Bioenergetics

PhD. student
Dr. A. Y. Al-Dubakel.

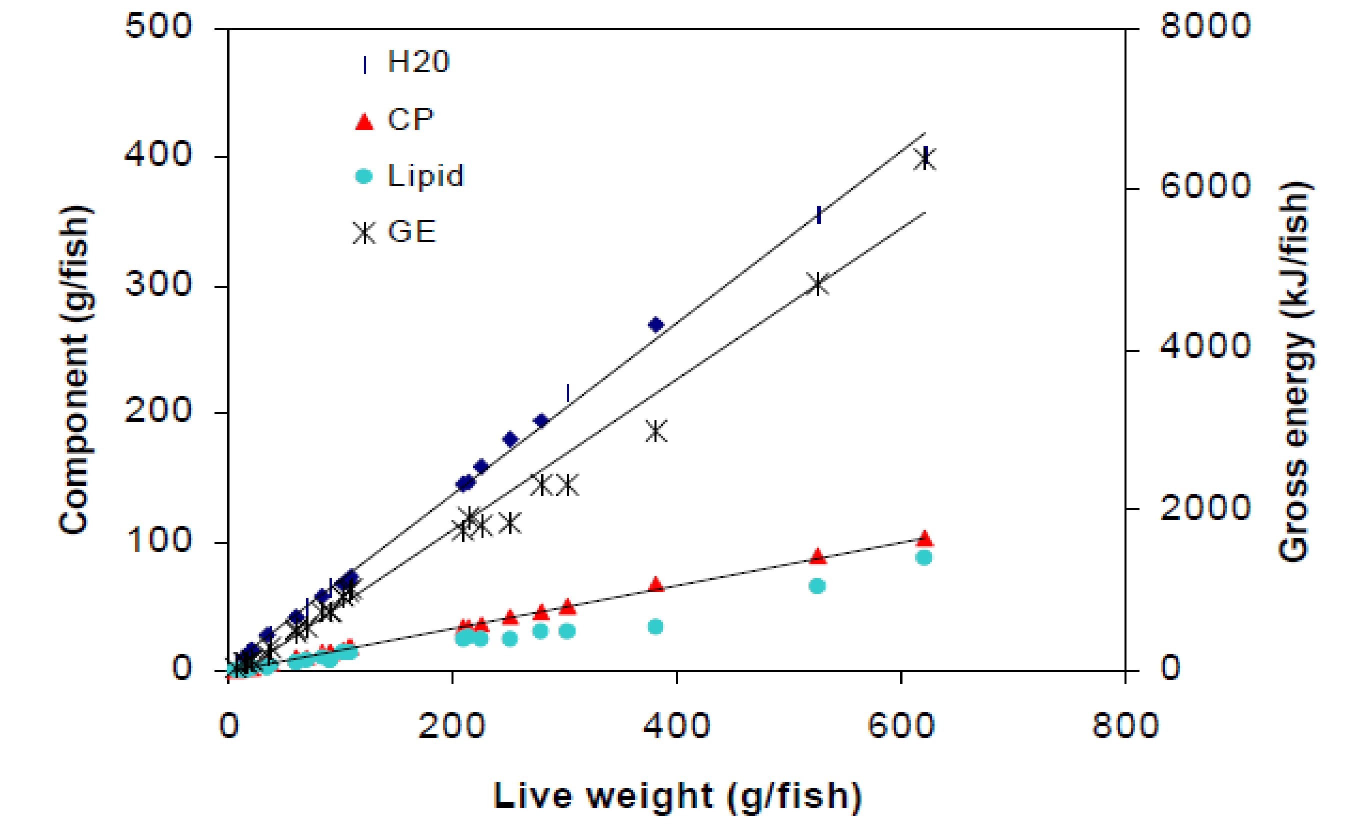
5- Bioenergetics models 3

Bioenergetics models

Once the expected TGC and water temperature profile during the production period are established, expected live weight gain (LWG) and recovered energy (RE), nitrogen (RN) and phosphorus (RP) on basis of dry matter (DM, 20-35% of live body weight) in carcass can be computed.

Bioenergetics models

Figure 1



Chemical composition (absolute; g/fish or kJ/fish) of rainbow trout of various sizes fed practical diets with 20–22 g DP/MJ DE. Data from Bureau *et al.* (unpublished). Regressions: H_2O (g/fish) = 0.670 BW (g/fish) – 3.13 (R^2 = 1.00); Crude protein (CP) (g/fish) = 0.169 BW (g/fish) – 0.07 (R^2 = 1.00); Lipid (g/fish) = 0.125 BW (g/fish) – 2.52 (R^2 = 0.96); Gross energy (GE) (kJ/fish) = 8.6 BW (g/fish) –40.1 (R^2 = 0.98).

Bioenergetics models

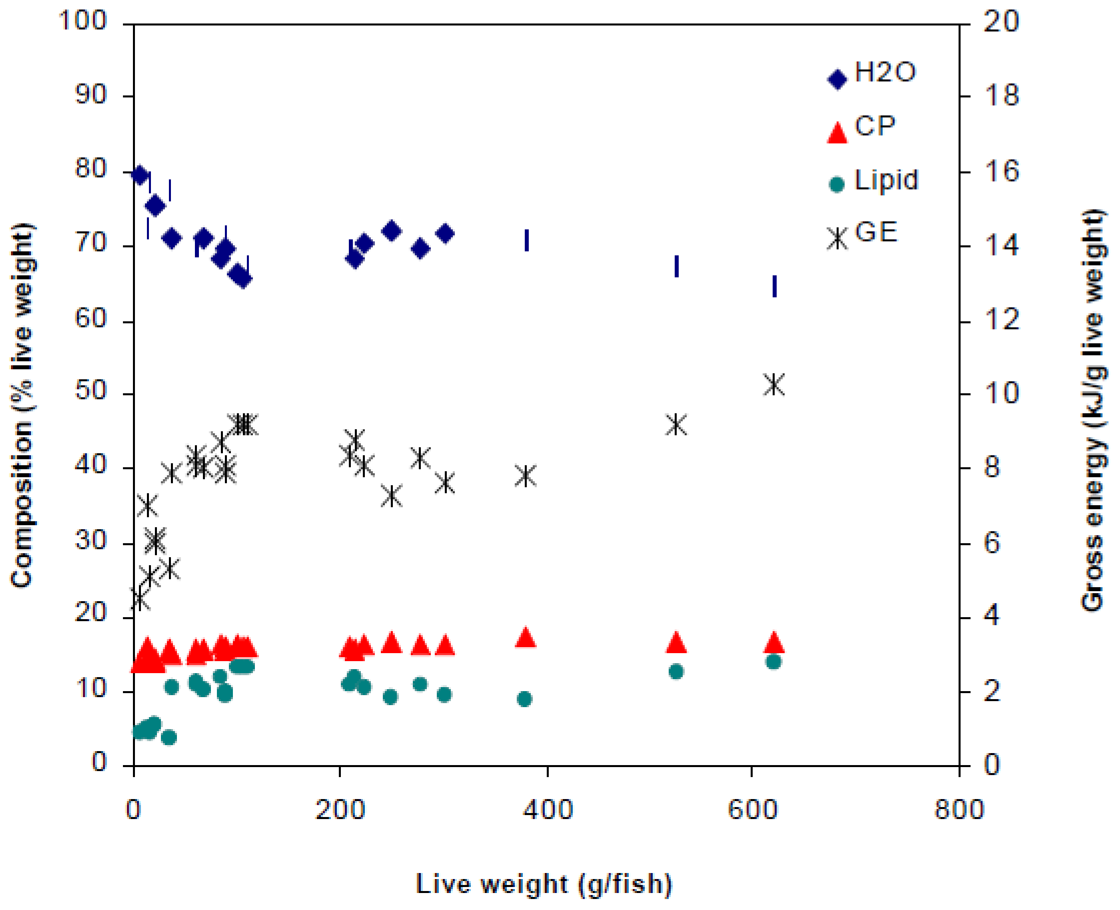


FIG. 2

Chemical composition (relative; % or kJ/g) of rainbow trout of various sizes fed practical diets with 20–22 g DP/MJ DE. d^{-1}, day^{-1}.

Bioenergetics models

Energy and Oxygen Requirements[a] and Expected Feed Efficiency of Rainbow Trout[b]

Live weight (g $fish^{-1}$)	GE (kJ g^{-1}) live weight)[c]	RE[d] (MJ kg^{-1} weight gain)	HeE[e] (MJ kg^{-1} weight gain)	HiE[f] (MJ kg^{-1} weight gain)	UE + ZE[g] (MJ kg^{-1} weight gain)	DE[h] (MJ kg^{-1} weight gain)	Oxygen[i] (g kg^{-1} weight gain)	Feed efficiency[j]
1	4.4	4.4	1.1	3.7	0.3	9.5	357	2.10
5	4.8	4.8	1.6	4.3	0.3	11.1	433	1.81
10	5.2	5.2	1.8	4.6	0.3	11.9	472	1.68
50	6.8	6.8	2.4	6.2	0.5	15.8	623	1.28
100	6.9	6.9	2.7	6.5	0.5	16.6	675	1.21
500	8.1	8.2	3.5	7.9	0.6	20.2	840	1.00
1000	9.8	9.8	4.0	9.2	0.7	23.6	968	0.85
1–1000	—	8.7	3.6	8.2	0.6	21.1	869	0.95

[a] MJ or g kg^{-1} weight gain.

[b] At various sizes or growing from 1 to 1000 g, based on the assumption that the fish are reared at 12°C, growing with a TGC = 0.220, and fed a diet with 20–22 g DP/MJ DE and 20 MJ/kg DE.

[c] GE, gross energy content of carcass. Calculated from experimental data (Bureau *et al.*, unpublished) as follows: for fish 30 g or less: GE (kJ g^{-1}) $= -0.0006$ (live weight)^2 $+ 0.0948$ (live weight) $+ 4.31$; for fish more than 30 g, GE (kJ g^{-1}) $= 0.0031$ (live weight) $+ 6.61$.

[d] RE = (live weight gain; g $fish^{-1}$) (GE content).

[e] $HeE = [-1.04 + 3.26(T) - 0.05(T)^2](0.0200.824)^{-1}\ day^{-1}$ (Cho, 1991).

[f] HiE = 0.67 (HeE + RE) (Azevedo, 1998).

[g] UE + ZE = 0.03(HeE + RE + HiE) (Kaushik, 1998).

[h] DE requirement = (RE + HeE + HiE + UE + ZE).

[i] Oxygen requirement = (HeE + HiE)/13.6 kJ g^{-1} O_2.

[j] Expected feed efficiency = weight gain/feed.

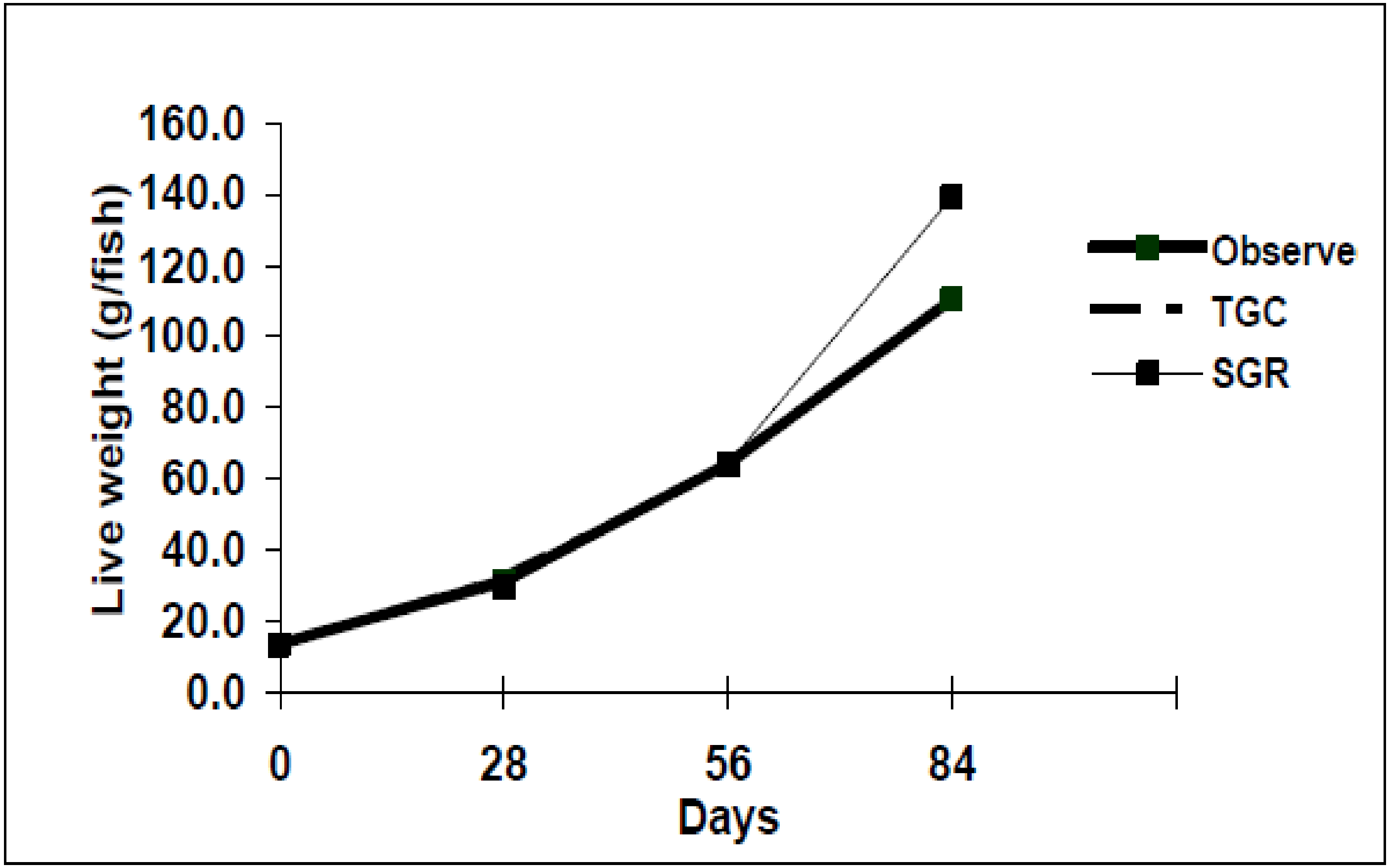
Bioenergetics models

The total energy requirement should ideally be expressed as DE, since FE and, consequently, IE are highly dependent on the composition of the diet fed. FE is mainly from undigestible starch, fiber, and some protein in the diet and is influenced by the quality of ingredients. Less expensive commercial diets tend to contain higher levels of undigestible plant products, diluting digestible nutrients and increasing the amount of FE.

Predicted number of days needed to reach harvest weight of rainbow trout strains with different growth potentials, expressed as thermal-unit growth coefficient (TGC).

Fish strain	**A**	**B**	**C**
Growth potential (TGC[1])	**0.153**	**0.174**	**0.203**
Initial weight, g/fish	10	10	10
Target harvest weight, g/fish	1000	1000	1000
Average water temperature, °C	8.5	8.5	8.5
Number of days to harvest	603	530	455

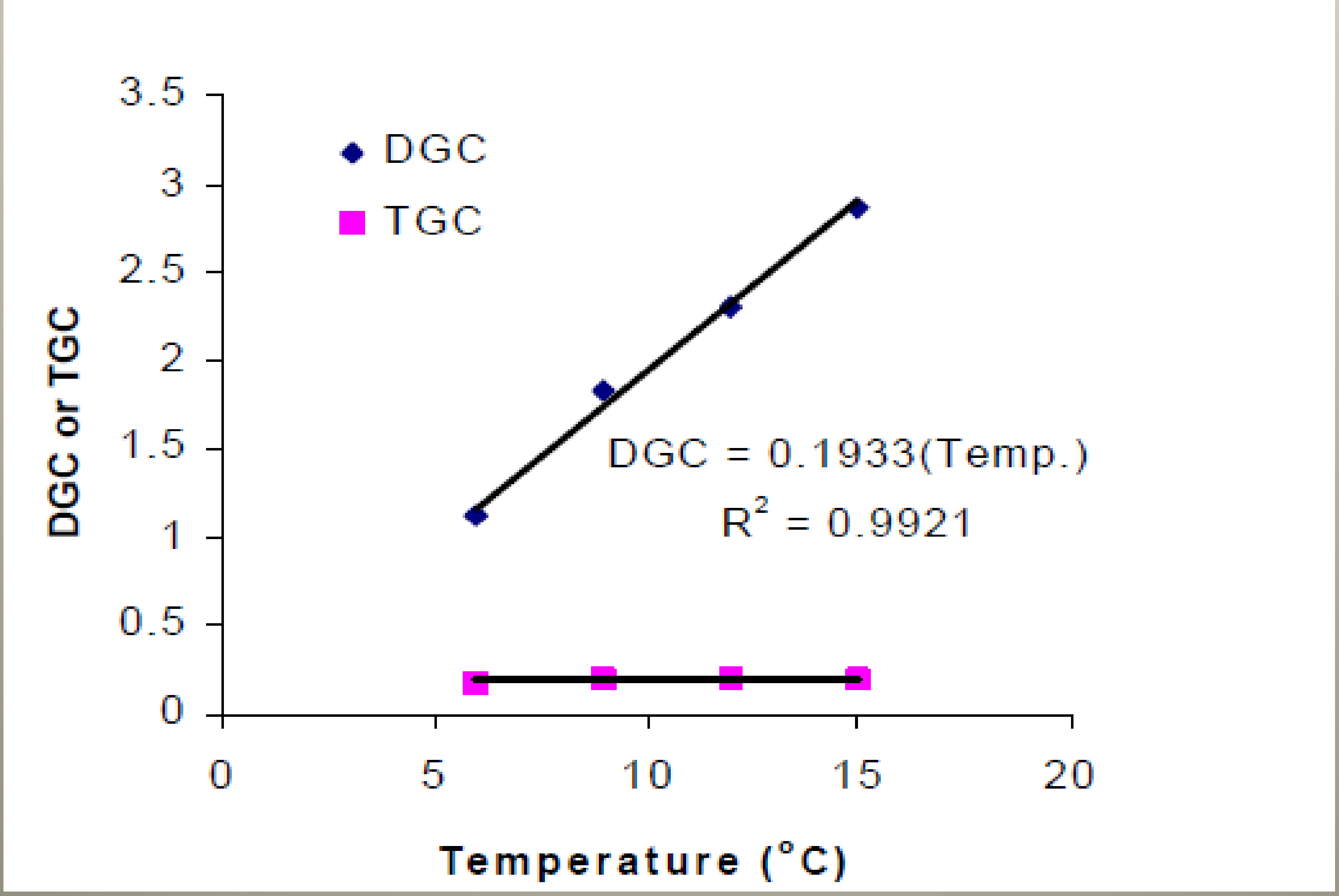
Bioenergetics models



Growth curve of rainbow trout fed to near-satiation and reared at 15°C and comparison of two growth models, the specific growth rate (SGR) and the thermal-unit growth coefficient (TGC).

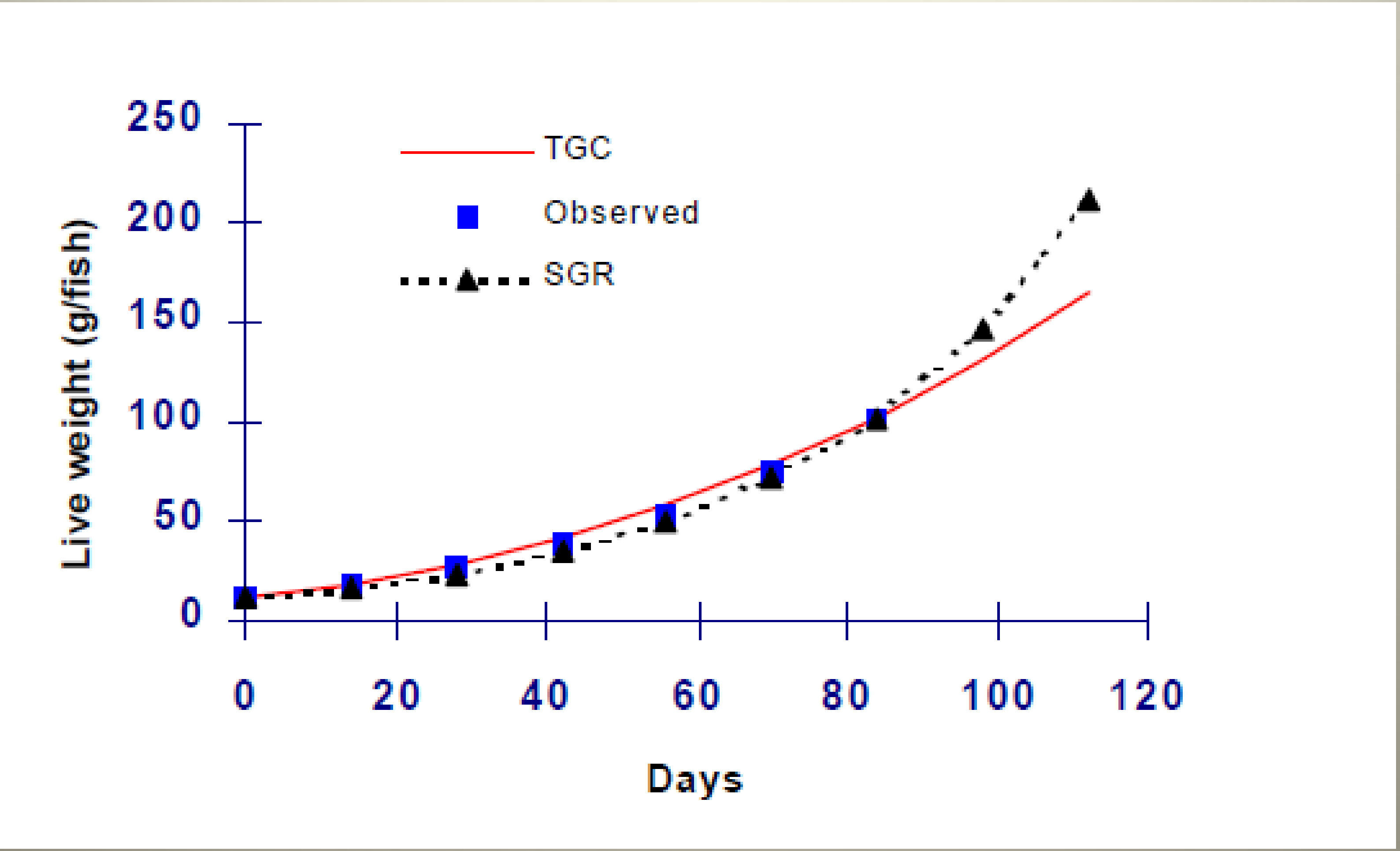
Bioenergetics models

Daily growth coefficient (DGC) = 100 x $(FBW^{1/3} - IBW^{1/3})/D$



Daily growth coefficient (DGC) and thermal-unit growth coefficient (TGC) of rainbow trout as a function of temperature.

Bioenergetics models



While it has only been demonstrated to be valid for salmonids, preliminary observations suggest that TGC model also faithfully represent the growth curve of some non-salmonid fish species, such as the Nile tilapia, *Oreochromis nilotica*