

OPTIMIZATION OF EDAM CHEESE, NATURAL CHEDDAR CHEESE, SOY PROTEIN ISOLATE FOR SPREADABLE CHEESE ANALOGUE WITH DESIGN EXPERT APPLICATION (MIXTURE DESIGN).

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ABSTRACT

The purpose this research is to characteristic (flavour, texture, and odor) of Spreadable Analogue Cheese product by the substitution of Edam cheese and Cheddar cheese, and also addition of Soy Protein Isolate. Beside, this research is also to determine the best formulation of Spreadable Analogue Cheese process making using the Design Expert Application with Design D-optimal method.

This research was done within two phases. The preliminary phase is to determine the objective function, dependent and independent variables in the process of Spreadable Analogue Cheese making which are put in the application. The application generates the desired sensory and chemical characteristics. The second phase is to determine the best formulation of Spreadable Analogue Cheese. The respon in this research are chemical responses (including amino acids, fatty acids, and moisture content analysis), physical response (including viscosity), and sensory response (including aroma, flavor, texture, spreadability, and spoonability)

The Spreadable analogue cheese is made from Edam cheese and Cheddar cheese, and the thickeners (Soy Protein and corn starch). The application provides 11 formulations. The best formulation based on desirability (score 1) is the formulation which contains 11,66% Edam Cheese, 9,75% Cheddar Cheese, 3,84% Soy Protein Isolat, 5% corn starch, 23% vegetable oil, 43,25% water, 1% salt, 2% emulsifier (25% Trisodiumcitrate, 75% disodiumphospate), 0,5% acetic acid, and 0,02% distilled monoglyceride.

The responses results are 0,84% for fatty acids, 0,19% for amino acids, 47,64% for moisture content, 385,44 d.pas for viscosity, 3,97 for aroma attribute, 3,64 for flavor attribute, 3,95 for texture attribute, 4,18 for spreadability, and 4,09 for spoonability.

Keyword: Spreadable analogue Cheese, Cheese, optimation

Pendahuluan

Milk is the complete and balanced proportion of nutrition. Naturally, milk is the yield obtained from milking bovines or the other mammals which could be consumed or be used as healthy and safety food, without any reduction of its components(Hadiyiwoto in Widyaningrum (2009) The milk

production and consumption are increasing through time. The production only adequates the 25-30% needs in the country. For the reason, import of milk from New Zealand, Australia, and Philipine is needed. The milk consumption in Indonesia is lower than the other countries. The consumption is only 7 litres per capita each year(Widagdo, 2008).

Even cheese does not come from Indonesia, the popularity of this food grows and becomes the most loved food in the country. The society is persuaded by the nutrition and benefits of cheese to consume it whether as breakfast, lunch, or daily snacks.

Analogue Cheese is a substitution or an imitation of cheese. Analogue Cheese contains of dairy or non dairy milk protein and alternative oil or milk fat for the substitutio of milk solids(Fawcett, 2006).

Materials and Research Methodology

The materials used for produced the Spreadable Cheese Analogue are Edam Cheese, Cheddar Cheese, Soy Protein Isolate, cornstarch, Vegetable Oil, Water, Salt, Emulsifier (Trisodium Citrate, Disodium Sulfate), Distilled Monoglyceride, Acetic Acid, HCl 6N.

The tools for produced the Spreadable Cheese Analogue are scales, plastic containers, spoons, knives, slicer, spatula, hand blender, mixer, stove and pans. Then, the tools used for analysis are viscometer, digital balance, bowls, flask, filter paper, plastic samples, water bath, distillation flask, HPLC, and desiccator.

Research Methods

Preliminary research conducted to determine the formulated ingredients on Design Expert used Mixture Design Methode as material that becomes fixed variable and material that becomes changed variable.

Results and Discussion

Pleminary research

This preliminary research conducted for determining the objective function that determine the best formulation Spreadable Cheese Analogue from various formulas that generated by the program. After the

determination of variable fixed and variable changes, variable selection is determined by how much influence the substance of the product to be produced. The variable in this study is Edam Cheese, Cheddar Cheese and Soy Protein Isolate. Edam Cheese and Cheddar Cheese selected because they are basic ingredient in the manufacture of processed cheese and Soy Protein Isolate election is as a filler cheese.

Processed cheese is cheese made by mixing natural cheese and use salt emulsifiers and materials either from dairy or non dairy processed using heat treatment and mixing continuously to form a homogeneous product and resilient products old (Kapoor and Metzger, 2008).

Primary Research

The primary research is the advanced research from preliminary research that begins with making Spreadable analogue Cheese with 11 formulations provided by the program Design Expert mixture method D-optimal design for each response optimization of chemical and organoleptic response. This program will perform the appropriate optimization of variable data and response measurement data is entered. The output of the optimization phase is the optimal recommendation new formula according to the program. The optimal formula is formula with the highest desirability value is 1.

Fatty acid

Results of analysis of variance or ANOVA test can be seen in Table 1 shows the formulas that made no significant effect (probability > 0.05) of the fatty acid levels were tested with 95% confidence interval. Analysis of variance performed by the program Design Expert methods Mixture design

D-optimal on the value of the chemical response of fatty acids to the formula are made, shows the model created was not significant (probability > 0.05), at the 95% confidence interval with a value of $p = 0,82$. That is the formula that created no significant effect on the response of the test score fatty acids, so that the value of such a response can not be used for the optimization process is to get a product with optimum characteristics.



Figure 1. Graph Based Optimal

Formulation Response fatty acid levels

To achieve the levels of fatty acids in accordance with those predicted by the program on the application of the product Spreadable Cheese Analogue must use 11.66% Edam Cheese, Cheddar Cheese 9.75%, and 3.84% Soy Protein Isolate.

Fatty acids, together with glycerol, is the main constituent of vegetable oil or fat in a living being. This acid is found in cooking oil (cooking), margarine, or animal fat and fatty acid derivatives will determine its nutritional value. Naturally, the fatty acids contained in free form (because the fat is hydrolyzed) and bonded as glycerides (Whitney in Basmal, 2010).

The fatty acids contained in Spreadable Cheese Analogue is myristic acid, palmitic acid, and stearic which belong to the saturated fatty acids. The fat content of the product contributes substantially to the aroma, texture, flavor, spoonable, and

especially the spreadability is generated.

Amino acid

Based on the Table 2 ANOVA methods Mixture Design amino acid levels Spreadable Cheese Analogue, A represent Edam Cheese, B represent Cheddar Cheese, and C represent flour Soy Protein Isolate.

Results of analysis of variance or ANOVA test can be seen in Table 3, showed the formula that made not significant (probability > 0.05) to the amino acid levels were tested with 95% confidence interval. Analysis of variance performed by the program Design Expert methods Mixture design D-optimal response value chemical amino acid of the formula are made, shows the model created was not significant (probability > 0.05), at the 95% confidence interval with a value of $p = 0, 75$. That is the formula that created no significant effect on the response of the test score of amino acids, so that the value of such a response can not be used for the optimization process is to get a product with optimum characteristics.

Amino acids contained in Spreadable Cheese Analogue is tyrosine, alanine, and tryptophan.

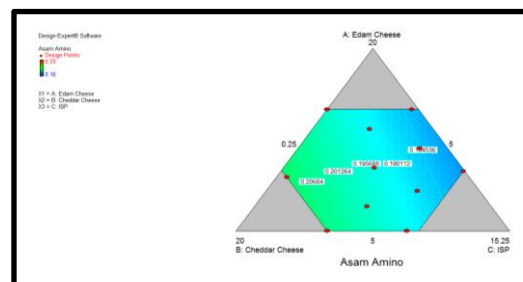


Figure 2. Graph Based Optimal Formulation Response amino acid levels

To achieve the levels of amino acids in accordance with those

predicted by the application program product Spreadable Cheese Analogue must use 11.66% Edam Cheese, Cheddar Cheese 9.75%, and 3.84% Soy Protein Isolate.

Amino acids contained in Spreadable Cheese Analogue is tyrosine, alanine, and tryptophan that included as non essential amino acids.

Water content

Results of analysis of variance or ANOVA test can be seen in Table 5 shows the formula that made a real impact (probability <0.05) in the water content was tested with 95% confidence interval. Analysis of variance performed by the program Design Expert methods Mixture D-optimal design on the value of the chemical response moisture content of the formula is made, shows the model created is significant (probability <0.05), at the 95% confidence interval with a value of $p = 0.01$, That is the formula that made significant effect on the response of the test score moisture content, so the value of these responses may be used for the optimization process is to get a product with optimum characteristics.

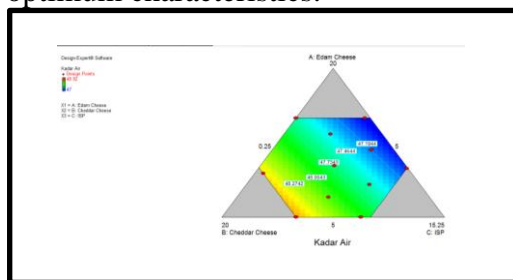


Figure 3. Graph Based Optimal Formulations Moisture Response

To reach the water content in accordance with the values predicted by the program on the application of the product Spreadable Cheese Analogue must use 11.66% Edam Cheese, Cheddar Cheese 9.75%, and 3.84% Soy Protein Isolate.

The role of salt in cheese making has three main functions, in addition to contributing directly to the flavor and sources of sodium salt also serves preservation because the effect on reduction of water content and will affect the use of more than 2% of the water content (Nugraha, 2015), spreadable cheese analogue levels lower than the standard that is above 50% this is because there is the addition of salt as much as 2% effect reduced water content in spreadable cheese analogue.

Viscosity

Based on the table 7 ANOVA methods Mixture Design viscosity response Spreadable Cheese Analogue, A represents Edam Cheese, B represents Cheddar Cheese, and C represents states flour Soy Protein Isolate. Term which comprises a single variable named letter stating linear effects while the term consisting of two letters stating two variables called interaction effects.

Results of analysis of variance or ANOVA test can be seen in Table 8 shows the formula that made a real impact (probability <0.05) in response to the viscosity tested with a confidence interval of 95%. Analysis of variance performed by the program Design Expert methods Mixture D-optimal design on the value of the chemical response viscosity of the formula that is made, shows the model created is significant (probability <0.05), at the 95% confidence interval with a value of $p = 0.01$. That is the formula that made significant effect on the response of the test score levels of viscosity, so that the value of these responses may be used for the optimization process is to get a product with optimum characteristics.

Graph optimal formulations based on the response of viscosity can be seen in Figure 4.

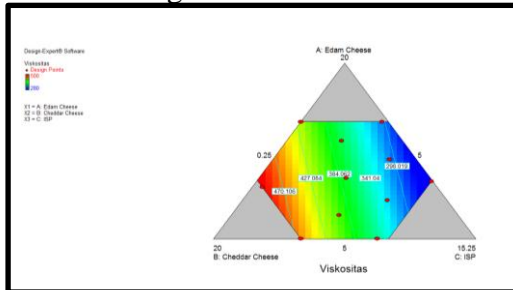


Figure 4. Graph Based Optimal Response Viscosity Formulation

To achieve the viscosity values correspond to those predicted by the program on the application of the product Spreadable Cheese Analogue must use 11.66% Edam Cheese, Cheddar Cheese 9.75%, and 3.84% Soy Protein Isolate.

Odor

Based on 10 ANOVA table attachment methods Mixture Design aroma response Spreadable Cheese Analogue. Results of analysis of variance or ANOVA test can be seen in Table 11 shows the formula that made not significant (probability > 0.05) on the response of aroma was tested with 95% confidence interval. t the 95% confidence interval with a value of $p = 0.33$, That is the formula that made not significantly affect the response aroma organoleptic test score, so that the value of such a response can not be used for the optimization process is to get a product with optimum characteristics.

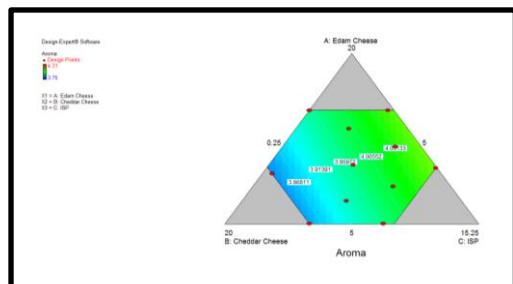


Figure 5. Graph Based Optimal Formulation Response aroma Appearance

To achieve the organoleptic aromas according to those predicted by the program on the application of the product Spreadable Cheese Analogue must use 11.66% Edam Cheese, Cheddar Cheese 9.75%, and 3.84% Soy Protein Isolate.

Aroma is a taste and smell are very subjective and difficult to measure, because everyone has a different sensitivities and preferences. In many ways, delish a food is determined by the smell of food. The results of organoleptic test on the aroma average is 4.35. Indicates that the panelists liked the smell of spreadable cheese analogue.

Texture

Based on the ANOVA method of attachment table 12 texture Mixture Design response Spreadable Cheese Analogue, A represents Edam Cheese, Cheddar Cheese B states, and C states flour Soy Protein Isolate. Term which comprises a single variable named letter stating linear effects while the term consisting of two letters stating two variables called interaction effects.

Results of analysis of variance or ANOVA test can be seen in Table 13 shows the formula that made not significant (probability > 0.05) on the response of the tested organoleptic. In the 95% confidence interval with a value of $p = 0.21$. That is the formula that created no significant effect on the response of the test score organoleptic texture, so that the value of such a response can not be used for the optimization process is to get a product with optimum characteristics.

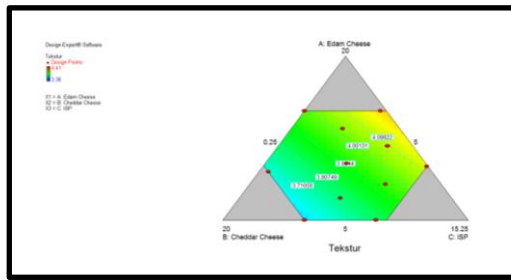


Figure 6. Graph Based Optimal Response Formulation Appearance texture

To achieve the organoleptic value of texture corresponding to those predicted by the program on the application of the product Spreadable Cheese Analogue must use 11.66% Edam Cheese, Cheddar Cheese 9.75%, and 3.84% Soy Protein Isolate.

The use of many Edam Cheese with Cheddar Cheese texture affect the organoleptic response because along with the resulting variations in fat content darimasing each cheese. This coincides with observations by Muir et al in Bayarri (2012), that the fat content is clearly affecting the sensory associated with the texture and mouthfeel of cheese spread, although there is no systematic difference in a variety of flavors with a fat content stabilized.

Flavor

Based on the annex table 14 ANOVA methods Mixture Design Analogue Spreadable Cheese flavors response, A represents Edam Cheese, Cheddar Cheese B states, and C states flour Soy Protein Isolate. Results of analysis of variance or ANOVA test can be seen in Table 15 shows the formula that made not significant (probability > 0.05) on the response of the organoleptic taste test with 95% confidence interval. Analysis of variance performed by the program Design Expert Mixture design method

d-optimal response value uji organoleptik taste of the formula made, shows the model created was not significant (probability > 0.05), at the 95% confidence interval with a value of $p = 0.17$. That is the formula that created no significant effect on the response of the test score organoleptic taste, so that the value of such a response can not be used for the optimization process is to get a product with optimum characteristics.

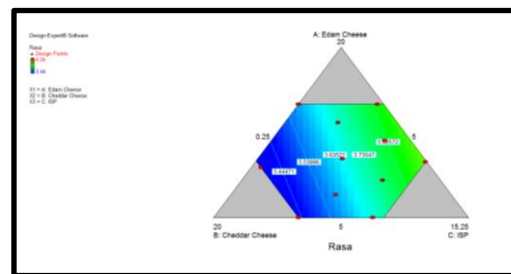


Figure 7. Graph Based Optimal Response Formulation Appearance flavor

To achieve organoleptic taste value in accordance with those predicted by the program on the application of the product Spreadable Cheese Analogue must use 11.66% Edam Cheese, Cheddar Cheese 9.75%, and 3.84% Soy Protein Isolate.

Most of the consumer population (88.6%) positive correlation with cheese like creaminess, softness or mouthfeel, compactness, cheese flavor, and not like the correlation with astringency. In addition, for a subgroup representing 38.7% of consumers, like positively correlated with the smell of cheese and consistency of cheese, and not like the correlation with saltiness, acidity and off-flavor (Bayarri, 2012).

Spreadability

Based on 16 ANOVA table attachment methods Mixture Design organoleptic response spreadability Spreadable Cheese Analogue, A

represents Edam Cheese, Cheddar Cheese B states, and C states flour Soy Protein Isolate.

Results of analysis of variance or ANOVA test can be seen in Table 17 shows the formula that made a real impact (probability <0.05) in response to the organoleptic spreadability tested with 95% confidence interval. Analysis of variance performed by the program Design Expert Mixture design method d-optimal response value ujiorganoleptik spreadability of the formula are made, shows the model created is significant (probability <0.05), at the 95% confidence interval with a value of $p = 0.02$. That is the formula that made significant effect on the response of the organoleptic test score spreadability, so that the value of such a response can not be used for the optimization process is to get a product with optimum characteristics.

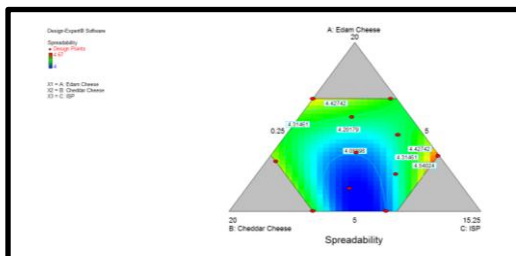


Figure 8. Graph Based Optimal Response Formulation Appearance spreadability

To achieve the organoleptic aromas according to those predicted by the program on the application of the product Spreadable Cheese Analogue must use 11.66% Edam Cheese, Cheddar Cheese 9.75%, and 3.84% Soy Protein Isolate.

The greater the degree of saturation of fat, the greater the degree of hydrophobicity and a low level of stickiness given on the product (Cunha, 2012). Southwestern cheese topical drawn between the power of attraction

between the surface of the food to be smeared cheese with cheese itself.

Spoondability

Based Table 19 ANOVA methods Mixture Design organoleptic response Spoondable Spreadable Cheese Analogue, A represents Edam Cheese, B represents Cheddar Cheese, and C represents flour Soy Protein Isolate. Term which comprises a single variable named letter stating linear effects while the term consisting of two letters stating two variables called interaction effects.

Results of analysis of variance or ANOVA test can be seen in Table 20 shows the formula that made a real impact (probability <0.05) in response to the organoleptic Spoondable tested with a confidence interval of 95%. Analysis of variance performed by the program Design Expert methods Mixture D-optimal design in response Spoondable organoleptic test value of the formula is made, shows the model created is significant (probability > 0.05), at the 95% confidence interval with a value of $p = 0.005$. That is the formula that made not significantly affect the response Spoondable organoleptic test score, so that the value of such a response can not be used for the optimization process is to get a product with optimum characteristics.

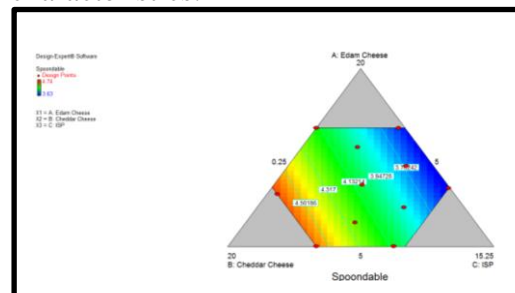


Figure 9. Graph Based Optimal Response Formulation Appearance Spoondable

To achieve the organoleptic aromas according to those predicted by the program on the application of the product Spreadable Cheese Analogue must use 11.66% Edam Cheese, Cheddar Cheese 9.75%, and 3.84% Soy Protein Isolate.

Formulation Optimization Selected

Formulation is a solution or formulation selected optimal predicted by design expert method D-optimal mixture design is based on an analysis of the chemical response (amino acids, fatty acids, and water content), the response organoleptic (aroma, flavor, texture, spreadability, dan spoonable) and physical responses viscosity test.

Component	Name	Level	Low Level	High Level	Std. Dev.	Coding
A	Edam Cheese	11.66	5.00	15.00	0.000	Actual
B	Cheddar Cheese	9.75	5.00	15.00	0.000	Actual
C	ISP	3.84	0.25	10.25	0.000	Actual
Total =		25.25				

Response	Prediction	SE Mean	95% CI low	95% CI high	SE Pred	95% PI low	95% PI high
Asam Lemak	0.843332	0.14	0.51	1.18	0.43	-0.15	1.84
Asam Amino	0.195988	0.014	0.16	0.23	0.043	0.097	0.29
Kadar Air	47.6391	0.15	47.28	48.00	0.46	46.57	48.71
Viskositas	385.448	20.61	337.91	432.98	61.80	242.93	527.96
Aroma	3.96941	0.060	3.83	4.11	0.18	3.56	4.38
Tekstur	3.94796	0.11	3.70	4.20	0.32	3.20	4.70
Rasa	3.64348	0.089	3.44	3.85	0.27	3.03	4.26
Spreadability	4.18092	7.507E-003	4.09	4.28	0.011	4.04	4.32
Spoonable	4.99037	0.083	3.90	4.28	0.25	3.51	4.67

Figure 10. Spreadable Cheese Analogue Formulations best

Accuracy of formulations and the value of each of these responses can be seen in desirability. Desirability is the degree of accuracy of the solution or the optimal formulation. Getting closer to the higher value of the ketepatan formulations, so it can be concluded based on the value of desirability that has reached 1.00, the resulting formulation has a high accuracy values.

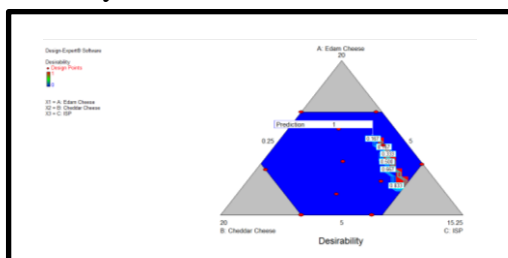


Figure 11. The graph desirability Spreadable Cheese Analogue

Based on the desirability above optimal formulation obtained Spreadable Cheese Analogue 1 formulations offered which has the percentage amount that is 11.66 % Edam Cheese, Cheddar Cheese 9.75 %, and 3.84 % Soy Protein Isolate. The formula predicted by the program with a fatty acid content of 0.84 %; amino acid content of 0.19 %; the water content of 47.64 %; viskositas value d.pas 385.45; organoleptic aromas value of 3.95; organoleptic texture value of 3.95 %; organoleptic taste value of 3.64; organoleptic spreadability value of 4.18; organoleptic value Spoonable 4.90.

Table. comparison of the results of expert design analysis method of design D - optimal mixture with laboratory analysis and organoleptic tests to Spreadable cheese analogue selected.

Componen	Aplicatio n	Laborator y
Fatty Acid	0,84%	13,29%
Amino acid	0,19%	0,12%
Water	47,64%	48,10%
Viskosity	385,44 d.pas	380 d.pas
Flavor	3,97	4,04
Taste	3,64	3,70
Texture	3,95	3,90
Spreadabilit y	4,18	4,25
Spoonable	4,09	4,12

Comparison of the results of the program with laboratory analysis and organoleptic tests to measure the desirability value generated by the program that has a value precision of 1

means very precise. Based on the data generated difference results from the two do not differ too much only response fatty acids which have a value of the test is higher compared to the results issued by the program, it can happen because the products are made later in the analysis experienced a process of saving for a few days so the content fatty acids increased.

Conclusion

Based on the results of a study of 11 formulations, water content and viscosity values while based on the organoleptic properties, attributes spreadability and spoonable a significant effect on the 11th formulations.

Optimal formulations based on data from all 11 basic formulations onto for products made from raw Spreadable Cheese Analog Cheese Edam and Cheddar Cheese that is

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11.66% Edam Cheese, Cheddar Cheese 9.75%, and 3.84% Soy Protein Isolate, and materials the other is the variable fixed at 5% cornstarch, vegetable oil 23%, 43.25% water, salt 1%, 2% emulsifier (Trisodium citrate phosphate disosium 25% and 75%), 0.5% acetic acid, and distilled monoglyceride 0.002%. The formulation has been predicted by the program with a fatty acid content of 0.84%, 0.19% amino acids, the water content of 47.64%, 385.44 d.pas viscosity, organoleptic assessment of the attributes aroma 3.97; organoleptic assessment of the attributes of a sense of 3.64; organoleptic assessment texture attributes 3.95; organoleptic assessment of the attributes spreadability 4.18; and assessment of organoleptic attributes Spoonable 4.09.

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