Relationship Between Insulin and Insulin Growth Factor I and The Effect on Trout

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Background Information on Trout

•Fish live in water and have a different diet than humans.
•The rainbow trout *(Oncorhynchus mykiss)* (Fig. 1) is one of the most studied fish (Thorgaard et al. 2002).
•The brown trout (*Salmo trutta)* (Fig. 2) is another type of trout that is used in studies.
•Trout are known to have a different response to insulin where liver glucose production is reduced (Forbes et al. 2019).

Figure 1. A picture of *Oncorhynchus mykiss*.
Photograph retrieved from https://www.ncwildlife.org/Learning/Species/Fish/Rainbow-Trout

Figure 2. A picture of *Salmo trutta*.
Photograph retrieved from http://www2.dnr.cornell.edu/cek7/nyfish/Salmonidae/brown_trout.html

IGF-I and Insulin

•Insulin-like growth factor I, also known as IGF-I, is a key hormone used to regulate growth, differentiation, and metabolism in fish (Zhong et al. 2022).
•Insulin is a hormone produced to help move glucose from the blood into cells (Navarro et al. 2004). The intake of nutrients is regulated and adjusted to what the fish needs (Navarro et al. 2004).
• Insulin in fish is secreted depending on their diet. *O. mykiss* are carnivorous, and their bodies adapt to glycemia slowly when tested with glucose (Forbes et al. 2019). Herbivorous and omnivorous fish will have higher insulin binding, while carnivorous fish will have lower insulin binding (Riddle et al. 2018).
•Arginine is an amino acid that can be used to trigger the secretion of glucose and insulin in fish (Riddle et al. 2018).

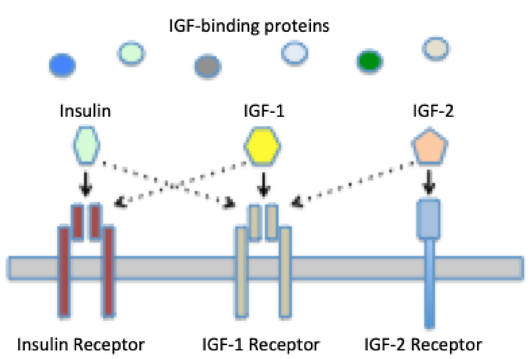


Figure 3. An image of IGF-I and IGF-II receptors binding with insulin receptors. IGF-2 receptor binds to IGF-1 receptor, IGF-1 receptor then binds to the insulin receptor.
Image retrieved from http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/otherendo/igfs.html

Arginine Injected

For the arginine experiment, 2-year-old *S. trutta* were collected and sorted into 2 groups of 4-6 fish and were fed daily. After 45 days of food deprivation when plasma insulin levels would be reduced, blood and adipose tissue samples were taken. Results of the arginine injection included an increase in IGF-I and insulin plasma levels and increased their binding as shown in Figure 4 (Planas et al. 2000).

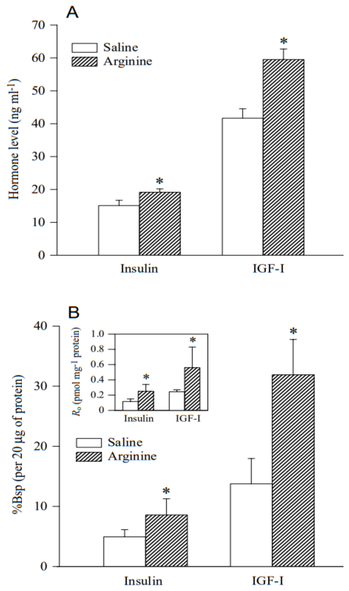
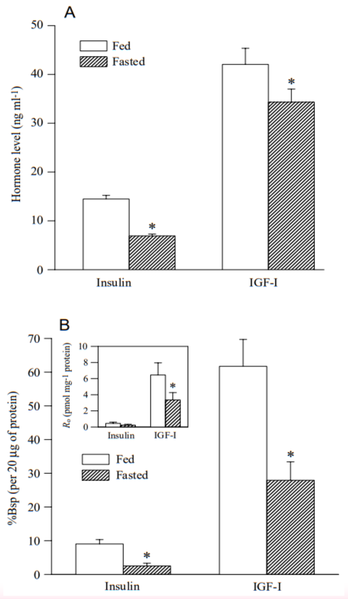


Figure 4. From arginine treatments, Fig. 4a shows the results of the plasma levels of IGF-I and insulin. Fig. 4b shows the results of the binding receptors of IGF-I and insulin, the smaller graph shows how arginine affects the insulin and IGF-I receptor number. Each thin line on top of each bar represent the mean of 4 different receptor purifications from three different adipose tissue samples.

* means there is a significant difference ($p<0.05$) between the fish injected with arginine and the control group (Planas et al. 2000).

Fasted on Insulin

For the fasting experiment, 2-year-old *S. trutta* were collected and split into two groups of 10. After 45 days of food deprivation when plasma insulin levels would be reduced, blood and adipose tissue samples were taken. Food deprivation decreased the IGF-I and insulin receptors shown in Figure 5 (Planas et al. 2000).



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The Roles of IGF, Insulin and Skeletal Muscle Growth

•*O. mykiss* were obtained from a fish farm in Spain, with the tissue collected by dissection. Rat tissue was used as a control (Bouraoui et al. 2010).
•To harvest the cells, the peripheral adipose tissue then passaged cell culture. Cell culture is where they grew the cells in the lab and then harvested them (Bouraoui et al. 2010).
•Adipose tissue is majorly important to energy balance. The tissue converts lipids that it either accumulates or breaks down into energy. It can expand throughout a lifetime with an increase of mature cells.
•To detect if IGF-I receptors (IGF-IR) were in the tissue, the cells went through immunofluorescence. Immunofluorescence is the technique that helps visualize the components of a tissue or cell. The presence of IGF-IR and insulin receptors were identified in days 5 and 14 of their experiments using western blot analysis and immunofluorescence as shown in Fig. 6 (Bouraoui et al. 2010).

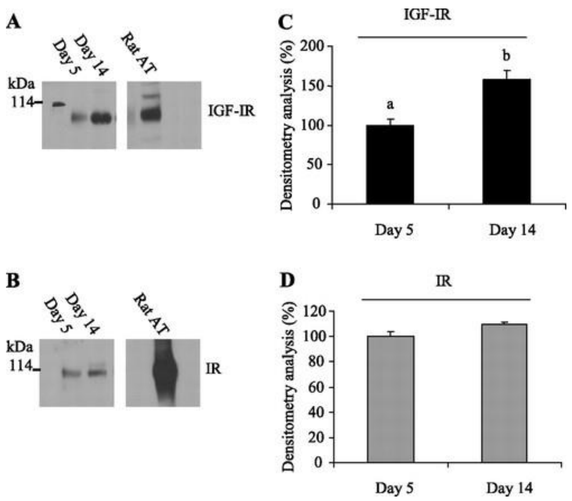

Figure 6. Fig. 6a is an immunoblot showing the presence of IGF- IR receptors in the tissue of *O. mykiss* in day 5 (preadipocytes) and day 14 (adipocytes) of the *O. mykiss* adipocyte culture. The control that is shown is Rat AT (Perivisceral rat adipose tissue.) Fig. 6b is also an immunoblot, but it shows the presence of insulin receptors. Fig. 6c and Fig. 6d are both western blots representing densitometry analysis which were taken from the same culture used for the immunoblots. (Bouraoui et al. 2010).

Literature Review

•When trout experience food deprivation, their IGF-I and insulin plasma levels reduce. When they are fed their IGF-I and insulin plasma levels increase.
•If a trout is food deprived and attempts to increase food intake, it will experience lower levels of plasma (Planas et al. 2000).
•When fish go through environmental and physical changes, IGF and insulin receptors try to balance nutritional levels and adapt. When the receptor count is reduced to where it is not able to help regulate growth and metabolism, it will either adjust or struggle.
•With trout being one of the most studied fish and the IGF system not yet being fully studied, there is so much more information about the IGF system that is yet to be discovered (Wood et al. 2005).

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