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Physicochemical, Microbiological, and Organoleptic Characteristics of Cookies During Storage with Egg Yolk Powder Formulation

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ABSTRACT

Drying technology is one method of preserving eggs by converting them into egg yolk powder. This study aims to analyze the physicochemical, microbiological and organoleptic characteristics of cookies made with egg yolk powder formulation over storage periods of 0, 15, and 30 days. The experimental design used a single factor of storage duration (0, 15, and 30 days) with analysis of variance (ANOVA) to determine the effect of storage time with a 95% confidence interval. Cookies with egg yolk powder formulation showed changes in both physicochemical (pH, Aw, water content and texture) and microbiological values during the storage period. There was an increase in water activity and water content of the cookies, while a decrease was observed in pH and breaking strength. The microbiological changes in the cookies still met the Indonesian National Standard (SNI) for cookies up to day 30 of storage. The organoleptic test results indicated that cookies with egg yolk powder formulation were generally well-received, with characteristics of color, aroma, texture, and taste falling within the range of like to favorably liked.

Keywords: cookies, egg, egg yolk powder, physical chemical, organoleptic

ABSTRAK

Teknologi pengeringan merupakan salah satu cara pengawetan telur dengan merubah telur menjadi tepung kuning telur. Penelitian ini bertujuan untuk menganalisis karakteristik fisikokimia dan mikrobiologi kukis menggunakan bahan formulasi tepung kuning telur selama periode penyimpanan 0, 15, dan 30 hari. Rancangan Percobaan menggunakan satu faktor penyimpanan Selama 0, 15, dan 30 hari dengan analisis varians (ANOVA) untuk menentukan pengaruh waktu simpan dengan interval kepercayaan 95%. Kukis dengan bahan formulasi tepung kuning telur selama waktu penyimpanan mengalami perubahan nilai baik secara fisikokimia maupun mikrobiologi. Kenaikan terjadi pada aktivitas air dan kadar air kukis, sedangkan penurunan terjadi pada pH dan daya patah. Perubahan nilai mikrobiologi kukis masih memenuhi SNI kukis sampai penyimpanan hari ke 30. Hasil uji organoleptik menunjukan kukis dengan bahan formulasi tepung kuning telur dengan karakteristik warna, aroma, tekstur, dan rasa pada kisaran agak disukai dan suka.

Kata kunci: fisikokimia, kukis, mikrobiologis, organoleptik, tepung kuning telur

INTRODUCTION

Eggs are a highly demanded livestock product among the public. This is influenced by their affordable price and easy availability in society. Additionally, eggs are rich in nutrients, consisting of water (75%), protein (12%), fat (12%), and carbohydrates and minerals (1%) (Kovacs-Nolan *et al.* 2005). 100 grams of whole eggs contain 327.0 IU of vitamin A and 256 mg of minerals (Wulandari and Arief 2022). The high nutritional content makes eggs an ideal breeding ground for bacteria.

The high water content facilitates bacterial growth and spoilage of eggs. Like other livestock products, eggs are classified as perishable food. An appropriate preventive measure to extend the shelf life of eggs is through drying. Drying technology is a method of preserving eggs by converting them into powder. The concept of drying as a preservation method involves reducing the water content in food. The benefits of preserved egg yolk products include easier storage, distribution, and longer shelf life.

Cookies are a type of snack that is highly favored by the public. The long shelf life of cookies is due to their low water content, which, according to the Indonesian National Standard (SNI), is around 5%. The low water content in cookies is influenced by the predominantly dry ingredients used in their production and the baking process. The dry ingredients in cookies include low-protein wheat flour, cornstarch, and powdered milk. The only wet ingredient used in cookies is egg yolk. Cookies can spoil during storage. Spoilage may occur due to contamination during storage. Factors affecting cookie spoilage include humidity, which can increase the water content in cookies (Labuza 1982). Egg yolk is an essential component in cookie-making. The similar characteristics between egg yolk and egg yolk powder have led many industries to switch to using egg yolk powder. This study aims to analyze the physicochemical. Microbiological and organoleptic characteristics of cookies made with egg yolk powder formulation over storage periods of 0, 15, and 30 days.

MATERIAL AND METHODS

Material

The equipment used in this research included an oven, egg separator, mixer, plastic containers, digital scales, and an autoclave. The equipment for testing physical properties included : analytical balance, pH meter (OAKTON 3563405), and water activity meter (SHN DN-40). The raw materials used included : egg yolk powder, wheat flour (Segitiga Biru), eggs, margarine (Palmia), baking soda, and powdered milk. The raw materials for testing included saturated NaCl solution and distilled water. The materials used for microbial testing included plate count agar (PCA) and Buffered Peptone Water (BPW). Cookie storage was done in polypropylene plastic containers at room temperature for 0, 15, and 30 days. The storage was carried out in plastic packaging made of polyethylene.

The method for producing egg yolk powder refers to the research conducted by Fadilah and Hertamawarti (2021). Figure 1 provides a flow diagram of the egg yolk powder production process. Cookie Formulation with Egg Yolk powder can seen at Table 1.

The variables analyzed were as follows:

Water activity testing was used to determine the amount of bound water in the product, measured with an aW meter (Supartono 2000).

pH testing used a pH meter following the AOAC method (2005).

Water content measurement was based on AOAC 2005 using the oven method.

Breaking strength was analyzed using a Texture Analyzer, by placing the cookie on the cross-section. The machine is operated until the arm breaks or presses the cookie. The arm used for the test is vertically long and tapered (Rahayu *et al.* 2021).

Total plate count was calculated using the method described in SNI 2897:2008.

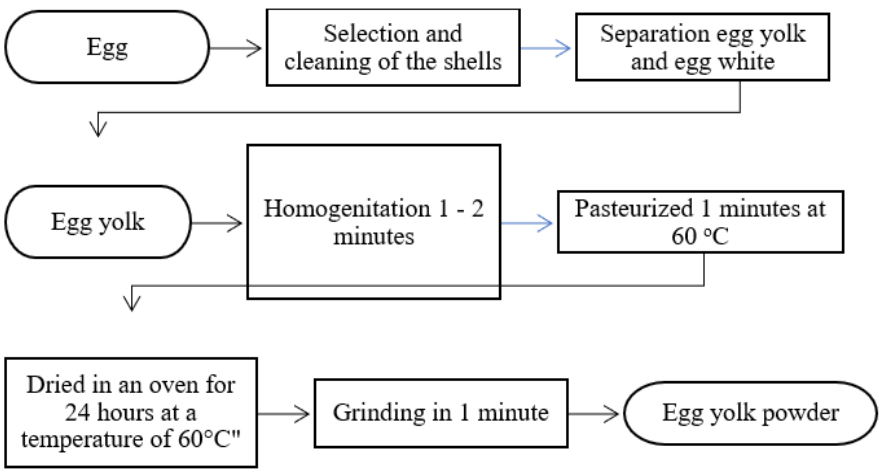

Figure 1. Egg yolk flour production process

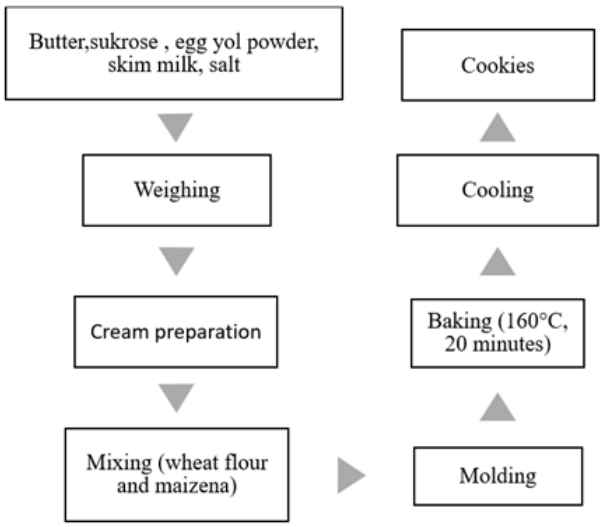

Figure 2 Cookie production process

Table 1. Cookie Formulation with Egg Yolk powder

Ingredients	Formulation
Butter	100 g
Sugar	25 g
Egg yolk powder	10 g
Salt	1 g
Wheat flour	250 g
Baking powder	5 g
Milk powder	10 g
Ekstract vanilla	3 g

Source : Nasution (2013)

The experimental design used in this research was a **completely randomized design (CRD)** with one treatment factor: storage time of 0, 15, and 30 days with three repetition. According to Steel and Torrie (1991), the statistical model used is as follows:

$$Yij = \mu + a + \varepsilon ij$$

Where:

- **Yij** = Response at storage time iii (0 days, 15 days, and 30 days) at repetition jjj (1, 2, and 3)
- **μ** = General mean of the research response
- **a** = Effect of storage time iii (0 days, 15 days, and 30 days) on the research response
- **εij** = Error effect of storage time iii on repetition jjj

The data obtained were analyzed using **Analysis of Variance (ANOVA)** to determine the effect of each formula with a 95% confidence interval. If the data showed significant differences, a **Tukey test** was performed (Steel and Torrie 1997).

RESULTS AND DISCUSSION

During the storage period, both increases and decreases were observed in the variables measured. The variables that showed increases included water activity and water content, while the variables that showed decreases included pH and breaking strength. The results for each variable are presented in Table 2.

Table 2. Results of Physicochemical Properties Testing of Cookies with Egg Yolk powder Formulation During Storage

Variable	Storage Period		
	H0	H15	H30
pH	6.89±0.06c	6.75±0.07b	6.60±0.09a
Aw	0.34±0.01c	0.35±0.01b	0.36±0.01a
Mositure (%)	2.61±0.27b	3.80±0.72ab	4.70±0.51a
Texture (gmm^{-1})	2.45±0.15a	2.25±0.05ab	1.97±0.29a

During the storage period, a change in pH was observed. This is supported by statistical calculations with $P < 0.05$. Table 2 shows that at 0 days of storage (H0), the pH was 6.89. A decrease was experienced during 15 days (H15) and 30 days (H30) of storage, with average pH values of 6.75 and 6.60, respectively. According to Arfiyanti (2013), the pH of cookies as a control ranges between 6.06–6.45 and may decrease or increase during storage. The decrease in pH during storage can be attributed to microbial activity within the cookies. The more sugar sources that can be metabolized, the more organic acids are produced, which lowers the pH (Meilina 2022). Microorganism growth indicates an increase in the water content of the cookies. This demonstrates a relationship between pH and water content.

Water activity reflects the degree of water activity in food, both chemically and biologically. Water activity is closely related to water content in food products. The level of water activity significantly affects the shelf life of food (Leviana *et al.* 2017). During cookie storage, there was an increase in water activity values over time. The water activity value at H0 was 0.34, at H15 it was 0.35, and at H30 it was 0.36. Crisp cookies typically have a water activity value below 0.39 (Katz and Labuza 1980). In addition to crispness, water activity also helps determine the shelf life of products. The lower the water activity value, the less free water there is, leading to a longer shelf life. This is related to the ability of microorganisms to proliferate.

Water activity is linked to water content. The **water sorption isotherm** connects water content data with water activity data at the same temperature. The isotherm is used to design drying processes, particularly in determining the drying endpoint (Dede *et al*. 2012). The isotherm curve of biscuits has a sigmoidal shape, approaching the Caurie prediction. The Caurie prediction explains that each increase in water content is accompanied by an increase in water activity in biscuits. According to Bell and Labuza (2002), the sorption pattern of tapioca starch is classified as type

II, caused by the cumulative effect of colligative, capillary effects, and solid surface interaction with water.

Water content is an important aspect for evaluating the shelf life and crispness of a product. According to SNI 2973-2022, cookies have a maximum water content limit of 5%. This reflects the crispness of the cookies and their long shelf life due to the difficulty for microbes to grow. Microorganisms find it very difficult to grow in environments with very little water. During storage, an increase in water content was observed in the cookies. The water content at the start of storage was 2.61%. This water content resulted from the baking process, which met the SNI quality standards. Additionally, the use of egg yolk powder in the dough reduces the water content compared to the moisture normally found in egg yolk. Increases in water content were observed on days 15 and 30, with values of 3.80% and 4.70%, respectively. This increase is caused by the absorption of water vapor from the environment during storage, which leads to a decrease in the quality of dry products (Putri 2023).

Breaking strength measures a product's resistance to applied pressure and is related to its crispness. Cookies are crisp and therefore easily broken. The average breaking strength analysis results showed significant differences in the product over the storage period. The higher the value obtained, the more difficult it is to break the product. The breaking strength of cookies is greatly influenced by water content and ingredients. During storage, the water content of the cookies increased. According to Siswantu *et al.* (2015), higher water content makes cookies easier to break. The breaking strength of cookies with added whey, as studied by Rahayu *et al.* (2021), showed an increase in breaking strength. Previous studies support that increasing water content affects the ease of breaking cookies. During storage, an increase in water content is caused by the absorption of water from the environment. This process increases the water content of the cookies. Cookies stored for 30 days were easier to break than those stored for 0 and 15 days.

Based on the Table 3, cookies with egg yolk powder substitution during the storage period conform to SNI 2973-2022. The total allowable microbes according to the SNI standard is 4 log CFU/g. During storage, there was an increase in bacterial growth, with statistical calculations showing a value of $P<0.05$. No bacterial growth was found at 0 days of storage (H-0). According to SNI 3926-2008, the maximum allowable microbial count for the total number of microbes on eggshells and contents is 5 log CFU/g.

Table 3. Results of the total microbes of cookies made with egg yolk powder during storage

Variable	Storage Period		
	H0	H15	H30
Total Microbes (log CFU g^{-1})	< 1.19	3.56±0.45b	4.16±0.44a

Note: Numbers followed by different letters in the same row indicate a significant difference in treatments at a 95% confidence level ($P<0.05$).

Table 4. Results of the organoleptic test of cookies with egg yolk powder substitution

Characteristics	Average organoleptic test
Hedonic	
Color	3.70±0.72
Aroma	4.10±0.83
Taste	4.45±0.61
Texture	4.09±0.79
Hedonic Quality	
Color	3.42±0.82
Aroma	3.39±0.81
Taste	2.23±0.45
Texture	4.09±0.73

Hedonic scale:

1 = strongly dislike,

2 = dislike,

3 = somewhat dislike,

4 = somewhat like,

5 = like,

6 = strongly like.

Hedonic quality scale:

Color:

1 = light cream,

2 = dark cream,

3 = light brown,

4 = dark brown.

Aroma:

1 = no egg yolk flour aroma at all,

2 = no egg yolk flour aroma,

3 = slight egg yolk aroma,

4 = egg yolk flour aroma,

5 = strong egg yolk flour aroma.

Taste:

1 = not savory at all,

2 = not savory,

3 = slightly savory,

4 = savory,

5 = very savory.

Texture:

1 = not crunchy at all,

2 = not crunchy,

3 = slightly crunchy,

4 = crunchy,

5 = very crunchy.

The baking process, which uses a temperature of 160 °C, kills the bacteria. In addition, cleanliness during the production process helps minimize contamination. Mold can grow at water activity levels of 0.3–0.5. Microbial growth causes a loss of crispness in snacks (Labuza 1982).

Microbial growth started on the 15th day of storage. This growth may have been caused by contamination of the storage container from the beginning. The low water content and water activity (A_w) of the product hinder the microbial growth in cookies. During storage, water content tends to increase. The microbes that grew during cookie storage were molds. Additionally, the longer the storage period, the more microbes tend to grow. Microbial growth can also be caused by environmental air entering the packaging due to high packaging permeability, the nutrient content of the product, and contamination during the cooling process before packaging (Danarsi 2016).

Physical appearance or color influences the attractiveness of food. According to Fitriani (2011), appealing colors suggest better taste compared to dull-colored products, even if their compositions are identical. Organoleptic tests on cookies with egg yolk flour substitution revealed that the panelists liked the taste, describing the color as brownish due to the Maillard reaction, which darkens the cookies as more protein reacts with carbohydrates (Rosalin 2006). Organoleptic test results can be seen in Table 4.

Aroma also plays a crucial role in food evaluation. Farhan (2021) states that aroma is a combination of taste and smell. Panelists liked the cookie aroma, and the egg yolk flour's scent was minimal due to its small proportion in the dough.

Taste is a key factor in consumer acceptance. Setyarini (2022) claims flavor is the most important attribute for product acceptance. Panelists enjoyed the taste, with no significant egg yolk flour flavor detected.

Texture is another critical factor in food acceptance. Rosalin (2006) highlights the importance of texture in soft and crispy foods. The cookies were well-received for their crunchy texture, typical of dry biscuits, with a water activity level around 0.3.

CONCLUSION

Cookies made with egg yolk flour experienced changes in physicochemical and microbiological values during storage. Water activity and moisture increased, while pH and breaking strength decreased. The cookies met microbiological standards up to 30 days of storage, and were generally liked by panelists in terms of color, aroma, texture, and taste.

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