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Review

APPLICATION OF RECOMBINANT DNA IN WILDLIFE MEDICINE

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Abstract

In order to understand the paramount factors influencing the decline and prospective extinction of wildlife species, information on morbidity and factors stimulating mortality of endangered species becomes imperative. In recent time, diseases have gained more recognition as one of the factors influencing decrease in population of wildlife species and extinction. A fragment of DNA fabricated from the mixture of any minimum of two strands is popularly known as recombinant DNA. Recombinant DNA can be obtained due to the fact that all wildlife species have DNA molecules. These DNA molecules contain identical chemical structure, but their nucleotide arrangement is not homogenous, in as much as the total assemblage are the same. Therefore, this paper aims to give all-inclusive summary of the theoretical and experimental evidence provided in different literature to identify the tools of recombinant DNA technology, basics of recombinant DNA and the importance of rDNA coupled with their application in wildlife medicine. In game ranching, genetic engineering can be adopted to bring in desirable characteristics into genome of animals, because the genes have ability to resist communicable diseases and increase their value in terms of nutrition, quick growth, vaccine production, converting residues from game ranching into organic fertilizers to make foraging plants available at the lowest cost resulting to improved habitat management. In recombinant DNA technology, the common tools utilized in genetic engineering are; enzymes (with restriction enzymes inclusive), vectors and host organism. In terms of wildlife health advancement, recombinant DNA is currently performing a crucial function to promote the health conditions of wildlife species through the development of new vaccines and drugs, production of transgenic animals, prevention, control and diagnosis of diseases, improve wildlife habitat and decrease in ecological contamination. Subsequent research should be centered on the effectiveness of application of genetic engineering in recovery of extinct wildlife species.

Keywords: *wildlife species; DNA; recombinant DNA; vaccines and drugs; genetic engineering; wildlife health*

INTRODUCTION

Worldwide modification and loss of biological diversity has attracted attention of the international communities in recent time (IPBES, 2019; Hohenlohe *et al*., 2021). Wildlife species just like human are faced with three major challenges such as shortage in feeding items, health and ecological challenges. The health conditions and availability of feeding items are basic necessities of wildlife species apart from habitat free from pollution and predators (Khan *et al.*, 2016). Human activities have really affected the population and habitat of wildlife species through poaching, dam and road construction, agriculture, deforestation and emission of pollutants (Egwumah *et a*l., 2022). Other factors highlighted by Brand, (2013) are pollution, excessive use of wildlife species, habitat destruction, and introduction of exotic species coupled with climate change and diseases.

In order to understand the paramount factors influencing the decline and prospective extinction in wildlife species, information on morbidity and factors stimulating mortality of endangered species coupled with their comparative significance and effect on endangered populations becomes imperative, because it will enable wildlife managers to know the various factors limiting recovery of wildlife species in their natural habitat (Brand, 2013).

However, based on research findings infectious diseases have not often been measured as a prospective factor responsible for reduction in population of wildlife species, even to that status of endangered or extinction from history (MacPhee and Greenwood 2013; Brand, 2013).

In line with that, according to Smith *et al*. (2006) and Brand, (2013) extinction of about 25 (less than 4% of 724) flora and fauna species were connected to communicable diseases. Out of total of 2,852 wildlife species that were critically endangered, 223 (less than 8%) were identify to have communicable diseases as a key factor responsible for their endangered eminence, for examples; malaria (*Plasmodium relictum*) and pox in bird species were attributed for extermination of 16 endemic woodland birds and degenerations to endangered eminence of some other copious bird species in Hawaii. In recent time, diseases have gained more recognition as one of factors influencing decrease in population of wildlife species and extinction. Apart from that, it is also one of the factors inhibitions salvaging of endangered species (Brand, 2013).

However, several significant protected areas have been developed globally in recent decades due to growing appreciation of nature protection among the populace and government (Herzog, 2013). In Nigeria, ten new National parks have been established by the federal government across the country. This brings the total number of National parks in Nigeria, to seventeen (Anokwuru, 2020; Egwumah *et al*., 2022) and these protected areas are currently serving as habitat for wildlife species.

As a result, the long-term survival of a protected area is highly dependent on how man-wildlife interactions are handled. Apart from the conventional circumstance of wild creatures being a component of the protected area's goals, there are a few other possibilities to consider. So, just as the wildlife management concept can address the management of introduced and possibly invasive species, or large predators that cause crop or vegetation damage outside and inside the protected area, the wildlife management concept can also address the management of species that cause crop or vegetation damage inside the protected area (Herzog, 2013; Egwumah *et al*., 2022) coupled with other anthropogenic activities that might introduce heavy metals into wildlife habitat. Therefore, wildlife health facilities are substandard in most developing countries (Khan *et al*., 2016), even with broad efforts made by conservationist to protect wildlife habitat. Wildlife species are current facing food shortage due to habitat loss, habitat fragmentation and habitat degradation coupled with emission of environmental pollutants from industries and discharge of industrial wastes into natural water bodies. The aforementioned factor is currently increasing, thereby affecting wildlife species. However, using modern technology some of these problems can be addressed (Khan *et al.*, 2016), for example application of recombinant DNA.

The biochemical name for molecules that convey genetic directives in all wildlife species living in the environment are refers to as DNA. These molecules are made up of two strands that breeze all over each other to produce a framework branded as a double helix. If each of the strand is critically examined, it will reveal a backbone consisting of recurrent sugar (deoxyribose) and phosphate assemblages. There are four bases namely; adenine (A), cytosine (C), guanine (G), and thymine (T). However, one of the four bases are connected to every one of the sugars (Myasnikov, 2014). There is a bond binding the bases in between, for example; a bond exists between adenine and thymine and a bond also exist between cytosine and guanine. However, the arrangement of the bases alongside the backbones promotes accumulation of directives for molecules of protein and RNA in wildlife species.

In order to cut a gene which are DNA splinter, a prokaryotic or eukaryotic sample might be utilized (Kumar and Kumar, 2015). Limiting enzymes are used to abridge both the vector and the insert, coupled with purification of each of the splinter of concern after disconnection, or insertion (Joseph, 2021). Joining the decontaminated bits collected, requires a technique identified as ligation. The enzyme needed for ligation to take place is known as ligase, this enzyme serves as a catalyst that speed up the ligation reaction (Khattak *et al*., 2014). A solitary splinter of DNA can undergo isolation and expansion into a multitude of wildlife species to enable genetic engineers produce numerous copies that are identical. The process described above is known as molecular cloning, and it is a very powerful method that permits production of multifaceted mixtures of DNA splinters for most diverse medicating circumstance (Joseph, 2021). Therefore, almost all contemporary biomedical elementary investigation and translational applications relied on this technique (Joseph, 2021).

Modification in genomes of plant species is a product of any of the homologous recombination subject to the directives of the gene, or by nuclease- facilitated by location-explicit genome alterations, and oligonucleotide engaged in synthesis of genetic mutations can also be utilized (Khan *et al.,* 2016). A fragment of DNA fabricated from the mixture of any minimum of two strands is popularly known as recombinant DNA. Recombinant DNA can be obtained due to the fact that all wildlife species have DNA molecules. These DNA molecules contain identical chemical structure, but their nucleotide arrangement is not homogenous, in as much as the total assemblage are the same (Joseph, 2021). In other words, recombinant DNA molecules can be referred to as chimeric DNA. Similarly, using constituents from two diverse wildlife species such as mythical chimera, recombinant DNA can be fabricated. In terms of technology, palindromic classifications, resulting to synthesis of sticky and blunt ends adopted in R-DNA technology (Shinde *et al*., 2018). Therefore, this paper aims to give all-inclusive summary of the theoretical and experimental evidence provided in different literature to identify the tools of recombinant DNA technology, basics of recombinant DNA and the importance of rDNA coupled with their application in wildlife medicine.

Basics of Recombinant DNA

The short form of writing recombinant DNA is rDNA the "r" element stands for recombinant if elementary knowledge of DNA is put into consideration. DNA can be defined as the guardian of every data required to refabricate any living organism. Therefore, in wildlife management, DNA can be defined as the guardian of every data required to refabricate any wildlife species. Recombinant DNA (rDNA) molecules can be defined as DNA molecules fabricated from research laboratory techniques, which involves combination of genetic materials, for example molecular cloning which involves fetching genetic substances from diverse sources to establish a unique sequence that will not exist in the genome originally in any form (Shinde *et al*., 2018). DNA molecules are made up of two strands that breeze all over each other to produce a framework branded as a double helix. If each of the strand is critically examined, it will reveal a backbone consisting of recurrent sugar (deoxyribose) and phosphate assemblages. There are four bases namely; adenine (A), cytosine (C), guanine (G), and thymine (T) as discussed earlier.

However, one of four bases are connected to every one of the sugars (Myasnikov, 2014). There is a bond binding the bases in between, for example; a bond exists between adenine and thymine and a bond also exist between cytosine and guanine which were in line with our earlier discussion. However, the arrangement of the bases alongside the backbones promotes accumulation of directives for molecules of protein and RNA. Deoxyribose is the sugar utilized in DNA and in every wildlife species, the four nitrogen bases mentioned above are identical. However, diversity may exist due to the sequence and variation in number of bases. Wildlife species are not made by DNA, because DNA produces proteins only. The sequence involves in formation of Wildlife species may involve copying of the DNA into mRNA. Then mRNA is interpreted into protein substances, and finally the protein substances give birth to the wild animal. However, if modification of the DNA sequence in wild animals is permitted, the formation of the protein will be altered, resulting to production of either a dissimilar protein or a protein that is not active in wild life species (Minchin and Lodge, 2019).

Importance of Recombinant DNA in Wildlife Management

In recent time, recombinant DNA has gained some level of importance in wildlife medicine and as genetic diseases increase in wildlife species with reduction in wildlife populations (Dahm, 2008). In game ranching, genetic engineering can be adopted to bring in desirable characteristics into genome of animals, because the genes have ability to resist communicable diseases and increase their value in terms of nutrition. Apart from that, it also stimulates quick growth rate with respect to genes with fast growth hormone. In addition, it is necessary in vaccine production for some wildlife diseases such as fever and Newcastle disease in avian species (Temesgen, 2020). The residues from game ranching can be converted into organic fertilizers using bacteria that has been altered genetically. The organic fertilizer will then stimulate the growth of the plants in return. This technique enables farmers to produce wildlife species with desirable characteristics at a short period of time, because foraging items are made available at the lowest cost resulting to improved habitat management. In addition, high milk production could be obtained from this advancement to stimulate fostering of young ones.

In wildlife habitat management, production of green plants that are proficient in stabilizing nitrogen from the atmosphere, without the growth of the plant being promoted through the application of chemical or organic fertilizers may promote better habitat management for wildlife species, because the level of pollution in such habitat may be less especially for wildlife species that utilizes farmland as foraging site or home range. Through the aid of genetic engineering, some green plants are developed to have the ability to produce toxic substance for insects and worms. Nevertheless, this will improve the quality of foliage available to wildlife species, but it might reduce the diversity of insects and worms in such habitat. Genetic engineering also increases the ability of green plants to increases their ability to resist diseases, moisture and heat coupled with reduction in fertilizer requirement (Shinde *et al*., 2018).

With increase in anthropogenic activities production of green plants that are resistant to weed pesticides may reduce the mortality rates of plants, but may not improve the quality of habitat available and utilized by wildlife species with respect to environmental pollution. Conversely, some microorganisms with unique ability to investigate toxic substances, can be adopted to eradicate insect pests and organisms that are capable of causing diseases in wildlife species. Genetic engineering can also improve plant's ability to photosynthesize and can be adopted to address indiscriminate felling of trees and atmospheric pollution, through development of bacteria with unique ability to analyze waste products. In bioremediation, bacteria can be used to remove crude oil and petroleum products from wildlife habitat through the aid of biotechnology. The bacteria have ability to break down crude oil and petroleum products into fragments, and the fragments are consumed by the bacteria. Thereby reducing the rate of pollution in wildlife habitats (Jez *et al*., 2016).

Tools for Recombinant DNA Technology

In recombinant DNA technology, the common tools utilized in genetic engineering are; enzymes (with restriction enzymes inclusive), vectors and host organism.

1. **The enzymes (with restriction enzymes inclusive)**: This enzyme enhances cutting, the polymerases- enhances synthesis, and whereas binding of the protein molecules are stimulated by the enzyme's ligases. The spot at which the desirable genes are inserted into the vector genome is determine by the restriction enzymes. Therefore, in recombinant DNA advancement, restriction enzymes are very essential (Mukta, 2021). These enzymes are divided into two namely; endonucleases and exonucleases. In the endonucleases, cutting is carried out within the DNA strand, whereas removal of the nucleotides at the base of the strands is carried out by the exonucleases. In terms of sequence-specific, the restriction endonucleases are known for that, and they occur in palindrome sequences, cutting the DNA at precise spots (Shinde *et al*., 2018). They equally examine how long the DNA strand is, and a cut is made at a particular spot known as the restraint site, resulting to sticky ends in the structure. This similar restriction enzymes is also responsible for cutting of the desirable genes and the vectors, in order to acquire corresponding sticky notes, which in turn makes the work of the ligases very fast and easy with respect to binding desirable genes to vectors.

2. **The vectors:** In terms of conveying and incorporating genes of desirable characteristics in wildlife genetic engineering, vectors are very essential. Therefore, it is an essential component of genetic engineering and one of the paramount tools of recombinant DNA advancement. This is because vectors serve as critical automobiles that convey desirable genes into organism that serves as host (Khan *et al*., 2016). In recombinant DNA advancement, the common vectors associated with rDNA technology are plasmids and bacteriophages. The aforementioned vectors are used in rDNA technology, because they have very high copy number. Theses victors comprises of the source of replication. The sequence of nucleotide commences from replication. A marker that is selectable makes up the genes, which usually demonstrate some resistance to convinced antibiotics such as ampicillin, and the cloning locations refers to the sites acknowledged by limiting enzymes where desirable DNAs are introduced (Shinde *et al*., 2018).

3. **Host organism**: This where recombinant DNA is presented, making it a crucial apparatus of recombinant DNA advancement which embraces the vector plotted around desirable DNA characteristics through support from the enzymes (Khan *et al*., 2016). In the course of inserting recombinant DNAs into the host, four steps are required namely; microinjection, biolistic or gene gun, alternate cooling and heating, use of calcium ions, etc. However, steps in recombinant DNA advancement as cited by Khan *et al*. (2016) are;

i. Choice and segregation of DNA insert
ii. Choice of appropriate cloning vector
iii. Bring together DNA-insert into vector to form rec DNA molecule
iv. Bring together rec DNA molecule into choice of appropriate host
v. Choice of altered host cells
vi. Appearance and duplication of DNA-insert in the host

Choice and segregation of DNA insert: Choice of DNA fragment of concern is the first and foremost step in rec DNA advancement. The selection of desirable DNA fragment of concern which could be refers to as cloned is the first step. The desirable DNA fragment is segregated enzymatically. The selected DNA fragment of concern is known as the DNA insert or exotic DNA or marked DNA or cloned DNA (Griffiths *et al*., 2000). In wildlife genetic engineering, this the first step in animal cloning because the wildlife species with desirable characteristic is selected and the DNA fragment is segregated enzymatically.

Choice of appropriate cloning vector: Any DNA molecule that are capable replicating itself could be considered as a good cloning vector, therefore DNA insert can be incorporated. In any rec DNA advancement, an appropriate cloning vector is usually nominated, and excellent examples of common vectors adopted in rec DNA technical know-how are plasmids and bacteriophages (Lodish *et al*., 2000). Any of the aforementioned vectors can be adopted especially in a population of wildlife species that is threatened, where genetic difference must have been lost in already existing populations but the remnants (Hohenlohe *et al*., 2021) could be found in the museum or directly harvested from the field where old samples were collected. These samples could be analyzed for low-quality DNA into the genetic history to established opportunity for new conservation initiatives (Bi *et al*., 2013; van der Valk *et al*., 2019; Hohenlohe *et al*., 2021).

Bring together DNA-insert into vector to form rec DNA molecule: The desirable DNA or DNA insert already taken out, and chopped enzymatically through the aid of careful restriction endonuclease enzymes are combined to a vector through the aid of enzyme ligase to produce rec DNA molecule. This rec DNA molecule are often described as cloning-vector-insert DNA construct (Wil *et al*., 2014).

Bring together recombinant DNA molecule into choice of appropriate host: In recombinant DNA advancement, a choice of appropriate host cells is very essential coupled with the rec DNA molecule produced. This is the process of bring together rec DNA molecule into their host cells, and the process could best be described as transformation. Bacterial cells such as E. coli are known for their popular demand as host for rec DNA advancement, but with rapid growth in the field of genetic engineering yeast and fungi may be adopted as host as well (Shinde *et al*., 2018).

Choice of altered host cells: Any host cell engaged by recombinant DNA molecule could be described as altered cells or recombinant cells and altered cells are segregated from cells that are yet to be altered by using marker genes to identify individual cells (Shinde *et al*., 2018).

Appearance and duplication of DNA-insert in the host: This is the final stage to determine whether exotic DNA introduced into the vector DNA manages to express the desirable characteristics within the host cells. Apart from that, the altered host cells are reproduced in order to acquire satisfactory number of copies needed for continuous propagation. If necessary, the desirable genes could be transmitted and expressed in other wildlife species (Shinde *et al*., 2018).

Application of Recombinant DNA in Wildlife Management

In terms of wildlife health, advancement in recombinant DNA is currently performing a crucial function to upgrade the health conditions of wildlife species through the development of new vaccines and drugs. More kits that are used in investigating and observing wildlife health conditions has been developed coupled with the advancement of new therapeutic methods (Khan *et al.*, 2016). In wildlife conservation, several areas where recombination DNA is applicable in wildlife health and habitat management are;

1. **Production of Transgenic Animals:** Transgenic wildlife species can be produced through the application of rec DNA advancement where desirable genes are introduced into wild animals. Application of rec DNA advancement stimulate quickly and variety of selective breeding in wild animals, especially in wildlife ranching and game farming where emphasis is on profit making. Animals with better performance are produce (Shinde *et al*., 2018). Similarly, transgenic can also be used in animals to synthesize protein and drugs, basically for profit making and transgenic wildlife species can be used to research on the roles of genes in diverse wildlife species. In animal husbandry, biotechnologists have productively fabricated transgenic cattle, pigs, rats and sheep. These animals has been improved upon for their economic value such as rapid growth rate, high quality of meat and milk, high resistance to diseases and low mortality. In sheep, improve wool production is also an added value (Lai *et al.*, 2006).
   However, the first wildlife species to be created from transgenic process was a mouse in 1974 by Rudolf Jaenisch by bring together exotic DNA into its embryo (Jaenisch and Mintz, 1974). This was the genesis of transgenic in animals.
   In *myxoma virus*, genetic alteration was projected in order to protect European wild rabbits in the lberian peninsula to stimulate adequate control in Australia. To ensure this particular wildlife species in lberian is free from viral diseases, the genes from *myxoma virus* were altered and the modified genes, were used to immunize the rabbits. Similarly, in Australia the aforementioned virus was equally

altered genetically to lower fertility in rabbit population (Angulo and Cooke, 2002). From all indication, it seems genetic engineering might be alternative solution to bring wildlife species back from extinction since genome can be modify to look like that of close relatives of extinct one. Though, this perception was experimented in passenger pigeon and woolly mammoth (David, 2018).

2. **Prevention, Control and Diagnosis of Diseases:** Application of genetic engineering skills and practices over the years, has been able to address some of the challenges related to conservative approaches adopted for disease diagnosis. In addition, a better approach for prevention of diseases is made available for different diseases in human, farm animals and wildlife species. The most valuable tools, utilized for disease diagnosis is monoclonal antibodies. Hybridoma technology is usually adopted in synthesis of monoclonal antibodies (Tabll *et al*., 2015). *B. abortus* is a global, pathogenic species which are notorious for causing bovine brucellosis; *B. melitensis*, the foremost etiologic agent associated with ovine and caprine brucellosis; and *B. suis,* which is also linked brucellosis in pigs. The aforementioned *Brucella* species are responsible for establishment of abortion in livestock. In wildlife and livestock, it is multifaceted to carry out diagnosis of brucellosis coupled with the care required with respect to serological analysis of the results. In order to establish regulatory programs for livestock such as minor ruminants and cattle, the *B. melitensis* Rev. 1 and *B. abortus* S19 vaccines should be considered as the fundamentals respectively. However, there is absence of vaccine for some animals such as pigs or wildlife species with respect to brucellosis. Therefore, due to lack of brucellosis vaccine for man, preventing brucellosis in human, is a function of the rate of regulation of the aforementioned diseases in livestock and wild animals (Godfroid *et al*., 2010).

   In recent time, recombinant DNA has gained some level of importance in wildlife medicine and as genetic diseases increase in wildlife species with reduction in wildlife population (Dahm, 2008). In game ranching, genetic engineering can be adopted to bring in desirable characteristics into genome of animals because the genes have ability to resist communicable diseases and increase their value in terms of nutrition. Apart from that it also stimulates quick growth rate with respect to genes with fast growth hormone. In addition, it is necessary in vaccine production for some wildlife diseases such as fever and Newcastle disease in avian species (Temesgen, 2020).

3. **Improve Wildlife Habitat**

   The residues from game ranching can be converted into organic fertilizers using bacteria that has been altered genetically. This technique enables farmers to produce wildlife species with desirable characteristics at a short period of time and foraging plants are made available at the lowest cost resulting to improved habitat management. In addition, high milk production could be obtained from this advancement to stimulate fostering of young ones. In wildlife habitat management, production of green plants that are proficient in stabilizing nitrogen from the atmosphere, without the growth of the plant being promoted through the application of chemical or organic fertilizers may promote better habitat management for wildlife species, because the level of pollution in such habitat may be less especially for wildlife species that utilizes farmland as foraging site or home range. Through the aid of genetic engineering, some green plants are developed to have the ability to produce toxic substance for insects and worms. However, this can also improve the quality of foliage available to wildlife species, but it might reduce the diversity of insects and worms in such habitat. Genetic engineering also increases the ability of green to increases their ability to resist diseases, moisture, and heat coupled with reduction in fertilizer requirement (Shinde *et al*., 2018).

4. **Decrease in Ecological Contamination**

   With increase in anthropogenic activities production of green plants that are resistant to weed pesticides may reduce the mortality rates of plants but may not improve the quality of habitat available to wildlife species with respect to environmental pollution. However, some microorganisms that can investigate toxic substances can be adopted to eradicate insect pests and organisms that are capable of causing diseases in wildlife species. In bioremediation, bacteria can be used to remove crude oil petroleum products from wildlife habitat through the aid of biotechnology. The bacteria have ability to break down crude oil and petroleum products into fragments, and the fragments are consumed by the bacteria. Thereby reducing the rate of pollution in wildlife habitats (Jez *et al*., 2016).

In game ranching, livestock are integrated into wild animals. However, some of the livestock are notorious for releasing toxic substances into their habitat. A common example of the toxic substances is phosphate. Omnivorous farm animals lack the ability to digest foraging items that are rich in phosphate compound and phytic acid, but these substances are certainly present in wild plants. Phytic acid that are turn down by pigs are breaking down by soil bacteria, resulting to unnecessary emission of phosphate in wildlife habitat. However, if bacteria phytase genes are transmitted to pigs, it will enable the said species to digest huge quantity of phytic acid. The growth and development can be promoted through secretion of phytase in the saliva of wildlife species (Louis-Marie, 2014).

5. **Increase in Photosynthesis in Green Plants**
Genetic engineering can also improve plant's ability photosynthesize and can be adopted to address indiscriminate felling of trees and atmospheric pollution through development of bacteria with unique ability to analyze waste products. In bioremediation, bacteria can be used to remove crude oil and petroleum products from wildlife habitat through the aid of biotechnology. The bacteria have ability to break down crude oil and petroleum products into fragments, and the fragments are consumed by the bacteria. Thereby reducing the rate of pollution in wildlife habitats (Jez *et al*., 2016).

6. **Production of Hormones:** In production of hormones application of recombinant DNA advancement is very essential thereby resulting to the adoption of cells from bacterial to manufacture diverse unique chemical substances, for example *E. coli* cells can be used to produce insulin, somatostatin, somatotropin and pendorphin in human medicine (Khan *et al.*, 2016). However, the clinical trials were usually carried out in animals, and it has been proven to be successful. In a situation where wildlife species are faced with similar hormonal problems, the aforementioned recombinant DNA technology could be adopted or developed further basically for optimal wildlife management.

7. **Manufacturing of Vaccines:** One of the valuable ways of controlling wildlife diseases is through the production of vaccines. The level of effectiveness vaccines is a function of how it is dispensed to a larger population of wildlife species. Any chemical formulation made up of pathogen that are weakened or not active in nature, but may be dispense to consult their immunity to disease causing organisms can best be describe as vaccine. Numerous vaccines are produced biologically through the advancement of rec DNA to promote regulation of diseases, vaccines can be adopted to address a number of wildlife species that are susceptible or infectious to a particular disease. Examples of wildlife diseases controlled using vaccination are; red foxes (*Vulpes vulpes*) oral vaccine in eradication of rabies and wild boar for eradication of swine fever (Freya *et al*., 2020). Over the years, production of vaccines for wildlife species have undergone some level of advancement, and the aforementioned method has been used for treating different infectious diseases in wild animals using a research work containing gene encoding of an immunogenic protein basically from pathogen of interest (Shinde *et al*., 2018).

8. Biosynthesis of Interferon: Glycoproteins which are generated in very infinitesimal quantities through activities of cells infected by virus, could best be described as Interferon and they are notorious for their ability to fight virus and even cancer (Friedman, 2008; Shinde *et al*., 2018). Genetically, cloning and culturing of bacteria, can bring about expression of genes, resulting to increase production of the interferon. However, extraction and purification of this interferon will be the next line of action (Shinde *et al*., 2018).

9. Production of Antibiotics: Genetic engineering enhances manufacturing of antibiotics using microorganisms. These antibiotics are very operational when in contact with diverse viral, bacterial or protozoan disease-causing organisms, for example bacitracin, tetracyclin, streptomycin, penicillin and novobiocin to mention but a few. Application of recombinant DNA advancement brings about a rise in manufacturing of antibiotics, thereby resulting to improved microbial strains due alteration in genetic features (Labro, 2000).

10. Production of Commercially Important Chemicals: Different vital chemicals that are marketable in wildlife conservation are usually produce at easy and more proficiently with the help of rec DNA technology, for example vitamins manufacture from microorganisms (Vitorino and Bessa, 2017).

11. Application in Enzyme Engineering: Genetic engineering is very essential in modification of enzymes because they are prearranged by genes, once there is variation in genes, it will equally bring out a variation in the enzyme structure. The same principle is utilized by enzyme engineer to alter the enzyme structure by introducing enzyme modifiers into the genes which are coded for a specific enzyme (Homaei *et al.*, 2013).

12. **Gene Therapy:** One of the indisputably areas that is highly valuable in genetic engineering is gene therapy, which require the distribution of genes into animal's body to rectify diseases. Therefore, normal cellular activities are restore using gene transfer as alternative form of treatment (McCain, 2005). Through gene therapy, some researchers are hopeful that this new advancement in genetic engineering, if adopted could save endangered species and eradicated invasive species to stimulate proper conservation of wildlife species. Gene editing, if adopted could also save endangered species and eradicated invasive species to stimulate proper conservation of wildlife species, but there could be some disadvantages along the line.

13. **Practical Applications of Genetic Engineering:** In genetic engineering recombinant DNA advancement has been adopted to study wildlife species and it has been applied in restricting precise genes, DNA material sequencing, gene control mechanism, molecular investigation of diverse diseases and DNA mutation (Khan *et al*., 2016).

CONCLUSION AND RECOMMENDATIONS

In game ranching, genetic engineering can be adopted to bring in desirable characteristics into genome of animals because the genes have ability to resist communicable diseases and increase their value in terms of nutrition, quick growth, vaccine production, converting residues from game ranching into organic fertilizers to make foraging plants available at the lowest cost resulting to improved habitat management. In recombinant DNA technology, the common tools utilized in genetic engineering are; enzymes (with restriction enzymes inclusive), vectors and host organism. In terms of wildlife health advancement, recombinant DNA is currently performing a crucial function to promote the health conditions of wildlife species through the development of new vaccines and drugs, production of transgenic animals, prevention, control and diagnosis of diseases, improve wildlife habitat and decrease in ecological contamination. Subsequent research should be centered on the effectiveness and challenges of application of genetic engineering in recovery of extinct wildlife species to enable wildlife managers adopt recombinant DNA technology holistically.

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