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Optimization Of Salted Duck Egg Formulation With Maltodextrine In Producing Powdered Salt Duck Eggs Using The Foam-Mat Drying Method

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Abstrak: Penelitian ini bertujuan menghasilkan formulasi optimal pada pembuatan telur bebek asin bubuk dengan *foam-mat drying* menggunakan *Design Expert* 13 metode *Mixture D-Optimal* berdasarkan sifat kimia dan sifat organoleptik. Pemanfaatan telur bebek asin sebagai bumbu instan merupakan bentuk inovasi produk untuk meningkatkan konsumsi protein di Indonesia. Penelitian yang yaitu menentukan formulasi optimal telur bebek asin bubuk menggunakan program *Design Expert* 13 metode *Mixture D-Optimal* dengan menganalisis kadar protein, kadar air, dan organoleptik meliputi atribut warna, atribut aroma, atribut rasa, dan atribut tekstur (*handfeel*). Hasil penelitian berdasarkan prediksi program *Design Expert* 13 menunjukkan bahwa optimasi formula dengan kadar protein 18,04%, kadar air 1,56%, dan nilai organoleptik meliputi atribut warna 4,99, atribut aroma 4,67, atribut rasa 4,67, dan atribut tekstur (*handfeel*) 4,71. Lalu didapatkan nilai ketepatan (*desirability*) yaitu 0,761. Kemudian, hasil verifikasi menunjukkan kadar protein 18,23%, kadar air 3,04%, dan nilai organoleptik meliputi atribur warna 5,00, atribut aroma 4,80, atribut rasa 4,67, dan atribut tekstur (*handfeel*) 4,93. Selanjutnya dilakukan uji lanjutan, hasil yang didapatkan kadar lemak 30,91%, kadar abu 3,10%, kadar kabohidrat metode *by difference* sebesar 44,72%, dan kadar natrium (garam) 3,29%.
Kata Kunci : Bumbu instan; *Foam-mat Drying*; Optimasi Formula; Telur Bebek Asin.

Abstract: This study aims to produce an optimal formulation for making powdered salted duck eggs with foam-mat drying using Design Expert 13 Mixture D-Optimal method based on chemical and organoleptic properties. The use of salted duck eggs as instant seasoning is a form of product innovation to increase protein consumption in Indonesia. The research is to determine the optimal formulation of powdered salted duck eggs using the Design Expert 13 program using the Mixture D-Optimal method by analyzing protein content, moisture content, and organoleptics including color attributes, aroma attributes, taste attributes, and texture attributes (handfeel).The results of the study based on the prediction of the Design Expert 13 program showed that the optimization of the formula with a protein content of 18.04%, moisture content of 1.56%, and organoleptic values including color attributes of 4.99, aroma attributes of 4.67, taste attributes of 4.67, and texture attributes (handfeel) of 4.71. Then the accuracy value (desirability) was obtained, namely 0.761. Then, the verification results showed the protein content was 18,23%, mositure

content was 3,04%, and organoleptics value include color 5,00; aroma 4,80; taste 4,67; and texture (handfeel) 4,93. The results of follow-up tests, there are fat content 30,91%; ash content 3,10%; carbohydarate content by difference method of 44,72%; and sodium (salt) content of 3,29%.
Keyword: Instant seasoning; Foam-mat Drying; Formula Optimization; Salted Duck Eggs

1. Introduction

According to the Directorate General of Animal Husbandry and Animal Health (2020), national duck egg production reached 332 thousand tons in 2020, of which the largest production was in West Java at 69 thousand tons. It should be noted that duck egg production in West Java in 2023 will increase compared to 2020, namely 70 thousand tons. It is known that the average daily protein consumption in Indonesia per capita is 3.22 grams. Population protein consumption from March 2017 to March 2023 fluctuated, starting from 2017 to 2020 protein consumption decreased, but in 2021 it rose again and fell again in 2022 [1].

The lack of animal protein consumption can be met by increasing consumption of meat, milk and eggs, but the easiest and quickest way to meet the animal protein shortage in Indonesia is to increase egg consumption [2]. Adolescents who lack animal protein will be susceptible to infection and disease, disrupt neurotransmitter function which will reduce memory, disrupt the immune system, and experience growth delays. To prevent these bad effects, it is necessary to start consuming foods rich in animal protein as a daily diet. Animal protein needs can be met through eggs [3].

Duck or duck eggs (Anas domesticus) are a source of animal protein which has a very delicious taste, is easy to digest and is highly nutritious. The advantage of duck eggs compared to other poultry eggs is that they are rich in minerals, vitamin B6, pontothenic acid, thiamine, vitamin A, vitamin E, niacin and vitamin B12. Duck eggs are generally large in size and the shell color is white to bluish green. The average weight of a duck egg is 60-70 g [4].

Duck eggs are a food ingredient that is quite high in protein with a complete composition of amino acids. Apart from that, duck eggs contain

unsaturated fats, vitamins and minerals that the body needs and are very easy to digest. Good taste, relatively cheap price and can be processed into various kinds of food products, causing eggs to be widely consumed by the public [5].

Laying ducks are one of the poultry animals that are widely cultivated in Indonesia. This is because duck eggs are a food ingredient that is widely consumed by Indonesian people as a source of nutritious animal protein that is cheap and easy to obtain. In 2020, the high consumption of duck eggs by the public will make the cultivation of egg-laying ducks much in demand. In this way, the increasing interest can help increase Indonesia's economic value and help duck egg entrepreneurs in Indonesia and can even increase new innovations in developing products from egg raw materials that will present interesting new dishes in the future. This is shown by an increase in duck egg production of 2.56% in 2023, namely 358,220 tonnes compared to 2022 [1].

The availability of eggs knows no season, but eggs are very easily damaged, whether physical, chemical or biological. Therefore, it is necessary to carry out treatment to maintain the quality of eggs, namely changing the raw egg material into semi-finished processed products or finished products whose shape and characteristics are different from the properties of the raw material [6]. One effort to maintain egg quality is by preserving them [7]. There are many types of egg preservation and until now the best known and most popular among Indonesian people are salted eggs. The main aim of the egg salting process, apart from removing the fishy taste and creating a distinctive taste, is to extend the shelf life of the eggs [7].

Salted eggs were originally common in Chinese cuisine. In Indonesia itself, it developed in the 1950s and the longer the salted egg business in Indonesia developed. Salted eggs have become famous throughout Indonesia and have become a familiar thing for Indonesians to eat and have even become a complementary food in various dishes. "Salted eggs" became popular in Indonesia because they were carried over from Singapore's culinary trend. Many Indonesians visit Singapore and bring salted egg snacks as souvenirs [8].

Salted eggs have a limited shelf life even though the salting process has been carried out. One effort to increase the shelf life of salted eggs is processing

them into powdered salted duck eggs. Salted duck egg powder is a product that preserves eggs through a drying process. The egg drying process consists of several methods, namely spray drying, freeze drying, foam mat drying, and pan drying. Foam-mat drying is a technique for drying liquid and heat-sensitive materials through a foaming technique by adding a foaming agent. Drying in the form of foam can speed up the process of evaporation of water, and is carried out at low temperatures, so it does not damage cell tissue, thus nutritional value can be maintained. The foam-mat drying method is able to expand the interface area, thereby reducing drying time and speeding up the evaporation process [9].

Based on the information above, it was decided that research would be carried out on making salted egg powder products or salted duck egg powder based on salted duck eggs, Tween 80 as a foaming agent, and maltodextrin as a foaming stabilizer. In developing products, conventional formulations take a long time, are unpredictable, expensive, and cannot explain how one stage affects another stage. Therefore, a new method called experimental design with optimization techniques has been created to overcome the weaknesses of conventional methods.

One software that can be used to determine optimal formulations is Design Expert. Design Expert is used for process optimization in the main response caused by several variables and the aim is to optimize this response. Design Expert provides several design options with their respective functions, one of which is Mixture Design which functions to find the optimal formulation. Design Expert D-Optimal Mixture method is the software chosen because it is designed to help with experimental design tasks, the mixture menu used is specifically for processing formulations and the D-Optimal method has high flexibility in minimizing problems and suitability in determining quantities. material limits that change in more than 2 responses [10].

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2. Research Method

a. Materials and tools

The ingredients used in this research were salted duck eggs which had been salted for 14 days from the Salted Eggs Barokah "Cap Bintang" shop, maltodextrin and tween 80 which were obtained at the Subur Kimia Jaya Shop. The chemicals used for the analysis of powdered salted duck eggs, namely protein analysis using a mixture of selen, concentrated H2SO4, NaOH, HCl, PP indicator, and distilled water. Analyze salt or sodium levels using HNO3, HCl, yttrium, and distilled water. Analysis of fat content using n-hexane and boiling stones.

The tools used in this research are analytical scales (Matrix, Jakarta), hand mixer (Philips HR1552/10, China) with a speed of 1500 rpm, cabiner dryer, dry mill (Philips HR2115, China), tray, spatula and beaker. 250 mL (IWAKI). The tools used for analysis are analytical scales (Matrix), 50 mL measuring flask (IWAKI), 100 mL measuring flask (IWAKI), distillation flask (IWAKI), Erlenmeyer flask (Pyrex), condenser, oven, clamp and stand, flask circular, soxhlet, ICP-OES, 0.20 μm RC/GHP syringe filter, microwave digester, vessel, muffle furnace.

b. Research methods

The research method used in the research is primary research. The main research aims to optimize the formula for powdered salted duck eggs. In this research, the formulation was determined using the Design Expert program version 13, Mixture D-Optimal method. The changing variables used in this design are salted duck eggs and maltodextrin. Then several stages are carried out consisting of, namely, determining variables and responses, determining formulations, making products and testing responses, determining optimal formulations and verification.

Determination of the lower limit or minimum value limit (low) and the upper limit or maximum value limit (high) for each component is based on trial results and a framework of thinking. The limiting values can be seen in Tables 1 and 2.

Table 1. Fixed Variables for Making Powdered Salted Duck Eggs

Fixed Variable	Percentage (%)
Tween 80	1,00
Total	**1,00**
Variables Change	**99**
Total	**100**

Table 2. Variable Changes in Making Powdered Salted Duck Eggs

Variables Change	Lower Limit (Low)	Upper Limit (High)
Salted Duck Eggs	84,00	91,00
Maltodextrin	8,00	15,00

Based on the results of formulation calculations using the Design Expert program, Mixture D-Optimal method on powdered salted duck eggs, 11 formulations were obtained. The following 11 formulations produced by the Design Expert program using the Mixture D-Optimal method can be seen in Figure 1.

Run	Component 1 A:Telur Asin %	Component 2 B:Maltodekstrin %
1	91.00	8.00
2	85.75	13.25
3	91.00	8.00
4	84.00	15.00
5	91.00	8.00
6	87.50	11.50
7	84.00	15.00
8	84.00	15.00
9	91.00	8.00
10	87.50	11.50
11	89.25	9.75

Figure 1. Formulation produced by the D-Optimal Mixture Method Design Expert program.

The responses tested in this study included chemical and organoleptic responses. Test methods carried out on chemical responses include protein content analysis using the Kjedahl method and water content analysis using the gravimetric method. Then an organoleptic test was carried out using the hedonic test method with color, aroma, taste and texture (handfeel) parameters. In this hedonic test, the panelists used were 30 untrained panelists with a rating scale of very like to very dislike.

From the results of the data described, 11 formulations were produced with 2 changing variables, namely salted duck eggs and maltodextrin. After the data from the response test has been collected, it can then be entered back into the response column in the program. Design Expert will display and recommend the most optimal formulation. Next, verification of the optimal formulation is carried out which includes analysis of protein content, water content and organoleptic tests includes color, aroma, taste and texture (handfeel) as a validation stage for the suitability of results between predicted and actual data. The optimal formulation is determined by a desirability value of 0-1

3. Results and Discussion

This research was conducted to obtain the optimal formula for powdered salted duck eggs. The research carried out was making powdered salted duck eggs using 11 formulations recommended by the Design Expert 13 program using the Mixture D-Optimal method. Formula design with the Design Expert 13 program begins with determining fixed and changing variables, as well as the total composition of the raw materials in the product . The fixed variable is Tween 80 and the changing variables are salted duck eggs and maltodektsrin.

The following are the results of the chemical response analysis, namely protein content and water content with the following results:

Table 3. Results of Chemical Analysis of Powdered Salted Duck Eggs

Formulation	Salted Duck Eggs (%)	Maltodextrin (%)	Protein Content (%)	Water content (%)
1	91,00	8,00	18,29	4,35
2	85,75	13,25	15,13	5,77
3	91,00	8,00	18,29	3,24
4	84,00	15,00	13,10	3,50
5	91,00	8,00	18,29	4,53
6	87,50	11,50	16,88	2,74
7	84,00	15,00	13,10	3,84
8	84,00	15,00	13,10	4,10
9	91,00	8,00	18,29	2,25
10	87,50	11,50	16,88	3,20
11	89,25	9,75	17,27	1,50

Protein Content

Based on the results of the research that has been carried out, it can be concluded that the results of the chemical response analysis of the protein content of 11 powdered salted duck egg formulations ranged from 13.10-18.29%. Based on the analysis carried out by the Design Expert 13 program using the Mixture D-Optimal method, the polynomial model of the response to protein levels is quadratic. The ANOVA table shows that at the 5% level, the recommended model, namely quadratic, is significant, with a p"prob>F" value smaller than 0.05, namely <0.0001. The results of analysis of variance (ANOVA) at the 5% level show that the lack of fit value of the protein content response is not significant, relative to pure error.

From Table 3 and Figure 2, it can be seen that powdered salted duck egg products using salted duck eggs of 91% and maltodextrin of 8% have the highest protein content of 18.29%. This is because the greater the concentration of salted duck eggs, the higher the protein content.Stated that the increasing addition of salted duck eggs can provide an increase in protein levels, this is because the salted duck eggs used are whole and contain egg white which is the main component to increase protein levels.

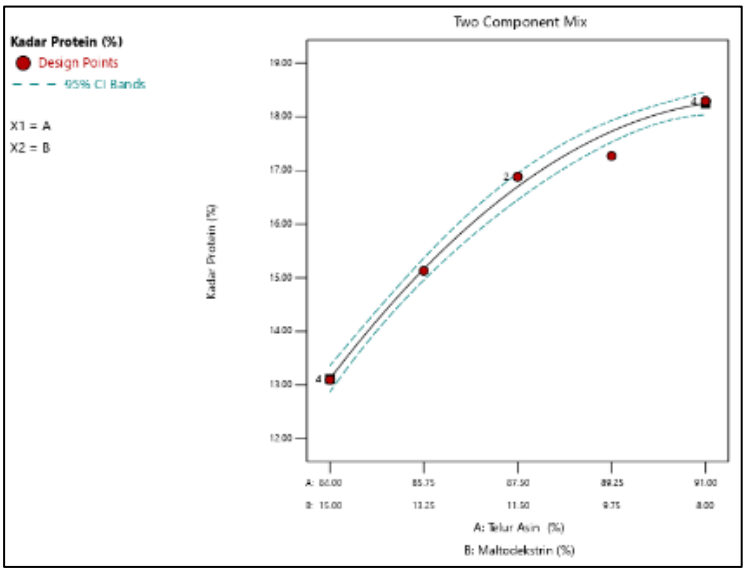

Figure 2. Graph of the relationship between protein content values in salted duck eggs and maltodextrin in powdered salted duck eggs.

The powdered salted duck egg product which has the lowest protein content is 13.10% with the use of salted duck eggs of 84% and maltodextrin of 15% can be seen in Table 3. This is because increasing the concentration of maltodextrin can reduce the protein content. According to [12], stating that increasing the concentration of maltodextrin does not increase the protein content of the product, this is because maltodextrin is a class of carbohydrates that does not contain protein, thus causing a decrease in the protein content of the product.

Water Content

Based on the results of the research that has been carried out, it can be concluded that the results of the analysis of the chemical response to the water content of 11 powdered salted duck egg formulations ranged from 1.50-5.77%. Based on the analysis carried out by the Design Expert 13 program using the Mixture D-Optimal method, the polynomial model of the water content response is cubic. The ANOVA table shows that at the 5% level, the recommended model, namely cubic, is significant, with a p"prob>F" value smaller than 0.05, namely 0.0267. The results of analysis of variance (ANOVA) at the 5% level show that the lack of fit of the resulting model is greater than 0.05, namely 0.5141 with an f-value of 0.4806. The value for lack of fit from the water content response is not significant, relatively pure error.

In Figure 3 it can be seen that the maximum water content point is in the combination of 86.75% salted duck eggs and 13.25% maltodextrin which has the highest water content level of 5.77%, while the minimum water content point is in the combination of salted duck eggs. 89.25% and maltodextrin 9.75% have the lowest water content, namely 1.50%.

In the results of the water content analysis, it is known that the lower water content value is influenced by the material, namely maltodextrin. According to [13], maltodextrin has the ability to bind water to food ingredients so that when the addition of maltodextrin increases, the water content will decrease, this is due to the presence of hydrophilic granules which are able to bind water.

Water content shows the amount of water contained per ingredient and is an important quality criterion for dry food products such as egg flour. The standard water content value for egg flour is according to SNI 01-4323-1996, where it is known that the maximum water content value for egg flour is 8% [14].

According to [15], the factors that influence the water content using the drying method are the treatment of temperature variations, particle size, and the size of the container or cup which influence the accuracy of determining the water content of food ingredients.

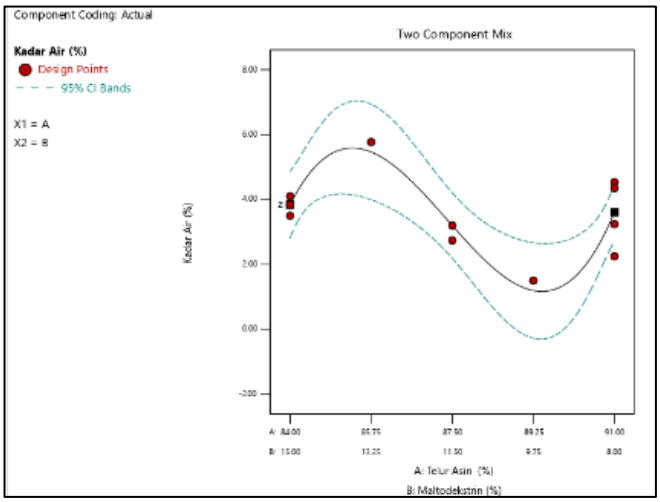

Figure 3. Graph of the Relationship Between Water Content Values in Salted Duck Eggs and Maltodextrin in Powdered Salted Duck Eggs.

Organoleptic Response

Following are the results of the organoleptic response analysis as follows:

Table 4. Results of Organoleptic Response Analysis of Powdered Salted Duck Eggs

Formulation	Salted Duck Eggs (%)	Maltodextrin (%)	Color	Aroma	Flavor	Texture (handfeel)
1	91,00	8,00	5,00	4,97	4,57	4,73
2	85,75	13,25	5,07	4,67	4,43	4,63
3	91,00	8,00	4,60	4,70	4,80	4,93
4	84,00	15,00	3,93	4,47	4,47	4,77
5	91,00	8,00	4,63	4,47	4,53	4,57
6	87,50	11,50	4,20	4,43	4,53	4,50
7	84,00	15,00	4,50	4,57	4,60	4,63
8	84,00	15,00	4,40	4,37	4,33	4,73
9	91,00	8,00	4,93	4,70	4,83	4,70
10	87,50	11,50	4,57	4,50	4,57	4,70
11	89,25	9,75	4,70	4,67	4,83	4,87

Color

Based on the results of the research that has been carried out, it can be concluded that the results of the analysis of the organoleptic response to the color attributes of 11 powdered salted duck egg formulations ranged from 3.93-5.07%. Based on the analysis carried out by the Design Expert 13 program, Mixture D-Optimal method, the polynomial model of the color attribute is quatric. The ANOVA table shows that at the 5% level, the recommended model, namely quatric, is not significant, with a p"prob<F" value greater than 0.05, namely 0.1054.

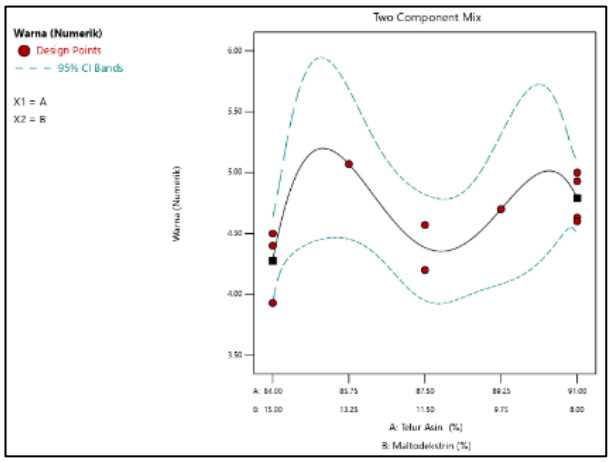

Figure 4. Graph of the Relationship Between Color Response Values for Salted

Duck Eggs and Maltodextrin in Powdered Salted Duck Eggs In figures 1 and 2 it can be seen that the maximum point of color response is in the combination of 85.75% salted duck eggs and 13.25% maltodextrin, while the minimum point of color response is in the combination of 84% salted duck eggs and 15% maltodextrin.

Aroma

Based on the results of the research that has been carried out, it can be concluded that the results of the analysis of the organoleptic response to the aroma attributes of 11 powdered salted duck egg formulations ranged from 4.37-4.97%. Based on the analysis carried out by the Design Expert 13 program using the Mixture D-Optimal method, the polynomial model of the aroma attributes is linear. The ANOVA table shows that at the 5% level, the recommended model, namely linear, is not significant, with a p"prob<F" value

greater than 0.05, namely 0.0679. This is shown by the lack of fit value being greater than 0.05, namely 0.5965 with an f-value of 0.6784. The lack of fit value of the aroma response was not significant relative to pure error.

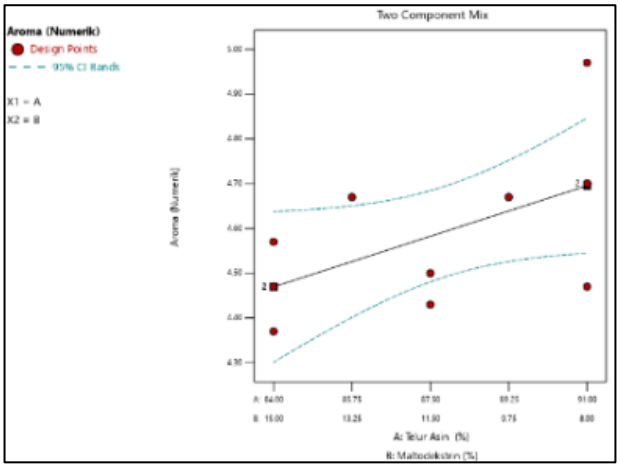

Figure 5. Graph of the Relationship Between Aroma Response Values for Salted Duck Eggs and Maltodextrin in Powdered Salted Duck Eggs

In Figure 5 it can be seen that the maximum point of aroma response is at the combination of 84% salted duck eggs and 15% maltodextrin, while the minimum point for aroma response is at the combination of 91% salted duck eggs and 8% maltodextrin.

Flavor

Based on the results of the research that has been carried out, it can be concluded that the results of the analysis of the organoleptic response to the taste attributes of 11 powdered salted duck egg formulations ranged from 4.33-4.83%. Based on the analysis carried out by the Design Expert 13 program using the Mixture D-Optimal method, the polynomial model of the taste attributes is linear. The ANOVA table shows that at the 5% level, the recommended model, namely linear, is not significant, with a p"prob>F" value smaller than 0.05, namely 0.0276. The results of analysis of variance (ANOVA) at the 5% level show that the lack of fit of the (linear) model is not significant. This is shown by the lack of fit value being greater than 0.05, namely 0.5091 with an f-value of 0.8644. The lack of fit value of the taste response was not significant relative to pure error.

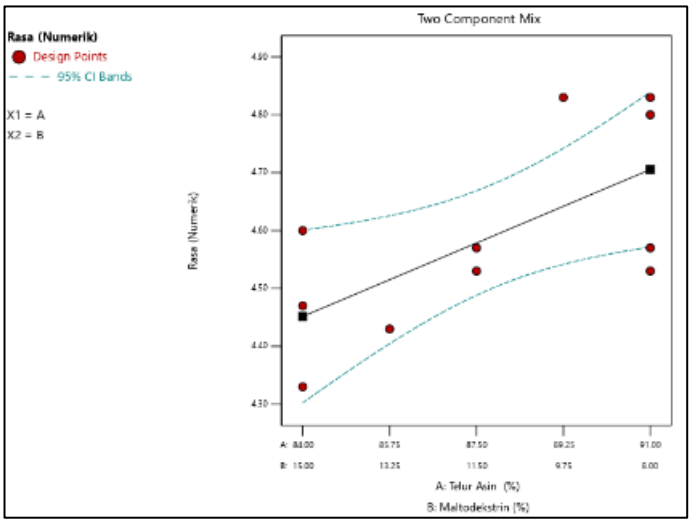

Figure 6. Graph of the Relationship Between Taste Response Values for Salted Duck Eggs and Maltodextrin in Powdered Salted Duck Eggs

In Figure 6 it can be seen that the maximum point of taste response is at the combination of 91% salted duck eggs and 8% maltodextrin, while the minimum point of taste response is at the combination of 84% salted duck eggs and 15% maltodextrin.

Texture (handfeel)

Based on the results of the research that has been carried out, it can be concluded that the results of the analysis of the organoleptic response to the texture (handfeel) attributes of 11 powdered salted duck egg formulations ranged from 4.50-4.93%. Based on the analysis carried out by the Design Expert 13 program, Mixture D-Optimal method, the polynomial model of the texture attribute (handfeel) is the mean. The ANOVA table shows that at the 5% level, the recommended model, namely the mean, is not significant. The results of analysis of variance (ANOVA) at the 5% level show that the lack of fit of the model (mean) is not significant. This is shown by the lack of fit value being greater than 0.05, namely 0.5197 with an f-value of 0.8980. The lack of fit value of the texture response (handfeel) is not significant relative to pure error.

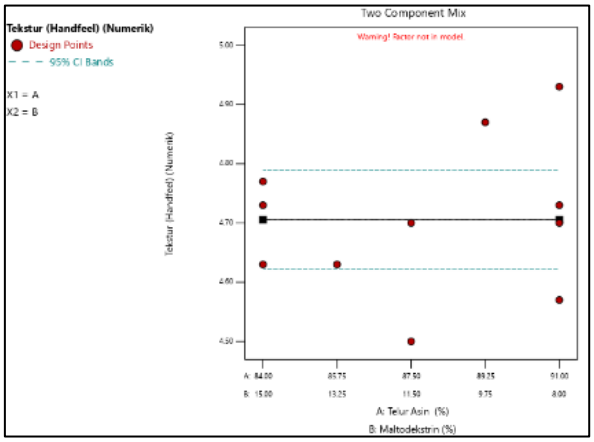

Figure 7. Graph of the Relationship Between Texture Response Values (handfeel) with Salted Duck Eggs and Maltodextrin in Powdered Salted Duck Eggs.

In Figure 7 it can be seen that the maximum point of test texture response (handfeel) is at the combination of 91% salted duck eggs and 8% maltodextrin, while the minimum point for test texture response (handfeel) is at the combination of 87.50% salted duck eggs and 11.50% maltodextrin. Formula Optimization Using the Design Expert Program 13 Mixture D-Optimal method.

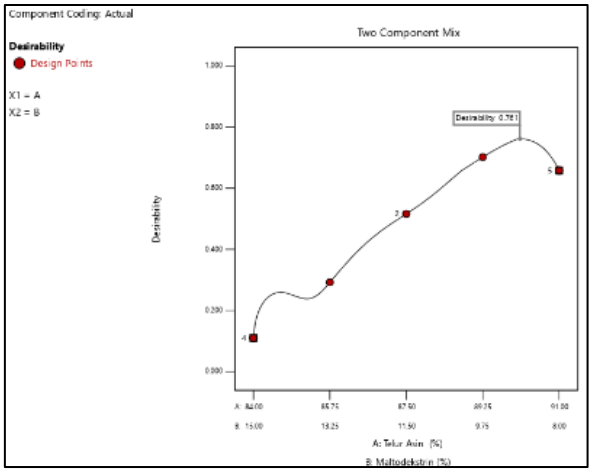

Figure 8. Desirability graph of the entire powdered salted duck egg product formula

The goal and importance of each response is determined so that the desirability value is obtained according to the researcher's wishes. After that, verification of the optimal formulation recommended by the Design Expert program is carried out.

The selected formula solution is the optimum powdered salted duck egg formula consisting of 90.10% salted duck egg and 8.90% maltodextrin. This formula has a desirability value of 0.761, which means this formula produces a

product that has characteristics in accordance with the optimization target of 76.1%. This formula is predicted to have a protein content value of 18.04%; water content of 1.56% and organoleptic values including color 4.99; aroma 4.67; taste 4.67; and texture (handfeel) 4.71.

The verification results show that the selected formula has a protein content of 18.23%, a water content of 3.04%, and organoleptic values include, namely, a color attribute score of 5.00; aroma of 4.80; taste of 4.67; and texture (handfeel) of 4.93.

Advanced Test

Further tests were carried out which included fat content, ash content, carbohydrate content and sodium content.

Fat Content

The method for analyzing fat content is broadly divided into two, namely the dry method and the wet method. One way to analyze fat is using the Soxhlet extraction method [16]. The results of further tests, namely analysis of the fat content in the optimal formula for powdered salted duck eggs, obtained a fat content of 30.91%.

Ash Content

According to Widyasanti [17], increasing the concentration of egg white will also increase the ash value, this is because egg white contains minerals. The results of further tests analyzing the ash content of the optimal formulation of powdered salted duck eggs showed an ash content of 3.10%.

Carbohydrate Levels

Several analyzes have been carried out, it can be seen the value of carbohydrate content using the by difference method, namely a 100% reduction in ash content, water content, protein content and fat content so that the carbohydrate content in the optimal formulation of powdered salted duck eggs is 44.72%. This test was carried out to find out how many calories were consumed in powdered salted duck egg products.

Sodium Levels

The results of follow-up tests on sodium (salt) levels in the optimal formulation of powdered salted duck eggs showed that sodium (salt) levels

were 2.03%. This test was carried out using the spectrophotometric method. Salting is the process of penetration into the material being salted by diffusion after the salt ionizes into Na+ and Cl-. Adding a certain amount of salt to a food can preserve the food and there will be an increase in salt levels, where the sodium levels will also increase [18].

4. Conclusion

The optimal formulation of powdered salted duck eggs is 90.10% salted duck eggs and 8.90% maltodextrin with a resulting desirability value of 0.761. Based on the optimal formulation obtained, the protein content was 18.23%, the water content was 3.04%, the color attribute score was 5.00, the aroma attribute score was 4.80, the taste attribute score was 4.67, and the texture attribute score (handfeel) was 4.93. The results of further tests on the optimal formulation of powdered salted duck eggs include fat content of 30.91%, ash content of 3.10%, carbohydrate content (by difference) of 44.72%, and sodium content of 2.03%.

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