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Design of Genetic Mapping System for the White Nest Swallow on the Island of Java

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Abstract - The distribution of the white swift (Collocalia fuciphaga) is on several large islands in Indonesia. The white swallow has an advantage over the nests of the black swallow and sriti, having edible parts reaching 85-100% of the total nest. Many types of white swallow's nests in Indonesia are known for their different physical characteristics, color and weight. It is not known that these differences occur due to genetic differences or simply due to differences in the type of food and living environment. Differences due to food and environmental factors do not really affect the health function of the nest. Differences due to genetics greatly influence the function of the nest for health. The design of this system is initial research to start mapping white nest swiftlets in Indonesia. The results of the design will be used as a data storage system for genetic mapping of white nest swallows on the island of Java by taking DNA samples of swallows from various habitat areas. The system will store data on habitat areas, record location points and take bird samples from these areas to then carry out laboratory tests to determine the DNA code test of each bird sample. Furthermore, it is hoped that clear genetic mapping results can be used to determine the quality and function of the bioactive components of white swift nests on the island of Java. The mapping results will also be a source of knowledge about the richness of the germplasm of native Indonesian swiftlets.

Keywords: GIS, Bioactive, genetic, Java, mapping, white swallow's nest

1. INTRODUCTION

Swiftlet nests from several species of swiftlets (Collocalia spp) are made from the saliva secreted by the salivary glands of male swiftlets during the breeding season and nesting season. Male swifts make nests with their saliva for 35 days[1]. The male swallow's saliva hardens after drying and forms a half bowl that sticks to the wall. Swiftlet nests can be processed so they can be consumed by humans. This nest is considered to have high nutrition, some of the nutritional content in it is protein, calcium, potassium and minerals[2]. Swallow's nest nutrition has been proven to be useful as an influenza antiviral, increases stem cells and functions to reduce the risk of chemotherapy[3]. Therefore, swallow's nests have become one of the main export commodities in Indonesia. Indonesia meets 80% of the world's need for swiftlet nests.

The many types of white swift's nests are known for their different physical

characteristics, color and nest weight, raising new questions for researchers as to whether these differences occur due to genetic differences or simply due to differences in the type of food and living environment. Differences due to food and environmental factors do not really affect the health function of the nest. Meanwhile, differences due to genetics will greatly influence the function of the nest for health[4].

Based on the results of research on the use of keratinase to maintain the pre-washing glycoprotein profile of edible swallow's nest, it can be concluded that there is no difference in the glycoprotein profile before and after washing with keratinase using FTIR and NMR analysis. This means that the keratinase enzyme is effective in maintaining the glycoprotein profile in swiftlet nests. With these considerations in mind, the white swift's nest was chosen as the focus of the research because it has the highest glycoprotein and has the best quality and the largest number of edible parts in one nest, namely in the range of 85-90%[5]. There has been no research that has studied the genetic differences in swallows spread across various places in Indonesia, especially Java Island. Clear genetic mapping data is needed from the white swift's nest, which is the public's favorite because of its quality and price. It is hoped that the results of clear genetic mapping can be used to determine the quality and health function of the bioactive components of swallow nests on the island of Java. Differences in the DNA of swallows that produce swallow nests greatly influence differences in the chemical composition of the bioactive components of the nest. These differences greatly influence its health benefits. The results of mapping using GIS (Geographic Information System) will also be a source of knowledge about the richness of the germplasm of native Indonesian swiftlets.

Based on the explanation above, it is concluded that clarity is needed regarding the mapping of swallows in Indonesia. Meanwhile, the genetic mapping of white-nested swifts in Indonesia is not yet known and much research is still needed. It is hoped that the results of clear genetic mapping can be used to determine the quality and health function of the bioactive components of swallow nests on the island of Java. With clear mapping, differences in the chemical composition of the bioactive components of swallow nests from different swallow locations can be seen. The next hope is that, with clear knowledge and a good level of confidence regarding the differences in the chemical composition of the bioactive components of swallow nests from different habitats, there will be further research regarding their health benefits.

2. RESEARCH METHOD

2.1 Literature Review

2.1.1 Genetic Mapping

Genetic mapping is an attempt to determine the locus or position of a gene/genetic marker relative to other genes or genetic markers. The results obtained are a sequence of positions of a number of loci in another group (linkage group). Other groups can be considered as members of a chromosome. Genetic mapping is an important stage in genomics. Genome comparisons in various types of organisms can be carried out and the results can be used in forensics, agriculture, medicine and anthropology. There are two methods of implementing genetic mapping, namely: linkage mapping and physical mapping.

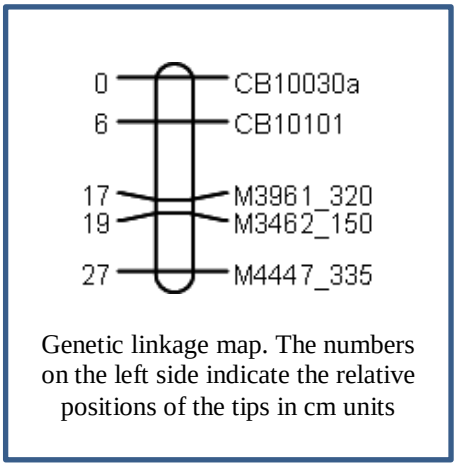

Figure 1. Genetic Linkage Map

2.1.2 White Nest Swallow

Swallow's nests are one of the main export commodities in Indonesia. Indonesia meets 80% of the world's need for swiftlet nests. One of the main consumers of swallow's nests produced in Indonesia is China. China consumes almost 60% of the world's bird's nest market. China, as the world's largest consumer of swallow's nests, wants swallow's nests that are of good quality and safe to eat[4].

Swallow's nests have many benefits and are widely used in the health industry and food industry. White swallow's nest (Collocalia fuciphaga) has long been known to be consumed by people, especially in China around 1500 years ago as a special food to increase stamina. In terms of nutritional content, the main components of swallow's nest are water-soluble proteins, carbohydrates, fats, elements such as calcium, phosphorus, iron, sodium and potassium and amino acids play an important role in increasing body stamina. Glyconutrients found in swallow's nest include 9% sialic acid, 7.2% Nacetylgalactosamine (galNAc), 5.3% Nacetylglucosamine (glcNAc), 16.9% galactose and 0.7% fructose. 1.5 Sialic acid has an effect in the secretion of mucus which can fend off bacteria, viruses and other dangerous microbes. Sialic acid also has an effect on reducing Low Density Lipoprotein (LDL), preventing strains A and B of influenza viruses, increasing fertility and regulating blood coagulation. Swallow's nest contains Epidermal Growth Factor (EGF) which can increase body resistance and cell proliferation. With the many benefits produced by swiftlet nests, the world's need for swiftlet nests will increase, so swiftlet breeders must start to increase their productivity. In order to meet these needs, it is necessary to increase the quality and quantity of swiftlet nests. The quality and quantity of swiftlet nests can be maintained with continuous food availability[6].

Bird's nest extract contains essential bioactive compounds, such as glycoproteins, which are important for health. Before consumption, the swallow's nest is harvested and washed. The washing process used for swiftlet nests is to use water to soak the nest to soften and clean it of bird feathers and dirt. However, this process can dissolve glycoproteins, the main bioactive compounds, present in the nest. The protein and glycoprotein content was found only in water protein extracted from white swallow's nests, this was influenced by differences in the type of food and metabolism from the nests of seriti and black swallow's nests. Based on the results of research on the use of keratinase to maintain the pre-washing glycoprotein profile of edible swallow's nest, it can be concluded that there is no difference in the glycoprotein profile before and after washing with keratinase using FTIR and NMR analysis. This means that the keratinase enzyme is effective in maintaining the glycoprotein profile in swiftlet nests[7,8,9].

2.1.3 Geografis Information System (GIS)

A Geographic Information System (GIS) is a computer system used to enter, store, check, integrate, manipulate, analyze and display data related to locations on the earth's surface. GIS is a special system for processing data bases that contain geographic reference data and spatial information. Geographic Information System comes from a combination of 3 words[10]: System, Information, and Geographic. From these three, it can be understood that a Geographic Information System is the use of a system containing information about the condition of the Earth from a spatial perspective. GIS input data is mostly obtained from remote sensing imagery. All of this information is processed using a computer which can then be combined into the desired information. So in short, GIS is a system that functions to collect, manage, store and present all data related to the geographical conditions of an area[11].

2.2 System Planning

The planning for genetic mapping of the White Nest Swallow is part of a planned multi-year research series. This research design has been prepared in the form of an article, which has been authorized: EC00202145949, 10 September 2021. This research design was carried out with reference to previous research on the use of GIS, in the research entitled Web-Based Geographic Information System for Mapping Livestock Animal Populations in South Sumatra [12]. Apart from that, genetic mapping of rabies virus in dogs as a basis for determining disease control (Genetic Mapping of Rabies Virus in Dogs as a basis for disease control)[13].

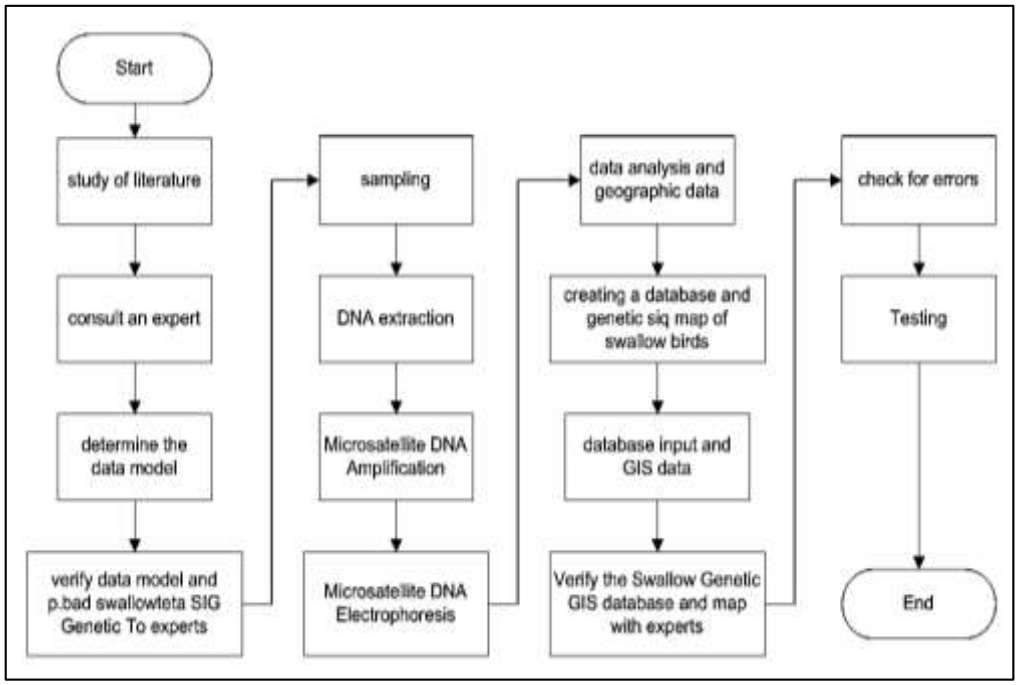

Fig. 2. Flowchart of Genetic Mapping Research of the White Nest Swallow (Collocalia Fuciphaga) in Java Island

Designing genetic mapping of white nest swiftlets (Collocalia fuciphaga) on the island of Java requires structured and systematic planning, because this research is basic research that can be developed into several subsequent studies. The research design used is in accordance with Figure 2, including activity planning as follows:

1. Study reference books, articles, or data related to research. Literature studies aim to enable researchers to find out about previous research and record everything that can support this research.
2. Important things obtained from the literature study, then consulted with experts in the genetics of the white nest swallow (Collocalia fuciphaga) with the aim of determining the important things that are truly needed and can be implemented for the development of research related to the genetics of the nest swallow. white on the island of Java.
3. Determining the data model is determining the most appropriate table model and GIS (Geographic Information System) model as well as the fields and applications used.
4. Sampling of birds (Collocalia fuciphaga) was carried out at the breeder's house, one of the collaborations with swallow nest breeders in the city of Banyuwangi, namely UD Sakinah, then bird samples from several cities in each province on the island of Java, aiming to represent the areas of origin and Geographical location of the white nest swallow on the island of Java.
5. DNA extraction from bird blood samples will use DNEasy (DNA extraction kit) from Qiagen. The DNA extraction protocol or work steps follow the work steps/protocol provided by DNEasy, namely using the Spin Column Method.
6. The amplification process for microsatellite DNA requires a reaction volume of 25 µl, containing 2x Type-it Multiplex PCR Master Mix; 10x primer mix 2µM of each primer (Aef 27, Aef 104, Aef 133) labeled with FAM, HEX and TET (Table 3); Q-Solution (used during multiplex PCR), RNase free water; and DNA templates. The reaction mixture is carried out slowly into the PCR tube. The DNA template is added last to the PCR tube. The DNA sample amplification process uses a Veriti Thermal Cycler from Applied Biosystem. Cycling conditions followed the Type-it Multiplex PCR Master Mix protocol.
7. Microsatellite electrophoresis using ultrapure agarose gel (Invitrogen) with a concentration of 2.5% at 1X TBE. Electrophoresis was performed at 100 volts for 90 minutes.
8. Data analysis is a very vital stage, because at this stage there is a process of changing non-digital data into digital data. This digital data must be used in several databases. So that the data can actually be used, a text processing process needs to be carried out.
9. Data input is the stage of entering data that has been obtained and analyzed into a planned database.
10. Verification with experts is included in black box testing, where testing is carried out by internal researchers. The purpose of this test is that if an error occurs in creating data and GIS, researchers can immediately correct it.
11. If the error in this research is stated as 0%. Trials can be carried out at the next stage, namely testing on data users.
12. White box trials were carried out on users of this data, namely researchers, students or swiftlet breeders.

3. RESULTS AND DISCUSSION

In the initial stages of planning the genetic mapping system for White-nested Swallows, the research team created a research plan for White-nested Swallows throughout Indonesia. Due to the large amount of data that needed to be ascertained and the research needs that had to be carried out, it was decided to carry out mapping steps on the island of Java first. The design of the genetic mapping system for White Nest Swallows on the island of Java was made in the form of a web-based system design and Geographic Information System (GIS). The planned system will display the live habitat points of the White Nest Swallow on the island of Java. The

system will provide information on location points and profiles of areas where birds live. And then the system will provide DNA code information from bird samples from various regions on the island of Java. Following are the results of the system design made in this study:

a. Research data

1. Input the Data
   The input data needed in the planned research are:
   a) Data on several samples of the white-nest swiftlet living habitat area on the island of Java that has been determined, namely the area on the south coast of Java Island.
   b) Latitude and longitude point data of habitat areas
   c) Bird blood samples from each predetermined area.
2. Description of Activities
   The stages of the activities carried out in the planned research are in accordance with the sequence of activities in Figure 2.
3. Results Data
   As explained in Figure 2, the planned yield data are DNA code data from each swallow sample from areas/habitats on the island of Java. The bird DNA code was obtained by carrying out the DNA extraction process from bird blood samples using the DNEasy (DNA kit extraction) from Qiagen. The protocol or work step for DNA extraction follows the work step/protocol provided by DNEasy, namely using the Spin Column Method.

b. System Architecture Design

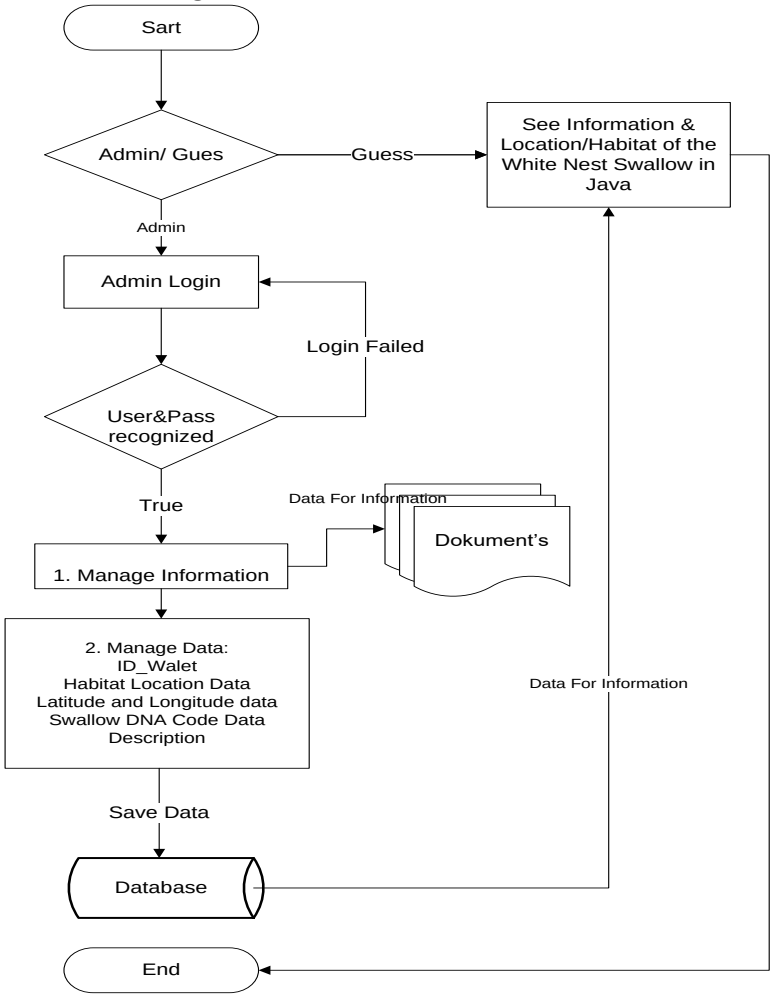

Fig. 3. Flowchart of the White Nest Swallow Genetic Mapping System in Java Island.

The system created for genetic mapping of the white nest swiftlet on the island of Java is planned to be website-based, so it is planned that the system will be accessible via the web. The system flow that is made runs according to the system flowchart in Figure 2 above. At the beginning of the system it applies to system administrators, in this case the research team. As an administrator who will manage the system, you must have clear access rights, you must enter through the system login. After the login is recognized, the user can manage the system, in this case inputting data, updating or deleting data and information in the system. Whereas system users who are guests (not admins) can only view information and access the search facility for the location of the white nest swiftlet habitat on the island of Java.

c. Data Table Structure

The data table created in this system is a table that is used to store the results of recording data on the DNA code of bird nests obtained from several bird nests originating from the habitat areas of the white nest swallow bird on the island of Java.

Table 1. Data Structure of DNA Sample Data

No.	Field	Description
1	ID_Bird	Nest sample identity number
2	Habitat	Location of Bird Habitat
3	Latitude	Point Latitut Location
4	Longitude	Ponit Longitude of the Location
5	Photo	Locations Dokumentations Picture
6	Code_DNA	Nest DNA code
7	Description	Description

d. Interface Design

This white nest wallet bird mapping system is made with a main page and an administrator page which contains several information/data presentation pages and a data management page for administrators, including:

1) Main Page

Fig. 4. Main Page of System

This view is the main page of the white nest swiftlet mapping system on the island of Java. This page contains system profile and general information about the White Nest Swallow in Java. On this page the user can get clearer information by clicking "Read More", and the system will provide various information about the white nest swallow and its habitat areas on the island of Java.

Fig. 5. About Information Page White Nest Swallow

Furthermore, on the main page the user can search for data on the location of the white nest swiftlet on the island of Java, as shown in Figure 6 below:

Fig. 6. Swallow Population Location Search Page

On the main page we can search for the location of the white swallow's nest, with categories and keywords, as well as the population in the location. The process of searching for the location / area of life of swiftlets will display the following results:

Fig. 7. Details of Habitat Location Search Results

2) Administrators Page

On this administrator page, which in this case is the research team, the first activity on the system is system login. The admin who enters and manages the system must have clear access rights and be responsible for the system and information. This is done to maintain the validity of the information in the system.

Fig. 8. Admin Login Page

After the admin login is recognized, then the user can manage data in the system, namely: input, update and delete data, as well as update information in the system.

Fig. 9. Form for New Data Input

The next admin page is the swallow data update page. This page is to view the data that has been input on the system. On this page you can also search data, edit data and delete data.

Fig. 10. Page Data View

In addition to the data view page, there is also a data update page, where the admin can update data, for example if there is new data and the development of swallows in habitat areas.

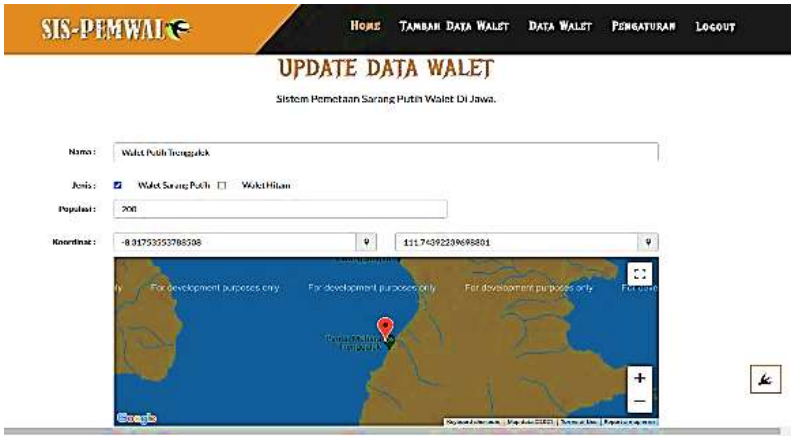

Fig. 11. Page_Data Update

Utilization of geographic information systems (GIS) in the design of this system has been tested, and can function properly according to the pictures above. The system is ready to use. The next step in realizing the genetic mapping research of the white nest swiftlet, is simply to record the bird's DNA code from the sample collection. The bird's DNA code is obtained by carrying out the DNA extraction process from a bird's blood sample using DNEasy (DNA kit extraction) from Qiagen. The protocol or work step for DNA extraction follows the work step/protocol provided by DNEasy, namely using the Spin Column Method.

4. CONCLUSION

From the preliminary exposure and the series of system design stages made in this study, the following conclusions can be drawn:

1. A Genetic Mapping System Design for the White Nest Swallow (Collocalia Fuciphaga) has been successfully created in Java with a Geographic Information System (GIS). The planned system is website-based and can be accessed online.
2. The planned genetic mapping research activities have been determined in accordance with the steps described in Figure 1, namely the flowchart of research on genetic mapping of the white nest swiftlet (Collocalia fuciphaga) in Java).
3. Sampling Plan The bird DNA code was obtained by carrying out the DNA extraction process from bird blood samples using the DNEasy (DNA kit extraction) from Qiagen. The protocol or work step for DNA extraction follows the work step/protocol provided by DNEasy, namely using the Spin Column Method.
4. Based on the results of the trial design of the system, the geographic information system (GIS) can function properly by showing the detailed position of the marked area and is the habitat of the white nest swiftlet, which means the system design is ready for use.

5. REFFERENCE

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