Changes in feed intake, weight, body size and appearance of lesions in tilapias (*Oreochromis niloticus*) (Linnaeus, 1759) subjected to gamma radiation.

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Abstract – Nuclear energy has been widely used for peaceful purposes in the fields of medicine, industry, agriculture and energy generation. This study aimed to verify the occurrence of biological effects of gamma radiation on changes in eating behavior and weight development in fish and may be using them as a possible tool for monitoring in contaminated environments. 32 males of Nile tilapia, with standard length of 11.8 cm and a mean weight of 46.8 g were used. The ranges of absorbed dose were 0 Gy, 20 Gy, 40 Gy and 80 Gy; for each dose range beamed up four fishes. Animals used in this study are more resistant to the deleterious effects of gamma radiation when compared to mammals. There is a certain proportionality of dose / effect when considering absorbed dose / food intake /death. Studies involving the effects of ionizing radiation should be developed for this species.

I. INTRODUCTION

Nuclear energy has been widely used for peaceful purposes in the fields of medicine, industry, agriculture and energy generation. Its use is not always viewed favorably at the continuing radiobiological accidents since the Second World War with the testing of nuclear war artifacts to the explosion of the atomic bombs on Hiroshima and Nagasaki. Such accidents may occur due to technical or human error. Accidents caused by technical failures have a low probability of occurrence; since the equipment currently produced are highly reliable (1). We conclude, therefore, that high magnitudes of accidents occur through human error or unforeseeable environmental catastrophic event. Reports employing tropical fish, linking environmental stress and biochemical changes such as cortisol and plasma protein patterns can be found in: *Prochilodus lineatus* (2), *Piaractus mesopotamicus* (3), (4) e (5), *Oreochromis niloticus* (6), (7), *Colossoma macropomum* e *Hoplosternum littorale* (8), *Brycon cephalus* (9), (10), *Rhamdia quelen* (11), no híbrido tambacu *P. mesopotamicus* x *C. macropomum* (12), (5) e *C. macropomum* (13), (14). In human beens, treatment of radiation-sensitive tumors has been used with increasing doses, occurring improvement in local tumor control and survival of patients (15). However, increased incidence of mucositis to varying degrees, with significant pain has also been observed (16). This study aimed to verify the occurrence of the biological effects of gamma radiation on changes in eating behavior and weight development in fish and may be using them as a possible tool for monitoring in contaminated environments.

II. MATERIALS AND METHODS

32 males of Nile tilapia, *Oreochromis niloticus*, with standard length of 11.8 cm and a mean weight of 46.8 g were used. The ranges of absorbed dose were 0 Gy, 20 Gy, 40 Gy and 80 Gy; for each dose range beamed up four copies. During the first 10 days of adaptation, the fish were fed twice daily with commercial feed (35% crude protein) at the rate of 3% body weight (g). The food remained available for 1 hour. After this period, waste food and excreta were removed. The amount not ingested was determined accurately by the use of a balance after drying of the pellets. During this period, water quality was monitored weekly and maintained in optimum condition. Fish were weighed and measured to determine biometric parameters before irradiation. Fish were irradiated in individual plastic containers with a capacity of 1.5 L of water. They were then

transferred to radiotherapy and exposed to gamma radiation. The radiation field involved the whole extent of the space where they are positioned unit. In determining the exposure time were observing the radiometric parameters that ensured uniformity of the radiation field. The doses were measured by the use of an ionization chamber calibrated for ^{60}Co radiation energy, following the protocol TRS-398 dosimetry of the International Atomic Energy Agency (IAEA). After exposure to gamma radiation, fish tanks returned to the source where they were observed for 30 days. After irradiation, in each 10 days, totalizing three periods, a new biometrics was performed. The data were subjected to statistical analysis (descriptive and ANOVA) employing the software ASSISTAT (16).

III. RESULTS AND DISCUSSION

Were used doses of 20 Gy, 40 Gy and 80 Gy, as in previous studies in our laboratory it was found that the irradiation from 1 to 10 Gy did not cause noticeable changes in fish. Regarding food intake on the first day after irradiation fish that received the dose of 80 Gy decreased from 1.22 g to 0.68 g on average, with significant ($p < 0.01$) from the fourth day. Fish that received 40 Gy decreased from the fourth day, and revealed significant variation ($p < 0.01$) from the ninth day (1.22 g to 0.65 g), and fish that received 20 Gy showed no significant variation. On the fifth day, the fish that received 80 Gy could not eat the pellets, throwing them out. It is believed that due to the start of a mucositis (5). In fish that received 40 Gy, 62.5% of them also had the symptom. Concerned to body weight, it was found a significant difference within 10 days after irradiation with doses of 40 Gy and 80 Gy differed from the control group. The group of 80 Gy differed from animals which received 20 Gy (Table 1). It was observed the same behavior in animals receiving 80 Gy over its length (Table 2).

Table 1: Comparison of mean weights (g) in groups of absorbed doses, in experimental periods.

Dose	0	10	20	30
0 Gy	49.39[a]	65.19[a]	70,84[a]	81,35[a]
20 Gy	46.97[a]	59.98[ab]	64,61[a]	73,70[a]
40 Gy	45.02[a]	54.89[bc]**	60,47[a]	69,07[a]
80 Gy	47.49[a]	50.65[c]**	-	-

Fcalc.= 9,38 Fcrit.=4,60 **p<0,01

Table 2: Comparison of body lengths (cm) in groups of absorbed doses in experimental periods.

Dose	0	10	20	30
0 Gy	12.01[a]	12.96[a]	13.74[a]	14.17a
20 Gy	11.75[a]	12.73[a]	13.13[a]	13.61[a]
40 Gy	11.63[a]	12.13[ab]**	12.73[a]	13.20[a]
80 Gy	11.83[a]	11.90[b]**	-	-

Fcalc.= 5,32 Fcrit.=4,57 **p<0,01

Fish that received 80 Gy died (100%) between the eighth and twelfth day; fish that received 40 Gy, 62.5% died between the twelfth and eighteenth day, suggesting a response corresponding to the dose. On the eighth day showed up mouth lesions, indicating mucositis (Figure 1).

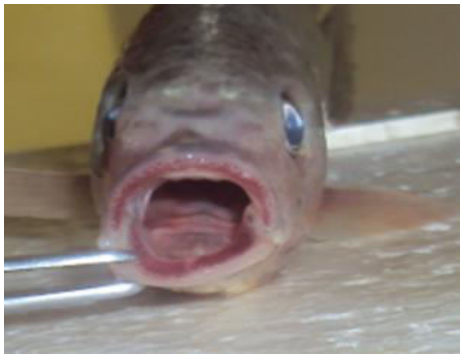

Figure 1 - Lesions in the mouth indicating mucositis.

Some authors who have worked with tropical fish and environmental stress, reported changes in levels of cortisol, blood biochemistry and even plasma protein patterns (1, 2, 3, 4, 8, 10, 15 and 16) and increased mortality to transport (6). Data from this study agree with the above cited as the ionizing radiation may be viewed as an environmental stressor. Some fishes showed tumor lesions between eighth and thirteenth day after irradiation, with a fish-80 Gy (Figure 2) and two fishes of 40 Gy (Figure 3), all came to death. From the sixteenth day there were no evidence of mucositis, or tumor lesions and no variation in feed on fishes that remained of 20 and 40 Gy.

Figure 2 - Fish received 80 Gy, early tumor on the eighth day.

The absorbed dose to the whole body, in mammals, of 5 to 15 Gy generates damage to the gastrointestinal tract, with a survival rate of 7 to 20 days (18). In fish, it was observed the occurrence of mucositis in patients receiving doses above 40 Gy.

Figure 3 - Fish that received 40 Gy, early lesion apparent on the thirteenth day.

The period between exposure and detection of cancer in humans, called latency period may be several years. The mean latency for leukemia is 8 years and 2 or 3 times higher for solid tumors. In fish solid tumors were observed in the period between 8 and 13 days. The deaths occurred between 8-18 days. This shows that the species appears to be more resistant to damage caused by gamma radiation. Some fishes that received 40 Gy survived and showed no signs of oral lesions. It is suggested that the deaths occurred due to an opportunistic infection likely due to mucositis as a side effect of radiation exposure.

IV. CONCLUSION

Fishes used in this study are more resistant to the deleterious effects of gamma radiation when compared to mammals. There is a certain proportionality of dose / effect when considering absorbed dose / food intake / death. Studies involving the effects of ionizing radiation must be developed so that this species can be used as a tool in monitoring contaminated areas.

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