# COLOR INDEX DEVELOPMENT OF NAGOYA COCHIN EGGSHELL

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## ABSTRACT

The eggshell surface of a hen named the Nagoya breed (commonly known as Nagoya Cochin) has a unique color, which is one of the reasons for its attractiveness. The purpose of this study was to survey an attractive color range and develop a color visualisation system for eggshells of Nagoya Cochin to manage their visual quality. These results will be useful for agricultural producers to maintain traditional breeds and improve their commercial value. As the first experiment to determine the appropriate color range of Nagoya Cochin eggs, the eggshell color of 60 eggs was measured, and the visual quality of each egg was evaluated using the eggshell photo image by 14 visual inspection experts of the Aichi Agricultural Research Center. They scored the attractiveness of Nagoya Cochin's eggshell color on a five-point Likert scale in five steps, and the relationship between colorimetric data and color attractiveness score was determined in the color space. Second, color variations of eggshells were generated based on the actual image of the egg, and the visual qualities of 315 egg images were scored quantitatively by seven experts. Although the actual eggs differed individually in size and shape, in this experiment, they were standardised and only the visual quality of color was examined. From the results of the two experiments, the color range of the attractive eggshells of Nagoya Cochin was determined using the Hunter LAB color space. Finally, a prototype system to visualise the quality of eggshell color was developed, and the color quality was confirmed as reddish or yellowish using colorimetric data from the CM-700d spectrophotometer (Konica Minolta). After testing the system in the field, several functions that required improvement were identified, and the graphical user interface was modified. This system is expected to be a useful and practical tool for agricultural producers to continue traditional breeding to obtain regional products.

**Keywords**: Eggshell, Nagoya Cochin, Color attractiveness, Visualization, Prototype system

## INTRODUCTION

The Nagoya breed (commonly known as Nagoya Cochin) is one of the most famous chicken breeds and was the first domestic commercial chicken in Japan. It is a traditional breed with a long history since 1868 that cannot be mass-produced. Chicken meat and eggs of Nagoya Cochin are more expensive than those of other popular breeds. The eggshell surface of the Nagoya Cochin has a unique visual characteristic called "Sakura Fubuki" because of its cherry blossom colored body with white speckles (Figure 1), which helps maintain its brand power. However, numerical management methods for eggshell color have not yet been developed and Aichi Agricultural Research Center does not have an accurate color index for quality control [1]. This study aims to determine a practical color index and develop a color visualisation system that is easy to use for managing job sites.

In the next chapter, the appropriate range of attractive color for Nagoya Cochin eggs using Hunter LAB color system will be confirmed. Then, the development of the prototype system to measure and manage the eggshell color is described.

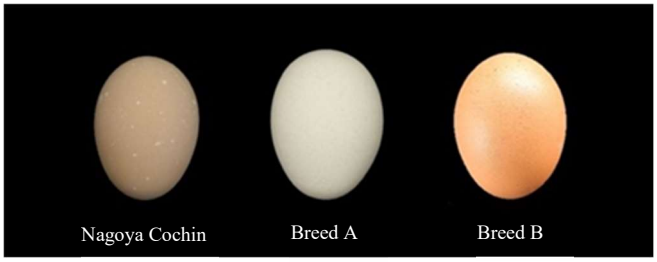



**Figure 1: Appearance of eggs of three types**

## COLOR RANGE SURVEY

Photographs of 60 Nagoya Cochin eggs that were randomly selected are shown on the left side of Figure 2. Colors ranging from yellowish pink to reddish pink were observed. Colorimetric data and visual evaluation scores for the 60 eggs are summarised on the right side of Figure 2. Colorimetric data of the Hunter LAB color system were measured using a colorimeter TC-8600A (Tokyo Denshoku). In addition, a visual evaluation experiment was conducted to score the color attractiveness of "Sakura Fubuki" in Nagoya Cochin eggs. The 14 inspectors who had experience in the visual evaluation of eggshells of Nagoya Cochin at the Aichi Agricultural Research Center rated the "attractiveness of the Nagoya Cochin's eggshell color" on a Likert scale in five steps. These scores and their relationship to colorimetric data of the Hunter LAB color space were then described. Figure 2 confirms the range of egg colors with an attractiveness score of 3.5 or higher. The attractive color range was determined as follows: lightness (L), 60–65; chromaticity (C),10–20; hue angle (h), 40–56.

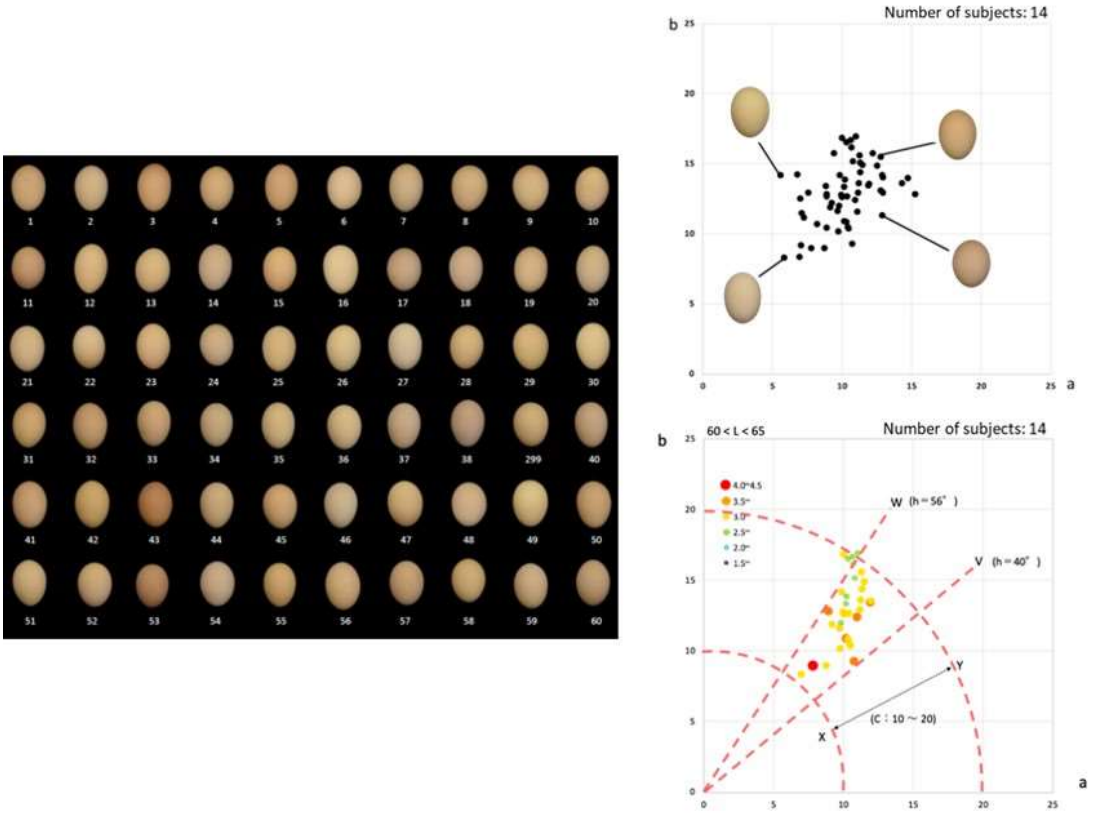



**Figure 2: Results of colorimetric data of sixty eggs and their color evaluation scores**

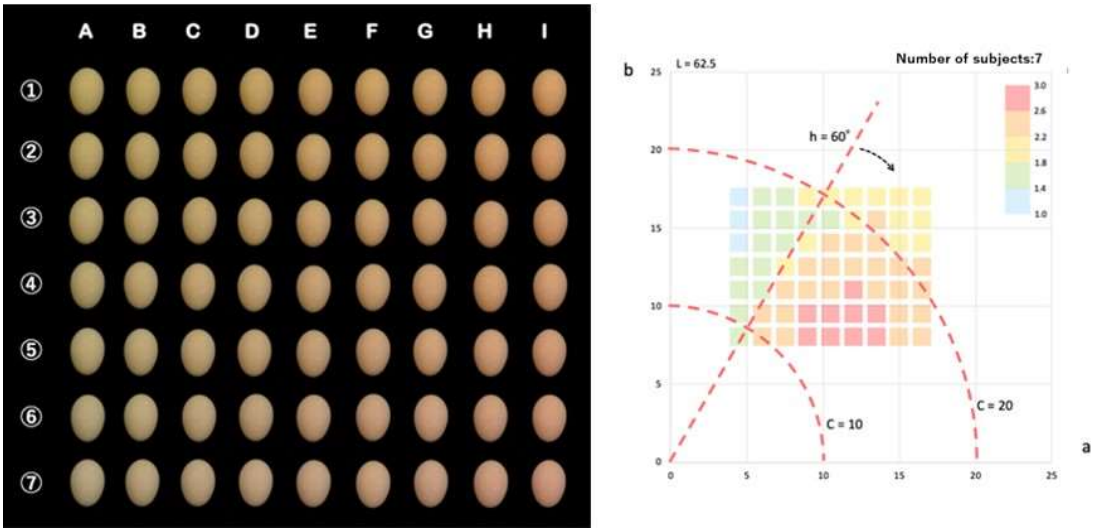



**Figure 3: Color variations of eggshells on the screen and colour attractiveness scores**

Second, the color variations of eggshells were generated based on the real egg's photo image using Adobe Photoshop, and the "attractiveness of the Nagoya Cochin's eggshell color" of 315 egg images was scored on a 3-point scale by seven experts. Although the eggs differed individually in size and shape, they were standardised, and only the effect of color was examined in this experiment. For the first time, the color simulation experiment enabled us to understand the color range of attractiveness in the form of contour lines and clarify the effect of the hue angle and positioning of the three-dimensional color space.

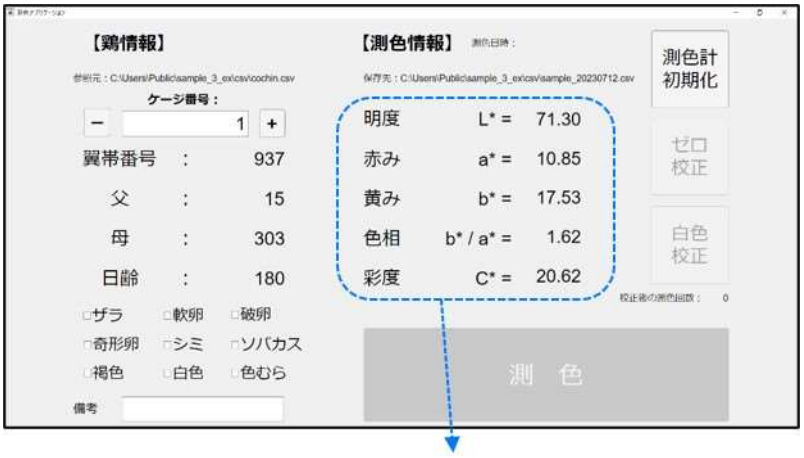
The results of the above two experiments showed that the appropriate L range was between 60 and 65 for Nagoya Cochin's attractive eggshells. For L = 62.5°, C was between 10 and 20°, with higher scores for hue angles closer to the axis [2].

## DEVELOPMENT OF THE COLOR VISUALIZATION SYSTEM

A prototype system for visualising the color quality of an eggshell was developed using the color range survey described above. In this system, the color quality can be confirmed as reddish or yellowish, for instance, using colorimetric data from the CM-700d spectrophotometer (Konica Minolta). The system consists of a spectrophotometer, laptop computer, and external input device (Figure 4) and is implemented in two types of graphical user interfaces (GUI) that measure and visualise color (Figure 5). The software development kit (SDK) provided by Konica Minolta was used to control the colorimeter through the computer [3]. MATLAB (MathWorks) was used for the implementation of GUI. The user can command the initialisation and calibration of the colorimeter and measure egg color from an external input device. The user can also check colorimetric data in real time on the screen and record special notes on the egg surface directly from the GUI. For example, after many measurements are completed, the user can search for eggs with the same mother and confirm the color positioning of the same egg group and its changes based on past data on a single graph. Furthermore, the attractiveness range of colors for Nagoya Cochin eggs is also indicated on the graph, such that the user can immediately understand if the color is outside the proper range.

After testing this prototype system on many actual eggs in the field, several functions that require improvement can be identified and modified. This prototype system is expected to be a useful and practical tool for agricultural producers in managing and maintaining traditional breeds to obtain regional products.


**Figure 4: Prototype of the color visualization system for egg color**



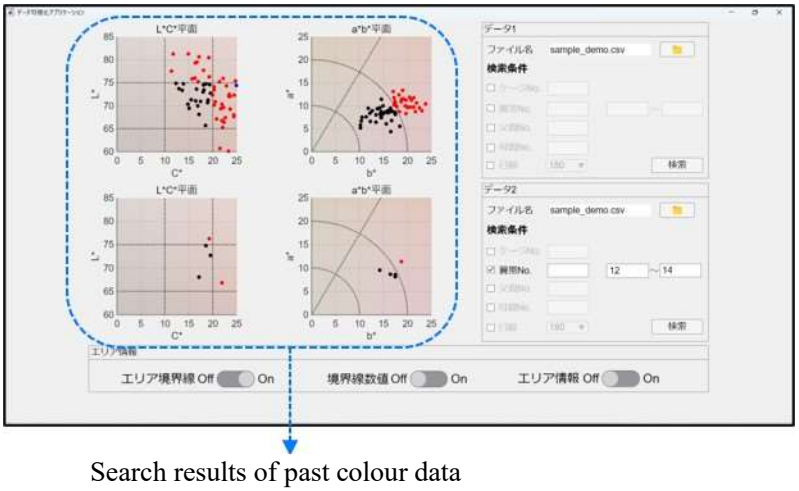




**Figure 5: Example of GUI on the prototype system**

## CONCLUSION

A prototype system that measures the color of eggshells of Nagoya Cochin and indicates their position in real time was developed. The prototype system was successfully debugged. This system will operate on trial in an actual colorimetry scenario in October. After the demonstration of the feasibility of the system, we plan to organise the results of interviews with on-site staff and resolve issues, including user operation errors.

In the near future, we will focus on white spots on the surface of Nagoya Cochin eggs and analyse their distribution patterns to enable automatic visual quality judgment in combination with color management.

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