I. Introduction

A drug is a chemical entity, or combination of chemicals, used to diagnose, prevent, treat, or alleviate a variety of illnesses and medical conditions. Drugs have an impact on biological systems, generating a range of effects that can be helpful or harmful to the organism. These are often referred to as adverse drug responses (ADRs) or side effects[1, 2]. The research found that 25 (92.6%) of the 27 drugs that were taken off the market were linked to serious adverse drug reactions[3]. The current prediction accuracy percentage for these negative impacts is approximately 78.8%[3]. As a result, identifying and reducing ADRs is still essential to patient safety and upholding public health standards[5].

Conventional drug discovery approaches, such as in vitro and in vivo, are widely used to analyze side effects, but they have disadvantages such as high costs, labor intensity, extended timelines, and limited accuracy[4, 6]. To solve these challenges, alternative ways are required. The in silico method is an option to anticipate undesirable effects using computer models and simulations rather than direct testing on living beings[4, 7]. This process is more cost-effective, time-efficient, lowers research risk, and does not require the use of human or animal subjects, making it an appealing alternative to typical drug development approaches[6].

Researchers have used in silico approaches to anticipate pharmacological side effects in a variety of research. In 2020, F. Azmi et al used an artificial neural network and a genetic algorithm to develop a QSAR model that predicted the activity of fusidic acid derivatives as anti-malarial drugs, with high validation scores of 0.96 (internal) and 0.92 (external)[8]. In 2022, Ke Han et al used Feature Selection-Multi-Label K- Nearest Neighbour (FS-MLKNN) with a genetic algorithm to predict pharmaceutical adverse effects. This combination aided in the selection of relevant features, reduced computational burden, and increased the accuracy of multi-label prediction models, resulting in more precise and efficient side effect predictions[9].

In 2023, Aditya et al used fingerprint data to optimize an artificial neural network for toxicity prediction using the Grey Wolf Algorithm, successfully attaining an accuracy of 0.88 and an F1 score of 0.59 for complex non-linear interactions[10]. By 2024, Rizwandy et al have improved neural network performance for toxicity prediction using the Cuckoo Search Algorithm, outperforming methods such as Particle Swarm Optimization and Genetic Algorithm, respectively, with accu- racy and F1 scores of 0.96 and 0.61[11]. In 2024, Adhitya et al used the Camel algorithm and ensemble approaches like Random Forest, AdaBoost, and XGBoost and found that metaheuristic approaches can improve artificial neural network models for various prediction applications. Their study also found that XGBoost gives the best performance with an F1 score of 0.75 and an accuracy of 0.89[12].

Choosing the best model, whether through deep learning or traditional categorization, remains the existing challenge, with both techniques having opportunities for improvement. Typically, manual design limits the performance of deep learning architectures like artificial neural networks. An automated optimization procedure using metaheuristic methods, such as the Camel algorithm, can improve predicted accuracy. Artificial neural networks significantly enhance the accuracy and reliability of this algorithm. This method is useful for complex fields such as predicting side effects and tasks.

This research aims to predict side effects by using an artificial neural network tuned by the Camel Algorithm for the case study of reproductive systems and breast disorders. The camel algorithm (CA) was utilized to improve the performance of artificial neural networks (ANN) in predicting the side effects. For the case of optimization problems, the combination of these methods should help find better results. This approach provides a more reliable and accurate prediction model for these medical situations by focusing on making the optimization process more stable and effective.