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Use of Fish As Experimental Animals in Biomedical Research

İbrahim Cengizler* [*1],

**Corresponding Author E-mail:icengiz@cu.edu.tr*

[1] *Cukurova University, Faculty of Fisheries*
Dept. of Aquaculture
01330, Adana, Turkey

Abstract

Factors such as the fact that fish are not difficult to maintain and breed, easy to obtain, and the environment in which they live can be easily adjusted according to demand and number, cause them to be preferred as experimental animals. In addition, the ease of application of drugs and chemicals to be used in experiments (depending on their water solubility) makes the use of fish as experimental animals widespread. However in the case of using fish as experimental animals, first of all, it is necessary to know their basic biological structures very well. Because fishes constitute the lowest group in terms of evolution among the pisces, amphibia, reptilia, aves and mamalia groups in the vertebrata subphylum, and some of their characteristics are quite different from mammals. Evolutionary positions and aquatic life characteristics of fish have caused them to be considered as ideal creatures in the study of both somatic and reproductive and molecular evolution. In recent years, fish have started to be seen as an important experimental model in the field of biomedical, especially in subjects such as embryology, neurobiology, and endocrinology. In this article, information about the use of fish as experimental animals in biomedical research is given, and in addition to this, the historical process of using other animals as test subjects is also examined.

Keywords: Pisces; Animal; Experiment; Biomedical

1. Introduction

When an effect reaches a living thing, different animals are used in order to examine the biological systems and behaviors of that creature according to the variability of the effect. These animals, in which experiments are carried out in vivo, are called experimental animals. It is known that the first experiments on animals were most likely made by Aristotle (384 -322 BC) and Erasistratus (304 -258 BC)[1]. One of the first to apply vivisection, which means the dissection of living animals, was a researcher named Galen, who was a doctor in Rome in the second century. He used goats and pigs as test animals because of the church's strict and strict rules that did not allow human autopsy. For this reason, Galen is called the father of vivisection [2]. Experimental use of animals, which became widespread in the 18th and 19th centuries, continues today on certain rules and scientific foundations. According to a study, nearly 100 million animals, from fish to primates, were used for experimental purposes in 2010 [2]. 93% of the animals used in European Union countries are vertebrate animals [3]. Animals, which are frequently used in biomedical research in human history, have also taken their place in the focus of discussion and criticism, especially due to vivisection. Famous researchers such as Louis Pastor, Robert Koch, Ivan Pavlov, who took their place in the history of medicine, used experimental animals. Likewise, insulin was first isolated from dogs in 1922 and made available to humanity [4]. The sheep Doly, which has the title of being the first mammal cloned in 1996, has brought great controversy [5]. Thus, many countries had to enact laws controlling the experiments. The debates that have been going on for centuries focus on three issues.

1-Results from animals are not suitable for humans. Animals are not suitable for experimental use.

2-During vivisection, the animal may undergo physiological changes and the results may be misleading [6].

3-Even if the experiments are conducted with animal welfare in mind and beneficial results are obtained, it is not ethical in terms of animal rights.

On the other hand, those who see the use of animals in experiments as a necessity see this approach as an indispensable way to produce biological knowledge and advance in medicine[7]. The principles known as the 3R, which were written by Russell and Burc for the first time in 1959 regarding the ethical use of experimental animals, have guided researchers despite all the discussions. These principles are;

1-If there is an alternative method, it should be used instead of the experimental animal. eg computer modelling.

2-Experiments should be planned in such a way that the same level of information can be obtained, and the number of animals used should be reduced.

3- During the experiment, the welfare of the animals should be at the forefront, and methods that alleviate or minimize pain and distress should be applied [8].

According to these principles, if animal testing is unavoidable, the best result should be aimed with animal welfare in the foreground. Today, these three Principles are clearly stated in regulations on animal use. In recent years, organoids that scientists have produced from human or animal stem cells in vitro can show the structure and physiology of organs such as the brain, kidney, liver, lung, and intestine. In these aspects, they have taken the place of experimental animals. Organoids are widely used in pharmacological and toxicological research [9]. In addition, thanks to the developments in statistical analysis methods and computer technologies, modern imaging and processing techniques reduce the number of experimental animals used. As a matter of fact, the use of dogs and primates as experimental animals has decreased all over the world. However, the most important deficiency and handicap here is that only 37 countries publish their national statistics all over the world. In a study, the number of experimental animals in the world, which was 115.2 million in 2005, was estimated to be 192.1 million in 2015 [10]. Invertebrates are widely used as well as experimental animals. Unfortunately, there are no protective legal regulations for these creatures yet. The most commonly used invertebrate species are Drosophila melanogaster, a fruit fly, and Caenorhabditis elegans, a nematode [11][12]. Rodents are one of the most common vertebrate animals used as experimental animals. Especially mice are preferred due to their size, ease of use, and rapid reproduction. The similarity of their genes to humans is 95% [13]. Other vertebrate groups are also used for different studies. For example, in 2016, around 500 thousand fish and 9000 amphibians were used in research [14]. In addition, rabbits, cats, dogs, pigs and primates are among the most heavily used vertebrates. It is very important to keep the animal welfare at the highest level and to comply with ethical and legal procedures in a research using experimental animals, but it should be noted that it is also a necessity to know the biology of the species on which the experiment will be conducted. In this article, the biology of fish is briefly mentioned and information about their use as experimental animals is given.

2. Pisces

Pisces (fish) form the lowest group of vertebrate animals. If fish are to be used as experimental animals, it is necessary to know the basic biological structures of the fish very well. Because among the pisces, amphibia, reptilia, aves and mamalia groups in the vertebrata subphylum, some features of fish, which constitute the lowest evolutionary group, are quite different from mammals. Pisces and amphibian groups are in the anamnia class as breeding type. These animals lay their eggs in water and fertilization takes place in the water. Other groups are in the amniota class. Amniotic fluid is a fluid that protects and nourishes the embryo. Creatures in the Amniota class have adapted to land life. Pisces, amphibia, reptilia groups are poikilotherm (variable temperature), while aves and mamalia groups are homoiterm (constant temperature). Poikilotherm creatures change their body temperature according to the environmental temperature [15]. Fishes are represented by a group of vertebrates known as ostracodermi, which emerged in the Ordovician period 525 million years ago, and their habitats are located in a vertical line of about 15 kilometers from sea level to 4000 meters above sea level and 11000 meters depth [15]. They have adapted to spend their entire lives in water. They can absorb oxygen dissolved in water through their organs called gills. Fish heart is two-eyed and always contains dirty blood. Fish are the group with the most species of vertebrates. According to different evaluations, the number of fish species varies between 15000 and 32000. It is generally accepted that there are around 30000 fish species. In other words, fish make up about 45% of all vertebrates. The high number of fish species is seen as a result of millions of years of evolution, causing adaptation in fish living in regions with different characteristics of the aquatic environment. The high number of species is also seen as an advantage in using fish as experimental animals. Factors such as the ease of maintenance and production of fish, the convenience of supply, and the fact that production environments can be easily created according to the population have caused fish to be widely preferred as experimental animals. In addition, the ease of application due to the water solubility of the drugs and chemicals to be used in the experiment is one of the reasons why they are preferred as experimental animals. The first legislation in Turkey regarding the use of experimental animals was established in 2004 and is in line with the laws and regulations of the European Union. A study shows that 2,104,828 experimental animals were used for experimental and scientific purposes between 2008 and 2017 in Turkey. Fish constitute 30.6% of these animals [16]. After the legislation on the subject was created in Turkey, universities and public institutions quickly determined ethical committees and rules. Thus, a certain standard has been achieved thanks to control and permission procedures. At the end of the process, a definite improvement was achieved in animal rights and ethics.

3. Conclusions

The evolutionary position of fish and their aquatic life characteristics have caused them to be seen as ideal creatures in the study of both somatic and reproductive and molecular evolution. In addition to topics such as Embryology, Neurobiology, and Endocrinology, they are seen as an important part of research in the field of Biomedical. Fish are also useful as biomarkers of environmental contaminations. Fish are used to reveal the presence of many toxic chemicals and pollutants, as well as to reveal the history of the host response [17]. Another reason for the widespread use of fish all over the world is the belief that fish do not suffer during experiments. However, this argument is not valid today. The presence of nociceptors (pain receptors) has been demonstrated by research in fish [18]. Evidence that fish may suffer has been cited by European Union food safety authorities [19]. An independent panel of experts appointed by the British Royal Society for the Prevention of Cruelty to Animals in 1980 stated that all vertebrates suffer to varying degrees [20]. For this reason, as with other vertebrate animals, animal welfare and ethical rules must be followed and necessary permissions must be obtained in all experiments with fish. The importance of the research and whether to use animals in the research is a matter for the researcher to evaluate and decide. In the presence and safety of adequate in vitro techniques, of course, animals should not be used. In addition, scientific journals should include detailed methodological information in the articles they will publish. The aim should always be to avoid the use of animals or to reduce their numbers. If they are to be used, the rules must be followed. In biomedical research, if fish are to be used, a concept must be given to systematically evaluate the suitability of the tests [21]. It will be useful to get help from experts about the fish species and methodology to be used in the experiments.

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