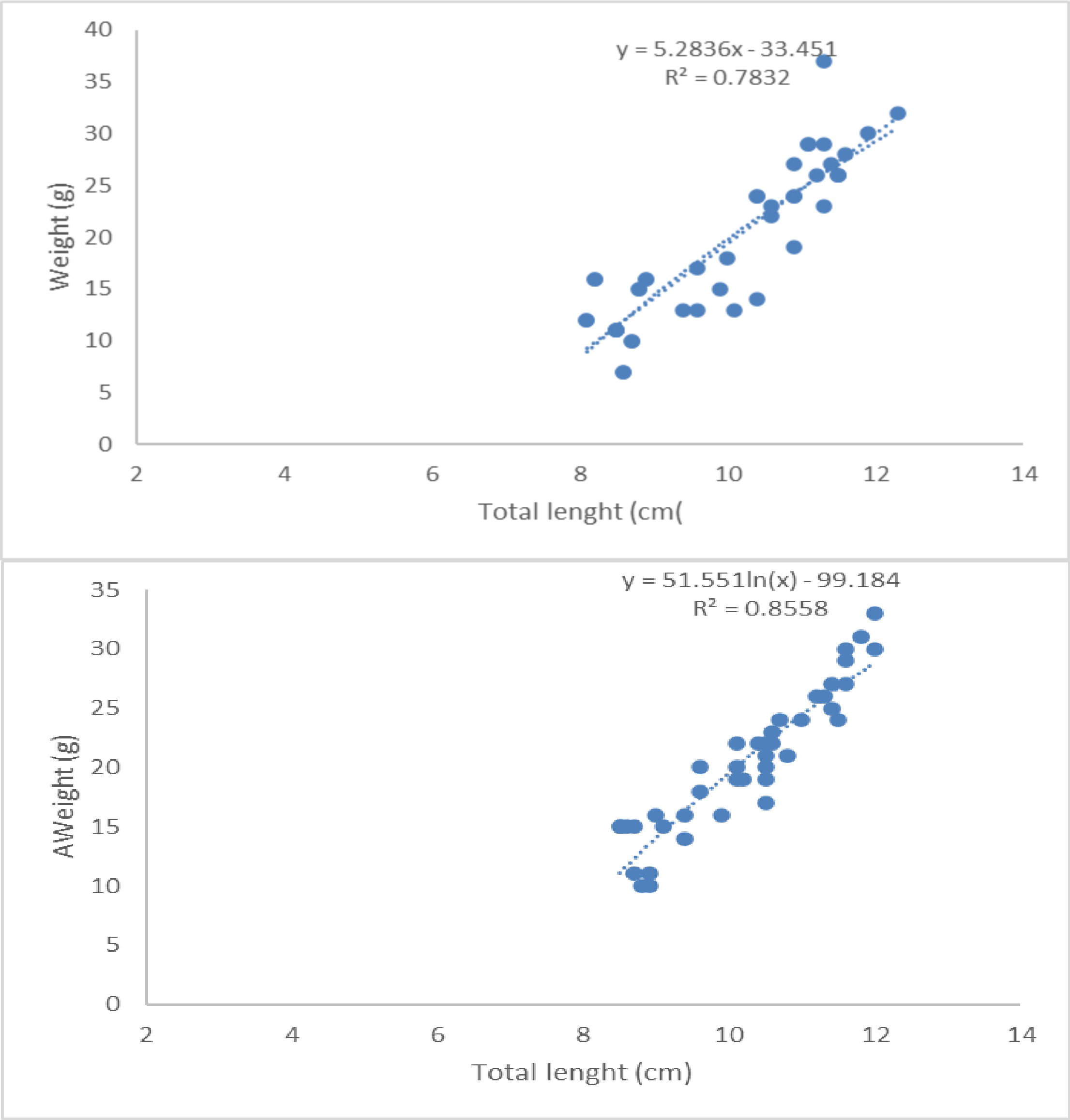


Length weight relationship

- The LWR measures isometric growth of fish, general well-being and fitness.
- Isometric if *b* equal or very close to 3 and allometric if *b* significantly different from 3; negative allometric if $b < 3$ and positive allometric if $b > 3$
- This study didn’t show any isometric growth, all fish exhibited a negative allometric growth and tended to be thinner.
- All regressions were highly significant, with the coefficient of determination (r^2) ranging from 0.53 (T1) to 0.85 (T4) ($p < 0.01$)

Length-weight relationship (LWR)





Log length -weight relationship in Rabbitfish *(Siganus sutor* T1 and T2

Log length -weight relationship in Rabbitfish *(Siganus sutor* T3 and T4

DISCUSSIONS

- The culture of *S. Sutor* in intertidal earthen pond cages is **a new aspect** in addition to feeding the species with BSFL formulated diet.
- The species is **herbivory** and can easily be weaned to **formulated feeds** in captivity thus making them suitable for commercial aquaculture.
- Fish were of good healthy throughout the experimental period
- **Water parameters** in all treatments remained within the acceptable and tolerable levels for fish growth and survival, $p>0.05$.

Conclusion and recommendations

- Based on the **growth performance** and **survival** findings, farming of *Sigunus sutor* in cages installed in intertidal earthen ponds is feasible.
- Rabbitfish respondent to BSFL **formulated diets** well.
- More research is needed in open intertidal ponds and sea cages to assess the viability of the intervention.
- Production of BSFL using domestic and market wastes could be an asset for the aqua feed industry as a possible protein source.

References

Ahmad, J. P. A., Siddiqui, G., Nabi, K. M., Khan, A., & Zamir., A. Y. (2020). Substitution of fishmeal with plant protein source the soybean meal in the diets of Arabian Yellowfin Seabream Acanthopagrus arabicus Juveniles Thalassas: *An International Journal of Marine Science*, 36 (2) (2020), 589 596. Retrieved 30 June, 2021, from 10.1007/s41208-020-00225-9.

FAO. (2016). The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress. *Food Agric. Organ. Publ. Rome.*

FAO. (2018). The state of world fisheries and aquaculture 2018 - Meeting the sustainable development goals. FAO, Fisheries Department. Rome, Italy, 210 pp.

FAO. (2020). The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome. 244 pp. Retrieved 19 July, 2021, from https://doi.org/10.4060/ca9229en

GoK. (2015). The 2015 long rains season assessment report. Kenya Food Security Steering Group (KFSSG), Government of Kenya, Nairobi, Kenya.

Khalid, H., Habib, U. l., Mohammad, A., Momin, S., & Abdel-Aziz, M. F. A. (2020). Effect of varying dietary protein levels on growth performance and survival of milkfish Chanos chanos fingerlings reared in brackish water pond ecosystem. The Egyptian Journal of Aquatic Research, 47(1), 35-40

Mirera, O. D., & Ngugi, C. C. (2009). Sustainability and income opportunities of farming milkfish (Chanos chanos) to local communities in Kenya: assessment of initial trials of earthen ponds. EC FP7 Project SARNISSA [www.sarnissa.org]

Rachmansyah, R., & Triyanto, T. (1997). Pengaruh Cara Booster terhadap Efikasi Vaksinasi Oral dengan Debris Sel Aeromonas hydrophila pada Lele Dumbo (Clarias sp.). Journal Perikanan Universitas Gadjah Mada, 8(1), 36-43.

Tacon, A. G. J., & Metian, M. (2009). Fishing for feed or fishing for food: increasing global competition for small pelagic forage fish. Ambio, 38(6), 294-302. Retrieved 20 August 2020, from PMid: 19860152. http://dx.doi.org/10.1579/08-A-574.1.

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