

APPLICATION OF WHOLE EGG POWDER PROCESSED BY OVEN DRYING AND FOAM MAT DRYING IN BREAD MAKING

Abdi^{1*}, Tuty Anggraini², Alfi Asben¹

¹Department of Agro-Industrial Technology, ²Department of Food and Agricultural Technology,
Faculty of Agricultural Technology, University of Andalas, Indonesia.

*Corresponding author : abdi1611122018@gmail.com

ABSTRACT

Whole egg powder has a longer shelf life than fresh eggs, easier to apply, and can be applied in bakery industry. This study aimed to evaluate the differences in the characteristics of bread made from chicken whole egg powder which was processed by oven drying and foam mat drying compared to bread made from fresh eggs. The results obtained show that bread from chicken whole egg powder which was processed by oven drying and foam mat drying was liked and accepted by consumers, especially from a sensory perspective (color, aroma, taste and texture), and even has a preference compared to bread made with the use of fresh eggs. The best formulation for bread was obtained from bread made using chicken whole egg powder processed using foam mat drying with color, taste, aroma and texture parameter value are 4.1, 4.3, 3.9 and 4.2 respectively, while the increasing volume was 289.6% and hardness value was 50.8 N/cm². However, the characteristics of the bread produced using chicken whole egg powder from both the oven drying and foam mat drying were not much different from bread made using fresh eggs and can be a new alternative in food industry.

Keywords : whole egg powder, oven drying, foam mat drying, bread, characteristic

INTRODUCTION

The bakery industry is one of the industries that use eggs the most, so there is a high opportunity of using egg powder in the bakery industry. Bread is a processed food made from wheat flour using yeast (*Saccharomyces cerevisiae*) or other leavening agents and then baking [1]. Bread, especially white bread, is one of the processed foods from wheat which is widely consumed by the wider community.

White bread is a type of sponge bread which is mostly composed of gas bubbles. The price is relatively cheap, making white bread easy to reach by all levels of society, from the lower, middle to upper layers. This can be proven by the increasing number of bakery industries both on a

household and medium scale industry. In the making of white bread, food additives are needed such as emulsifiers which can be obtained from eggs such as lecithin [2]. So far, bread is made using fresh eggs such as chicken eggs or duck eggs.

Fresh eggs are classified as perishable foods and have short shelf life. Indonesia is a large country and difficult for the transportation due to the long distance between the farm and the table, which causes the damage such as cracking and breaking during distribution, resulting in losses. Egg powder can be an alternative to this problem, in which egg powder has a longer shelf life of up to 10 years, reduces storage space and costs, reduces transportation costs as well as easier to apply [3,4,5]. According to Asghar and Abbas [6] the functional properties of whole egg powder such as for stability, emulsification, ability to form foam, gel and can be applied in the food sector for the manufacture of mayonnaise, bread, ice cream, salad, candy, pasta and many convenience foods.

In making whole egg powder, proper drying technology must be considered to produce adequate products that can replace fresh eggs. Oven drying is one of the most common and simple drying processes, and it is also cost-effective. In addition, foam mat drying is known as a technique to accelerate the drying process by adding the foaming agent and has been often applied in the drying of agricultural products. These drying processes are highly potential to be utilized in making whole egg powder.

MATERIAL AND METHOD

Materials

The main material used in this study was egg chicken that was purchased from farm and was used to make chicken whole egg powder. The obtained chicken whole egg powder was used to make bread with addition of other materials such as wheat flour, sugar, yeast, salt, margarine, UHT milk, powder milk, vanilla, water and bread improvement which were purchased from local market.

Instrumentation

The used instrumental was texture analyzer (AMETEK Brookfield) which was used to measure the texture of bread with syringe diameter 6 mm.

Method and Procedure

This study was used explorative methods with 2 treatments and 1 control as described below :

- Treatment A :Using chicken whole egg powder processed by oven drying to make bread
- Treatment B :Using of chicken whole egg powder processed by foam mat drying to make bread
- Treatment C :Addition of fresh egg to make bread (Control)

Preparation to make chicken whole egg powder was done as following steps:

Oven drying: oven drying was carried out according to the reference by Abreha et al. [5] with some modifications. Eggs were cleaned and washed. Then eggs were cracked and separated from their shells. Eggs were homogenized using a mixer. Then 0.1% yeast was added and fermented for 1 hour 30 minutes. Eggs were pasteurized at a temperature of 57-60°C for 10-15 seconds. Eggs were dried at 44°C 50°C until the moisture content under 10% in oven. Then, grinded with blender and filtered through a 60 mesh sieve. The obtained whole egg powder was used for further analysis.

Foam mat drying: foam mat drying was carried out according to the modified description by [4,5]. Eggs were cleaned and washed. Eggs were cracked and separated from their shells. Eggs were homogenized using a mixer. Then 0.1% yeast was added and fermented for 1 hour 30 minutes. Then, 1% tween 80 of the used egg weight was added. Eggs were pasteurized at 57-60°C for 10-15 seconds. Eggs were dried at 50°C until the moisture content under 10% in oven. Then, grinded with blender and filtered through a 60 mesh sieve. The produced whole egg powder was used for further analysis.

In this study, the used ingredients and formulations to make bread are shown in table 1.

Table 1. Bread Formulation with the Use of Chicken Whole Egg Powder [7]

Materials	Treatments		
	A (<i>oven drying</i>)	B (<i>foam mat drying</i>)	C (control)
Wheat flour (g)	400	400	400
Egg (pcs)	-	-	1
*Whole egg powder (g)	14	14	-
Margarine (g)	30	30	30
Water (ml)	100	100	100
UHT milk (ml)	100	100	100
Sugar (g)	30	30	30
Instant yeast (g)	8	8	8
Salt (g)	3	3	3
Powder milk (g)	10	10	10
Vanilla essence (ml)	1	1	1
Bread improver (g)	5	5	5

Note: *14g of egg powder dissolved in 40 ml of water equals with 1 piece of egg based on the calculation of water content and yield of whole egg powder produce.

The stages of making white bread are as follows [8]:

- a) Mix all the ingredients such as flour, eggs (chicken whole egg powder), sugar, instant yeast and powdered milk, then stir using a mixer while adding water little by little.
- b) After that add margarine and salt and stir until smooth.
- c) Then flatten the dough and roll it according to the size of the mold.

- d) Transfer the dough into a bread mold and cover with plastic wrap and let it rest for 30 minutes until the dough has doubled in size.
- e) Then bake the dough in the oven using a temperature of 140-180°C for 20-25 minutes.
- f) The obtained bread was used for further analysis such as sensory analysis, increasing volume measurement and hardness measurement.

Analysis

Organoleptic Testing of Bread [9]

Organoleptic testing was carried out on the resulting product. Samples are presented in a uniform form. This organoleptic test included a preference test for color, aroma, taste and preference for bread products for each treatment which was carried out by 30 semi-trained panelists. This test was conducted to determine the panelist's level of preference for the product produced (treatments A and B) and compared with control product. Testing was presented by presenting white bread that has been cut into pieces. The test used is the hedonic scale test using 5 numerical scales, namely from : very dislike (1), dislike (2), ordinary (3), like (4), like very much (5). More details can be seen in the organoleptic test form contained in Appendix 6.

The organoleptic test stages in this study were:

- a) Each sample as much as 1 piece into the test plate.
- b) Each sample is coded randomly with 3 digits.
- c) Then an assessment of color, aroma, taste and texture was carried out.
- d) Panelists must put a mark (√) on the table provided.
- e) The test was carried out in a separate room with 20 panelists.
- f) The test numbers are listed on the organoleptic test form.

Increasing Volume of Bread [10]

Measuring the increasing volume of bread was done manually using a ruler as a tool to measure the risen volume of white bread from before it was baked to after it was baked. The initial plain bread dough was prepared and then the midpoint was taken and then the radius of the bread dough was measured as the starting point. The measurement was then carried out again on the white bread that has been cooked at the midpoint of the white bread and then the radius was measured as the end point. The increasing volume was calculated by equation 1 below:

$$\text{Increasing Volume} = \text{final volume} - \text{intial volume} \times 100\% \dots\dots\dots (1)$$

Hardness Value of Bread [11]

The principle of measuring elasticity is to apply a force to a material with a certain amount so that its hardness value can be measured. The test was carried out using a texture analyzer by placing sliced bread on the sample table. Then do the force with the probe 2 times. Measurement of the texture hardness value was calculated using equation 2 below:

$$Hardness = \frac{\text{peak value that apperas on the tool (kg)} \times 9.8}{\text{needle area (cm}^2)} \pi r^2 \dots\dots\dots (2)$$

RESULT AND DISCUSSION

Sensory analysis

Organoleptic test is a parameter to determine quality characteristics and consumer acceptance of a product. This organoleptic test was a hedonic (liking) test performed by the human senses as the main tool for measuring product quality. In this study, hedonic tests were carried out on bread products made from chicken whole egg powder which were dried using the oven drying and foam mat drying as well as bread made from fresh eggs (control). The parameters tested were color, taste, aroma and texture of the bread.

During the organoleptic test, 31 people were asked to rate the product with a range of numerical scales such as (5) really like, (4) like, (3) normal, (2) don't like, (1) really don't like. The results of the organoleptic test assessment in this study are shown in table 2 and figure 1.

Table 2. Organoleptic Value of Bread

Parameters	Treatment		
	Control	Oven drying	Foam mat drying
Color	3,80	4,16	4,10
Taste	3,77	3,81	4,30
Aroma	3,71	3,81	3,94
Texture	4,13	3,84	4,19

a. Color

Color is one of the first indicators seen by the human senses. Attractive colors and in accordance with the wishes of consumers are the main attraction in choosing a product, due to color is one of the parameters that can be responded easily and quickly in giving a good impression [12]. The results of organoleptic tests on the color parameters of bread made with chicken whole egg powder as a substitute for fresh eggs were shown in figure 1 and the produced bread also can be seen at figure 2.

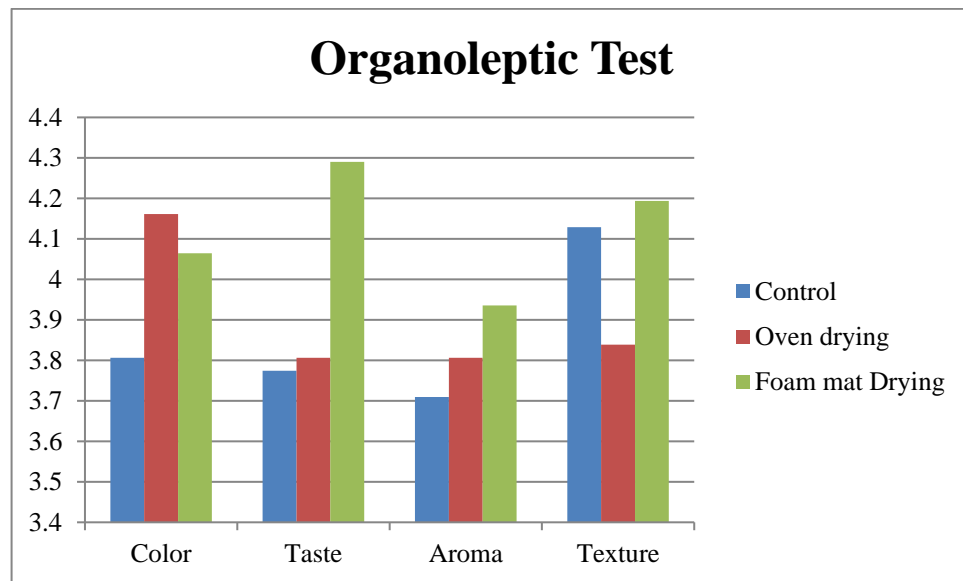


Fig 1. Recapitulation of bread organoleptic tests

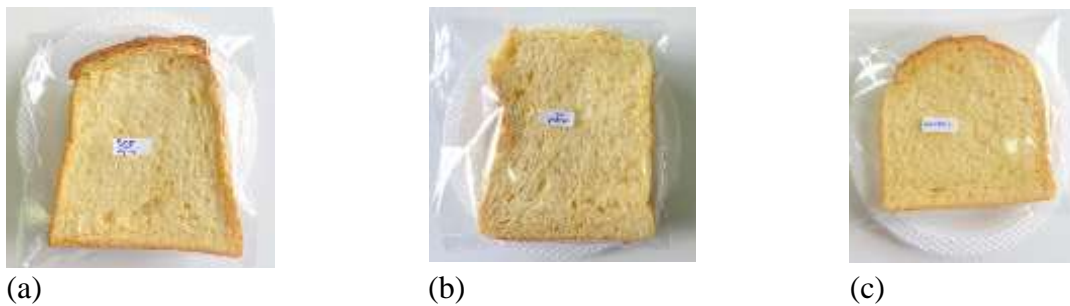


Fig. 2. a) Bread made from whole egg powder dried with foam mat drying, b) Bread made from whole chicken egg powder dried with oven drying, c) Bread made from fresh egg

Table 1 shows the color value of bread made from chicken whole egg powder was 4.16 (oven drying) and 4.06 (foam mat drying), which means that the replacement of fresh eggs with chicken whole egg powder was preferred by the panelists. Meanwhile, it was 3.08 (preferred) for bread made using fresh eggs (control treatment). Therefore, we can conclude that chicken whole egg powder can replace the function of fresh eggs in making bread.

The obtained bread had a brownish-yellow color on the outside of the bread crust and a cream-white color on the inside. The produced color was influenced by the treatment of the chicken whole egg powder used. Bread from chicken whole egg powder using the foam mat drying produced darker color than bread from chicken whole egg powder using oven drying and bread with fresh eggs (control). This color difference can be seen in the chicken whole egg powder produced, where chicken whole egg powder dried by the foam mat drying had a darker yellow color compared to chicken whole egg powder dried by the oven. This difference is due to the browning reaction that occurs during the drying process of chicken whole egg powder and the baking process of bread

[13], where the reaction occurs between the primary amine group of protein and the carbonyl group of reducing sugar that will produce brown pigments (melanoidins). In addition, the color of bread is also influenced by the used ingredients and good mixing or processing [14].

b. Aroma

Aroma is the second parameter that is assessed by consumers after considering color or appearance. Aroma is the main parameter that determines consumer acceptance of a food product [15]. Aroma is also an important factor in determining the level of consumer acceptance of a product. Recapitulation of bread organoleptic test values for aroma parameter is shown in table 2 and figure 1.

The aroma from the resulting bread was still normal and was liked by the panelists with a value of 3.7 (control), 3.81 (oven drying) 3.94 (foam mat drying). The produced bread with addition of chicken whole egg powder using oven drying had a unique aroma and was liked by the panelists, while the addition of whole egg chicken powder using foam mat drying had the highest score compared to oven drying and control treatment.

The difference in the aroma of produced bread was influenced by the chicken whole egg powder used. Chicken whole egg powder dried using the foam mat drying produced a distinct fishy aroma that was stronger than chicken whole egg powder dried using the oven drying. The resulting aroma came from the high protein and fat content in the chicken whole egg powder produced. The use of different temperatures in the chicken whole egg powder drying affected the hydrolysis of protein and fat in eggs. The process of decomposing protein acids into amino acids and fats into fatty acids and glycerol will produce a distinctive fishy odor. In addition, Xue et al. stated that the unique aroma and taste of processed egg products are also influenced by the Maillard reaction that occurs during the process of drying eggs and baking bread [16].

In addition, the aroma of bread was also influenced by other ingredients used in making white bread such as margarine. Margarine is an emulsifying agent made from vegetable fats. Margarine is also a basic ingredient for making bread which indirectly contributes to the formation of volatile compounds. Based on the research of Dadali and Elmaci [17], several volatile compounds were found in margarine, including 2,3-butanedione, butanoic acid ethyl ester, butanoic acid, and vanillin from the ketone, ester, acid and aldehyde groups respectively. Usually the aroma of a product is associated with an odor substance which is volatile (volatile) and slightly soluble in water and fat. The formation of volatile compounds can also be influenced by several factors. According to Izzreen et al. [18], fermentation conditions such as yeast concentration and fermentation temperature are factors that influence the formation of volatile compounds in bread. If the fermentation lasts a long

time, the nutrients contained in the dough will decrease and there will be too much accumulation of the fermented flavor which causes the distinctive aroma of the bread to disappear. However, the higher the concentration of yeast used, the higher the percentage of area in the group of important compounds that contribute to the aroma of bread and vice versa. These compounds include alcohols, aldehydes, esters, ketones, pyrazine, and others [19].

c. Taste

Taste is the third parameter assessed by the human senses after color and aroma. Taste is the main factor chosen by consumers when choosing a product. The tendency of consumers to always consume delicious products but considering the functionality has created the perspective that taste is an important factor in making decisions when they want to buy a product.

Table 2 shows that the taste of bread made from chicken whole egg powder were acceptable to consumers. The use of chicken whole egg powder from foam mat drying became the panelists' favorite for the taste parameter, which was 4.3 (Figure 1). Whereas bread made using chicken whole egg powder dried using the oven drying and fresh eggs (control) had the same acceptance level of 3.8. According to the panelists, using chicken whole egg powder from foam mat drying has a more savory and delicious taste comparing with other treatments.

Bread made with chicken whole egg powder has a distinct flavor which was stronger than bread made with fresh eggs. The resulting taste came from the fat contained in chicken whole egg powder and margarine used in making bread. According to Sartika [20] the addition of fat to food gives a delicious taste effect and a softer texture. In addition, the taste produced on white bread is influenced by the Maillard reaction [16], which occurs during the process of drying eggs and baking white bread. According to Winarno, taste is also influenced by several factors such as the chemical compounds contained, temperature, concentration and interactions between other flavor components [14]. Taste is the third parameter assessed by the human senses after color and aroma. Taste is the main factor chosen by consumers when choosing a product. The tendency of consumers to always consume delicious products but considering the functionality has created the perspective that taste is an important factor in making decisions when they want to buy a product.

d. Texture

Texture is the final parameter that is assessed by the human senses in a product. The texture of bread made from using chicken whole egg powder which were dried using the oven drying and foam mat drying s and bread made using fresh eggs (control) is shown in table 2. According to Mudjajanto and Yulianti, the essential criteria for bread that are soft and elastic texture [1]. Table

2 shows that the texture value of bread from chicken whole egg powder dried with foam mat drying was the highest which is 4.19, followed by the control treatment and oven drying treatment with values of 4.12 and 3.84 respectively.

The texture of bread was influenced by several factors, including the presence of protein, water and fat content of the basic ingredients for making bread. Fine bread pores were formed because air enters the dough and is dispersed in the form of fine bubbles when flour and water are mixed and kneaded, because wheat flour contains proteins that are capable of forming gluten when added to water and mechanically [21].

Increasing Volume of Bread

The swelling power of the bread is the ability of the bread to increase in size before and after the baking process. The results of observing the volume expansion power of bread in this study can be seen in table 3.

Table 3. Increasing Volume of Bread

Treatment	Increasing Volume % \pm SD
Oven Drying	236,6 \pm 11,4
Foam Mat Drying	289,6 \pm 8,2
Control	254,6 \pm 14,4

Based on table 3, it can be seen that the treatment used has an influence on the increasing volume of bread produced. The use chicken whole egg powder which was dried using the foam mat drying produced bread with the highest increasing volume (289.6%) compared to bread made with other treatments. Even the use of chicken whole egg powder which was dried using the foam mat drying produced bread with higher increasing volume compared to bread made using fresh eggs (control). The high increasing volume of bread made with chicken whole egg powder dried using the foam mat drying was due to the fact that the functional properties of the chicken whole egg powder used were still good and maintained. The addition of a foaming agent also increases the functional properties of chicken whole egg powder such as emulsifying power, foaming power, water absorption and oil absorption, which properties are needed in bread production [22,23]. Meanwhile, bread made from chicken whole egg powder which was dried using the oven drying produced bread with nearly the same increasing volume as bread made with fresh eggs (control). This showed that chicken whole egg powder can be used as a substitute for fresh chicken eggs, especially in making bread in this study.

Increasing volume is also affected by the ratio of amylose and amylopectin, heat, and water [24]. According to Estiasih, during kneading, starch is able to absorb water from the ingredients and trap air so that small air bubbles form [25]. After the heating process is carried out, a starch gelatinization process will occur which begins with starch swelling, crystalline melting, starch dissolving, spreading, expansion and expansion. Amylose has the ability to form complexes with lipids in starch, thereby inhibiting the swelling process. Meanwhile, the amylopectin branch contributes to the increase in development value because amylopectin easily traps water [26]

Increasing volume of bread is related to the ability of the dough to hold CO₂ bubbles during the fermentation process [27]. According to Cauvin, during fermentation, the yeast *Saccharomyces cerevisiae* added to the bread-making process will produce CO₂ gas as a result of glucose metabolism [2]. The CO₂ gas formed would increase the growth of air bubbles on the bread. The longer the fermentation time, the more CO₂ gas that was formed and diffuses into the gas bubbles in the dough which caused the bubbles to increase and expand the dough. Increasing volume of bread was also affected by the amount of water bound by the dough. The dough baking process experienced water loss. This caused the gluten layers to trap and separate the gas from each other by forming a protective layer to form a froth which then becomes tough and the dough expands [28].

Hardness Value of Bread

Chicken whole egg powder dried by oven drying and foam mat drying s was applied in the manufacture of bread. Then the obtained bread was tested for hardness value. Measuring the hardness of bread was done on the inside of the bread using the Texture Analyzer tool. The hardness value on the texture of the resulting white bread is shown in table 4.

Table 4. Hardness Value of Bread

Treatment	Hardness Value of Bread N/cm ² ± SD
Oven Drying	94,4 ± 1,7
Foam Mat Drying	50,8 ± 4,2
Control	78,2 ± 6,1

Table 4 shows that the hardness values obtained differ for the treatments. Bread made using chicken whole egg powder dried with foam mat drying had the smallest hardness value of 50.8 N/cm², followed by control and oven drying treatments with values of 78.2 N/cm² and 94.44 N/cm² respectively. This showed that bread made using chicken whole egg powder dried with foam mat drying has a smoother texture than other treatments. The smaller the hardness value, the finer the texture of the resultin bread. This was also supported by the organoleptic tests carried out where

bread made with chicken whole egg powder dried with foam mat drying was the most preferred product by consumers and obtained the highest test scores for the texture category as well.

The hardness values obtained were not much different from the results of research conducted by Pusuma et al. which obtained hardness value for white bread substituted with coconut dregs flour of 29.8–115.7 g/10 mm [13]. One of the factors that affect the texture of white bread was the gluten content. Gluten in bread making functions to trap and hold gas so that bread can expand with a smooth and uniform hollow structure and a soft and elastic texture [29,30].

Hardness is one of the physical properties that determine the quality of white bread which can determine the internal strength of the product. According to Adiluhung and Aji, the hardness value of white bread is also affected by proofing time and volume expansion [31]. Long proofing times can cause an increase in bread volume which affects the hardness value of the bread. The hardness value of white bread texture is inversely proportional to the increasing volume [32,33]. This was consistent with the research results obtained where the higher the increasing volume, the smaller the texture hardness value obtained, or the softer the bread obtained.

The texture of the white bread obtained had uniform pores and not a large size so that it makes the bread smoother and softer. Good bread pores are small and uniform in size across the crumb [13]. Bread pores were thin layers formed on gluten which function to trap carbon dioxide. Pores were formed during the fermentation process, at which time yeast activity begins to increase, the dough expands, and the volume of the dough increases due to the production of carbon dioxide gas by the yeast. In addition, gluten became elastic and softer due to the influence of alcohol, decreasing acidity so that gluten forms a thin layer that can hold gas. Suhardjito also stated that the formation of pores in white bread is also influenced by knocking down or grinding which causes the formation of the dough to relax again so that new gas appears [34].

CONCLUSION

Whole egg powder has a longer shelf life than fresh eggs, easier to apply, and can be applied in bakery industry. The results obtained show that bread from chicken whole egg powder dried using the oven drying and foam mat drying was liked and accepted by consumers, especially from a sensory perspective (color, aroma, taste and texture), and even has a preference compared to bread made with the use of fresh eggs. The best formulation for bread was obtained from bread made using chicken whole egg powder dried with foam mat drying with color, taste, aroma and texture parameter value are 4.1, 4.3, 3.9 and 4.2 respectively, while the increasing volume was 289.6% and hardness value was 50.8 N/cm². However, the characteristics of the bread produced using chicken

whole egg powder from both the oven drying and foam mat drying were not much different from bread made using fresh eggs and can be a new alternative in food industry.

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