International Journal of Multidisciplinary and Innovative Research

ISSN(print): 3050-6883, ISSN(online): 3050-6891

Volume 03 Issue 01 January 2026

DOI: 10.58806/ijmir.2026.v3i1n06

Page No: 51-56

The Effect of Different Concentrations of Cmc (CARBOXYMETHYL CELLULOSE) on The Physical Quality of *Rejected* Chicken Egg Yolk Powder

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ABSTRACT

Eggs that have suffered physical damage and do not pass sorting are also known as rejected eggs. The proper and quick processing of rejected eggs is to use them to make egg yolk powder. This study aims to determine the optimal concentration of CMC (carboxymethyl cellulose) to produce rejected egg yolk powder with good physical quality. The materials used were 2000 grams of rejected chicken egg yolks and 10 grams of CMC (carboxymethyl cellulose). The design used was a completely randomized design (CRD) with 5 treatments and 4 groups as replicates. The treatments included egg yolks with the addition of different concentrations of CMC (carboxymethyl cellulose), namely 0% (P0); 0.25% (P1); 0.50% (P2); 0.75% (P3); and 1% (P4). The data obtained were analyzed using analysis of variance (ANOVA), followed by Duncan's Multiple Range Test (DMRT) for treatments that had a significant or very significant effect. The results showed that the addition of CMC (carboxymethyl cellulose) at different concentrations did not have a significant effect ($P>0.05$) on the yield and moisture content of rejected egg yolk powder. However, the addition of 0.5% to 1% CMC (carboxymethyl cellulose) was able to increase ($P<0.05$) the foaming power of rejected egg yolk powder. The addition of CMC (carboxymethyl cellulose) also significantly increased the pH value of rejected egg yolk powder ($P<0.05$). The conclusion of this study is that the use of CMC in the production of egg yolk powder does not affect the moisture content and yield, but increases the pH value of rejected egg yolk powder. A concentration of 0.5% CMC (carboxymethyl cellulose) was able to increase the foaming power of rejected egg yolk powder.

KEYWORDS: physical quality, rejected eggs, carboxymethyl cellulose, egg yolk powder.

ARTICLE DETAILS

Published On:
19 January 2026

Available on:
https://ijmir.com

1 INTRODUCTION

Chicken eggs are a source of animal protein that is frequently consumed because they are highly nutritious, delicious, affordable, and widely available. In addition, the main components of egg whites and yolks are water. An egg consists of 10.5-11% shell, 31.0% egg yolk, and 58-58.5% egg white [1], [2]. However, during distribution and storage, eggs often suffer physical damage such as cracks or breaks due to various factors, ranging from transportation methods, storage conditions, to handling during harvesting. According to [3], contamination of eggs, such as cracks or breaks in the eggshell, occurs during storage and transportation. Eggs that experience physical damage and do not pass sorting are also called *rejected* eggs. According to [4], damaged or low-quality chicken eggs have the following criteria: white eggs, cracked eggs, and broken eggs. Damage in eggs cause a decline in egg quality and pose a potential economic loss because eggs with cracked or damaged shells are considered unfit for consumption and not fresh. Therefore, knowledge of how to properly preserve eggs is necessary to maintain their quality for a long time [5].

One appropriate method of handling and processing rejected eggs is to quickly utilize them in other processed products, such as egg yolk powder. According to [6], drying eggs into powder offers many advantages, including ease of storage, distribution, protection against microbial growth (low water activity), reduction in weight per volume of whole eggs, and longer shelf life. One method used is *foam mat drying*, but this method has a disadvantage, namely causing the Maillard reaction [7].

To overcome this, CMC (*carboxymethyl cellulose*) can be used as a stabilizer and thickener in the flour production process, improving the stability of the texture and physical quality of the product, as well as reducing nutritional damage due to the Maillard

reaction. According to [8], the polysaccharide bonds in CMC will more easily break down hydrogen and protein to minimize nutrient damage due to the Maillard reaction that occurs during drying. As a stabilizer and thickener, CMC also has the ability to bind water molecules [9].

Based on this, this study aims to determine the optimal CMC concentration that can improve the physical quality of *rejected* egg yolk powder. The research question is: what is the optimal concentration of CMC (*carboxymethyl cellulose*) that can produce *rejected* egg yolk powder with good physical quality? The hypotheses proposed include that differences in CMC concentration do not affect the physical quality of *rejected* egg yolk powder and that differences in CMC concentration affect the physical quality of rejected egg yolk powder. The purpose of this study is to determine the effect of different CMC concentrations on the physical quality of *rejected* egg yolk powder. The benefit of this study is that it can provide information on the best CMC concentration to obtain good physical quality of *rejected* egg yolk powder.

2. METHOD

2.1 Place and Time

This study was conducted at the Laboratory of the Faculty of Animal Husbandry, University of Jambi, from November 10 to November 18, 2025.

2.2 Materials and Equipment

The materials used were 130 *rejected* chicken eggs, 10 grams of CMC (*Carboxymethyl Cellulose*), and distilled water. The equipment used in this study included *an egg tray*, blender, *hand mixer*, plate, stirrer, digital scale, spoon, pH meter, stopwatch, *beaker glass*, *egg separator, aluminum foil*, and *plastic ziplock bags*.

2.3 Research Method

2.3.1 Production of Rejected Egg Yolk Flour

The research procedure for making egg yolk powder with added CMC was carried out in stages from [10], which has been modified, namely the sample was prepared, then the eggs were broken and the egg whites and yolks were separated using *an egg separator* and placed in different containers and the egg yolks were gently stirred until homogeneous. After that, the egg yolks were weighed at 100 grams or ± 7 eggs for each treatment. Then, the initial pH of the egg yolks was measured using a pH meter. CMC was added at concentrations of 0%; 0,25%; 0,5%; 0,75%; and 1% to the egg yolks, then stirred using a hand mixer at a speed of 19,000 rpm until foamy. Drying was carried out by pouring the egg yolk liquid evenly into a baking pan and then baking it at 60°C for 16 hours. The dried egg yolks were then blended using a blender. The egg yolk powder is then packaged in *ziplock* plastic bags. Physical quality testing of the egg yolk powder includes calculating the yield,

pH value, moisture content, and foaming capacity of *the rejected* egg yolk powder.

2.3.2 Research Design

The design used was a Completely Randomized Design (CRD) with 5 treatments and 4 groups as replicates. The following treatments were used:

P-0: *Rejected* egg yolk flour without CMC addition
P-1: *Rejected* egg yolk powder with 0.25% CMC addition
P-2: *Rejected* egg yolk flour with 0.5% CMC addition
P-3: *Rejected* egg yolk powder with 0.75% CMC addition
P-44: *Rejected* egg yolk powder with 1% CMC addition

2.4 Variables Observed

The variables to be observed in this study are pH value, moisture content, yield, and foaming capacity of rejected egg yolk flour.

2.4.1 pH value [11]

pH measurement was performed using a pH meter. First, a sample of 2 grams was taken, dissolved in 20 ml of distilled water, and homogenized. After homogenization, the pH value of the solution was measured using a pH meter and the results were recorded.

2.4.2 Moisture Content [11]

The empty dish to be used is first dried in an oven for 1 hour. Then the dish is cooled in a desiccator for 30 minutes and weighed. Take a 5-gram sample and place it in the dish (initial weight), then oven it for 12 hours at 105°C. After completion, cool the dish in a desiccator for 30 minutes. Weigh the dish and sample after oven drying (final weight). Calculate the moisture content percentage using the following formula:

$$\textbf{\textit{Kadar Air}}\ \% = \frac{Berat\ Awal - Berat\ Akhir}{Berat\ Awal} \times 100\%$$

2.4.3 Yield [11]

The main ingredient, rejected egg yolks, is weighed first. The egg yolks are then dried and ground into egg yolk powder. Afterwards, the *rejected* egg yolk powder is weighed. Yield is obtained by weighing the resulting egg powder, dividing it by the main ingredient (egg yolks), and multiplying by 100%. The yield formula can be calculated using the following formula:

$$\textbf{\textit{Rendemen}}\ \% = \frac{Bobot\ produk\ yang\ dihasilkan\ (gr)}{Bobot\ bahan\ utama\ (kuning\ telur)(gr)} \times 100\%$$

2.4.4 Foaming Power [12]

Foaming power is obtained by mixing 10 grams of egg yolk powder with 100 ml of distilled water and whisking the egg yolk powder using a hand mixer for 90 seconds at speed 2 (13,000 rpm) and then continuing at speed 3 (19,000 rpm) for 90 seconds. Calculate the foaming power using the formula below:

$$\textbf{\textit{Daya Buih}}\ \% = \frac{Volume\ Buih}{Volume\ kuning\ telur} \times 100\%$$

2.5 Data Analysis

The data were statistically analyzed using analysis of variance (ANOVA). If the results obtained in this study were significantly or very significantly influenced, they were followed up with Duncan's Multiple Range Test (DMRT).

The mathematical model of the Complete Randomized Design used is:

$Y_{ij} = \mu + \pi_i + €_{ij}$

Explanation:

Y_{ij} = Observation value in treatment i and repetition j

μ = General mean value

π_i = Effect of treatment i

$€_{ij}$ = Error (mistake) in the experiment for treatment i and repetition j

i = 1,2,3,4,5 (number of treatments)

j = 1,2,3,4 (number of replicates)

3. RESULTS AND DISCUSSION

After conducting the research, the average pH value, moisture content, yield, and foaming power of *rejected* egg yolk powder were obtained, as shown in Table 1 below:

Table 1. Average pH Values, Moisture Content, Yield, and Foaming Power

	Variable			
Treatment	pH Value	Moisture Content (	Yield (	Foaming Power (
Average ± SD				
P0	5.68^{b}±0.09	3.85±0.82	48.71 ± 1.39	45.0^{bc}±5.77
P1	5.91^{a}±0.23	3.00±0.86	48.71±1.09	40.0^{c}±8.16
P2	6.01^{a}±0.16	3.95±0.44	47.36±2.44	52.5^{ab}±12.58
P3	6.10^{a}±0.05	3.75±1.02	48.15±1.05	50.0^{ac}±0.00
P4	6.12^{a}±0.04	4.10±0.68	47.96±1.35	60.0^{a}±0.00
Average	5.96	3.73	48.18	49.5
Note	P<0.01	P>0.05	P>0.05	P<0.05

Note: P0=0%; P1=0.25%; P2=0.5%; P3=0.75%; P4=1%; P<0.05 = significantly different, P>0.05 = not significantly different; P<0.01 = highly significant effect; a,b,c = similar letters indicate no significant difference at the Duncan test level of 5%.

3.1 pH Value

The analysis of variance results showed that the use of CMC at different concentrations had a highly significant effect (P<0.01) on the pH value of *rejected* egg yolk powder. Based on Duncan's test, the pH value in the 1% treatment was not significantly different from the 0.25%, 0.5%, and 0.75% treatments, but was very significantly different from the 0% treatment. This is thought to be due to the chemical properties of CMC and its ability to bind acids and salts, thereby reducing the relative acidity of the final product. According to [13], processing food products using CMC will produce products with higher pH values,

because the pH of CMC ranges from 5 to 11 and is a hydrocolloid that is easily soluble in water. In addition, CMC also has an alkaline or basic environment due to the reaction of cellulose that has been alkalized with NaOH, so that the addition of CMC can increase the pH value of a product [14]. From Table 1,it can be seen that the pH value of the egg yolk powder obtained is in the range of 5.68 to 6.12. The pH results of this study do not meet the pH quality requirements for egg white powder according to [15], SNI 01-4323-1996, which is 6.5 to 7.5, but they do meet the pH requirements for fresh egg powder according to [16], which is 5.5–7, and are slightly below the quality standards according to [17], which is between 6 and 7.0.

3.2 Moisture Content

The results of the analysis of variance show that the use of CMC at different concentrations in the production of egg yolk powder from *rejected* eggs has no significant effect (P>0.05) on the moisture content of *rejected* egg yolk powder. Table 1 shows that the moisture content obtained varied between treatments P0 to P4, with an average moisture content ranging from 3.00% to 4.10%. The moisture content of egg yolk powder from this study met the [17]and [16], standardswhich is below 5%. The moisture content from this study also meets the moisture content quality requirements for egg white powder according to [15]and SNI 01-4323-1996, which is a maximum of 8%.

The relatively low moisture content of the egg yolk powder produced was due to the additives used. According to [18], the low moisture content produced is due to CMC functioning to bind water so that water molecules are trapped in the gel structure formed by CMC. [10]added that CMC has strong water-binding properties so that evaporation is more effective during drying.

3.3 Yield

The analysis of variance shows that the treatment of using CMC at different concentrations in the production of egg yolk powder from *rejected* eggs has no significant effect (P<0.05) on the yield of egg yolk powder. Table 1 shows that the yield obtained varied between treatments P0 to P4, with an average yield ranging from 47.36% to 48.71%. According to [10], the additives used in the raw materials will affect the yield value, as will the dry matter content of the raw materials.

Yield can also be influenced by several factors such as drying temperature, stirring, solvent, drying time, type of solvent, and flour particle size [19]. [20]added that small particle size can increase the surface area, thereby increasing interaction with the solvent.

3.4 Foaming Power

Based on the results of the analysis of variance, it was found that differences in CMC concentration had a significant effect (P<0.05) on the foaming power of *rejected* egg yolk powder. Table 1 shows that the foaming power of egg yolk powder obtained was in the range of 40% to 60%. Based on Duncan's test, the foaming power of the 1% treatment was not significantly different from the 0.5% treatment, but was significantly higher than the 0%, 0.25%, and 0.75% treatments. This is thought to be due to several factors, such as pH, egg freshness, and the additives used. According to [10], protein concentration, processing conditions, pH, egg freshness, and contamination in egg yolks are some of the factors that can affect foaming power.

The results of this study were higher than those of [10], who obtained a foaming power of 3.33% with fresh egg yolk and 0.5% CMC as raw materials. This is thought to be due to differences in the egg yolk raw materials, where fresh egg yolks are rich in whole fat and have high viscosity that inhibits foam expansion, resulting in low foaming power. According to [21], the very low foaming capacity of fresh egg yolks is due to their high fat content.

4. CONCLUSION

From the results of the research conducted, it can be concluded that the use of CMC in the production of egg yolk powder does not affect the moisture content and yield, but increases the pH value. A concentration of 0.5% CMC (*carboxymethyl cellulose*) can increase the foaming power of *rejected* egg yolk powder. Further testing of chemical and microbiological quality is needed to determine and ensure the suitability of using rejected egg yolk powder with added CMC (*carboxymethyl cellulose*) as a food additive and animal feed.

ACKNOWLEDGMENTS

The author would like to express his deepest gratitude to Mrs. Metha Monica, S.Pi, M.P. as the main supervisor and Mr. Heru Handoko, S.Pt., M.Si. as the assistant supervisor who have provided guidance, advice, and direction to the author in conducting research, data collection, and data processing from the results of this study.

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