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Physical Quality of Rejected Egg Flour with The Use of Carboxymethyl Cellulose (CMC) At Different Concentrations

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ABSTRACT

Eggs are one of the livestock products. The high production of chicken eggs has resulted in an increase in the number of rejected eggs that do not meet marketing standards due to cracks or shell defects, which can potentially cause economic losses if not further processed. This study aims to evaluate the effect of using Carboxymethyl Cellulose (CMC) at different concentrations on the physical quality of egg powder from rejected eggs, including yield, pH, moisture content, and foaming ability as the main parameters of functional quality. The materials in this study were rejected eggs and CMC. The method used in this study was a completely randomized design (CRD). The rejected eggs were processed into powder by mixing with CMC, drying at 60°C for 8 hours, grinding, and physical testing. The treatment consisted of five levels of CMC concentration, namely 0%; 0.25%; 0.50%; 0.75% and 1% with data analysis using analysis of variance (ANOVA) and followed by Duncan's test if there was a significant effect. The results showed that the use of CMC at various concentrations had no significant effect ($P>0.05$) on yield, pH value, and moisture content. Conversely, the addition of CMC had a significant effect ($P<0.05$) on foaming power, with concentrations of 0.75% and 1% producing the highest foaming power. In general, it can be concluded that CMC plays a role in improving the functional properties of egg flour as a foaming agent without changing its physical properties, so concentrations of 0.75% and 1% are recommended to produce rejected egg flour that is suitable for use.

KEYWORDS: egg powder, rejected eggs, Carboxymethyl Cellulose, physical quality.

ARTICLE DETAILS

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1. INTRODUCTION

Chicken eggs are one of the products of the poultry farming sector, an animal product widely consumed by the public as a source of high-quality and almost perfect animal protein. Chicken eggs are also rich in vitamins and minerals and play an important role in the food industry as a functional food. Eggs are also relatively inexpensive and easily available. One chicken egg with an average weight of 50-70 grams is divided into several parts, namely 8-11% eggshell, 27-32% egg yolk, and 56-61% egg white[1]

High egg production requires a selection process before distribution to consumers, resulting in many eggs being categorized as rejected due to several factors, including handling during harvesting and storage during harvest. This requires further action so that they can be reused because with high production levels, the rate of damage or cracks in eggs will also increase, which will result in higher economic losses. Therefore, further processing into egg powder is something that can be done to minimize excessive losses.

Rejected egg powder is one of the innovations used in egg processing. Eggs that do not meet distribution standards are rejected due to cracks or breaks in the shell, small size, and soft shells. Egg powder is the result of processing chicken eggs through a drying process to extend their shelf life and facilitate their use in the food industry, without reducing their nutritional value. The volume of the material becomes smaller [2], so it does not require large storage space and storage costs are more economical. The drying process in egg powder production uses the foam mat drying method, which is carried out simply at a temperature of 60°C for 8 hours. The foam mat drying method is one alternative that can be used to produce powder [3]. The drying process itself is a method of removing or eliminating some of the water contained in the flour. According to [1] in their research, the drying process can be

carried out using methods such as spraying and using an oven. [4]the drying method can also be carried out using spray drying, freeze drying, and pan drying methods.

One of the challenges in the flour production process is maintaining the physical quality of the flour so that it remains stable and has optimal functional properties, as it often causes a decline in quality, such as foam formation ability, increased moisture content, and the occurrence of the Maillard reaction. Adding additives such as Carboxymethyl Cellulose (CMC), which is a natural polysaccharide with emulsifying and stabilizing properties, has the potential to improve the physical quality of egg flour. CMC can also improve texture and retain moisture content, thereby improving the physical properties of egg flour, especially at varying concentrations. CMC itself is commonly used in the food industry as a thickener, stabilizer, and emulsifier. Stabilizers also have the function of maintaining the stability of the dough foam so that during the drying process, it will be quick and the ingredients will not be damaged due to heat [5]. However, the use of CMC must be at the right concentration to produce a quality product. This study focuses on discussing the effect of various concentrations used in the production of whole rejected egg flour to produce flour with good physical quality.

2. METHOD

2.1 Place and time

The study titled "Physical Quality of Rejected Egg Flour Using Carboxymethyl Cellulose (CMC) at Different Concentrations" was conducted at the Laboratory of the Faculty of Animal Science, University of Jambi, from November 10 to November 18, 2025.

2.2 Materials and Equipment

The materials used in this study were 40 rejected chicken eggs, 10 grams of CMC, distilled water, and the equipment used included a mixer, egg tray, stirrer, spoon, spatula, baking pan, pH meter, oven, plastic, label paper, desiccator, beaker, stopwatch, ziplock bag, and blender.

2.3 Research Method

The experimental design used in this study was a Completely Randomized Design (CRD) with 5 treatments and 4 replications:
P-0: Rejected egg flour without Carboxymethyl Cellulose 0%
P-1: Rejected egg flour with 0.25% Carboxymethyl Cellulose
P-2: Rejected egg flour with 0.50% Carboxymethyl Cellulose
P-3: Egg powder rejected the addition of 0.75% carboxymethyl cellulose P-4: Egg flour rejected with 1% Carboxymethyl Cellulose

2.4 Variables observed

The variables observed in this study were yield, pH value, moisture content, and foaming power of egg flour.

2.4.1 Yield[6]

Yield measurement was carried out by weighing the main ingredient (homogenized eggs) used, then drying the whole eggs into whole egg powder and allowing them to cool. After that, it was weighed again or obtained by weighing the weight of the whole egg powder (grams) divided by the main ingredient (homogenized eggs) (grams) multiplied by 100%.

$$\text{Yield \%} = \frac{\textit{Bobot produk yang dihasilkan } (gr)}{\textit{Bobot bahan utama } (\textit{telur utuh yang dihomogenkan})(gr)} x\ 100\%$$

2.4.2 pH Value[6]

pH measurement is performed using a pH meter. First, the measurement is performed by taking 2 grams of sample mixed with 20 ml of distilled water, then stirred until homogeneous. After homogenization, the pH value of the solution is measured using a pH meter.

2.4.3 Moisture Content[6]

For moisture content measurement, the empty dish to be used is first dried in an oven for 30 minutes or until the weight remains constant, then cooled in a desiccator for 30 minutes and weighed. Approximately 5 grams of sample is placed in the dish and heated in an oven for 12 hours at 105°C. The dish is then cooled in a desiccator and weighed again after cooling. The calculation used to determine the moisture content is as follows.

$$\text{Moisture Content \%} = \frac{\textit{Berat awal} - \textit{Berat akhir}}{\textit{Berat awal}} x\ 100\%$$

2.4.4 Foam Strength[6]

Foam strength is obtained by whisking whole egg powder at the same weight for 90 seconds at speed two (7000 rpm), then continuing at speed three (8000 rpm) for 90 seconds. Foam strength is calculated using the formula below.

$$\text{Foam strength \%} = \frac{Volume\ buih}{Volume\ telur\ utuh} x\ 100\%$$

2.5 Data Analysis

The data obtained in this study were analyzed using analysis of variance (ANOVA), and if the results were significantly different, Duncan's multiple range test was performed. The mathematical model of the Complete Randomized Design used is:

Yij= μ + πi+ €ij Explanation:

Y_{ij} = Observation value in treatment i and repetition j μ = Overall mean π_i = Effect of treatment i

$€_{ij}$= Experimental error for treatment i and replicate j i = 1,2,3,4,5 (number of treatments) j = 1,2,3,4 (number of replications)

3. RESULTS AND DISCUSSION

3.1 Yield

The yield of rejected egg flour ranged from 22.36% to 25.11%. The results of the egg flour yield analysis can be seen in Table 1.

Table. Average Egg Flour Yield Values

Treatment	Yield (%) ± SD
P0	22.36 ± 0.90
P1	24.26 ± 2.16
P2	23.38 ± 1.18
P3	25.11 ± 0.91
P4	22.87 ± 1.16

Based on the results of the analysis of variance, it shows that treatments P0, P1, P2, P3, and P4 have no significant effect (P>0.05) on egg flour yield. It is suspected that the factor that can affect the egg flour yield is the protein content in the product that can bind water. The yield of egg flour is not affected, presumably due to the loss of solids during the processing and the addition of other ingredients. It is suspected that this is because the protein content of the egg flour added with CMC did not change. In addition, the water content bound to the egg flour protein produced is also the same, so that evaporation during the drying process will also be relatively the same and produce a relatively similar yield [7]. According to [8], the factor that affects the yield is the protein contained in the product. Not only that, according to[9], sample size also affects yield, where the larger the sample surface area, the greater the contact or interaction with the solvent. The surface area of the container or drying place may also affect the yield value produced. Research by [10] states that the yield of egg white flour with the same concentrations, namely 0%; 0.25%; 0.50%; 0.75%; and 1%, also has no significant effect.

pH Value

The pH value of rejected egg powder ranges from 8.10 to 8.42. The results of the pH analysis of egg powder can be seen in Table 2.

Table 2. Average pH Value of Egg Powder

Treatment	pH Value (%)*± SD
P0	8.32 ± 0.13
P1	8.11 ± 0.27
P2	8.19 ± 0.25
P3	8.10 ± 0.14
P4	8.42 ± 0.13

Based on the analysis of variance, it shows that treatments P0, P1, P2, P3, and P4 have no significant effect (P>0.05) on the pH value of egg flour. This is thought to be because the initial pH of the eggs is relatively the same, and the addition of CMC, which acts as a stabilizer, has a greater effect on the physical properties and evaporation that occur during the drying process, which is also thought to affect the pH value.[7] stated that relatively similar initial pH values will result in relatively similar pH values in the final product. The pH of egg- s may also be influenced by the storage space due to water evaporation[11]. Meanwhile, the pH of CMC itself ranges from 6-8% [12].

Moisture content

The results of the moisture content analysis of rejected egg powder averaged between 4.30% and 5.45%. The results of the moisture content analysis can be seen in Table 3.

Table 3. Average Water Content of Egg Powder

Treatment	Moisture Content (%) ± SD	
P0	4.35	±0.44
P1	4.30	± 0.42
P2	5.05	± 0.44
P3	5.45	± 0.87
P4	4.80	± 0.49

Based on the analysis of variance, it shows that treatments P0, P1, P2, P3, and P4 have no significant effect (P>0.05) on the moisture content of egg flour. It is suspected that the moisture content of egg flour can be influenced by the composition of the ingredients and the conditions during drying in the oven. According to [13] in their research, during the drying process, bound water remains consistently present, so the evaporation process will be the same for each treatment. [14] stated that the factors affecting moisture content in the drying method are temperature, container size, and particle size. Moisture content indicates the amount of water contained in the material and is a quality criterion for dry food products. The average moisture content of this product is in accordance with the moisture content value of egg white flour according to SNI 01-4323-1996 [15], where the maximum moisture content value of egg white flour is 8%, but there is no clear maximum moisture content value for egg flour. Moisture content itself is one of the factors that affect the quality of food ingredients[16]. According to [17], the low moisture content value is due to CMC binding water so that water molecules are bound in the gel structure formed by CMC.

Foaming capacity

The average foaming capacity of rejected egg flour using CMC at different concentrations can be seen in Table 4.

Table 4. Average foaming power of egg white powder

Treatment	Foaming Power (%) ± SD
P0	42.50^{c}± 9.57
P1	52.50^{bc}± 5.00
P2	47.50^{c}± 9.57
P3	70.00^{a}± 8.16
P4	65.00^{ab}± 12.91

Based on the analysis of variance, treatments P0, P1, P2, P3, and P4 had a significant effect (P<0.05) on the foaming power of egg flour. Based on Duncan's multiple range test, treatments P0, P1, and P2 did not differ significantly (P>0.05) in terms of foaming power. Treatments P3 and P4 were significantly different (P<0.05) compared to P0, while P1 and P4 were not significantly different (P>0.05). This shows that CMC concentrations of 0.75% and 1% were able to significantly increase the foaming power of rejected egg flour. It is also suspected that the water content and pH in each treatment may affect the foaming power produced. Protein is the main component that plays an important role in foam formation due to its ability to reduce surface tension between the air and liquid phases, as well as other factors that can play a role in increasing foaming ability, namely the addition of thickeners [18].

Foaming ability is the ability of a solution to form foam when shaken and to maintain the foam volume for a certain period of time. CMC belongs to the hydrocolloid group, which can increase the viscosity of the liquid phase and form a thin film around air bubbles. This is reinforced by research [19] which, in its study of ice cream and milk drinks using CMC as a stabilizer, also showed an increase in air volume and foam stability.[20] in their study using yeast as a stabilizer also stated that the higher the amount of yeast added, the higher the foaming power. In line with the author's research using CMC as a stabilizer, the higher the concentration used, the greater the foaming power produced.

CONCLUSION

Based on the research results, it was found that the use of CMC in egg powder production does not affect yield, pH value, and moisture content. The use of 0.75% and 1% CMC can increase the foaming ability of rejected egg powder produced.

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