RJC

RASĀYAN J. Chem.
Vol. 9 | No. 4 |762 - 768 | October - December | 2016
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

# OPTIMIZATION FORMULATION CHEESE SPREADABLE ANALOGUE TO CHARACTERISTIC OF ORGANOLEPTIC AND CHEMISTRY USES RESPONSE SURFACE METHODOLOGY

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## ABSTRACT

The purpose this research is to characteristic (flavor, 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 Response Surface Methodology method Central Composite. 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 response 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). The responses results are 0.84% for fatty acids, 0.19% for amino acids, 47.64% for moisture context, 385.44 d.pas for viscosity, 3.97 for aroma attribute, 3.64 for flavor attribute, and 3.95 for texture attribute.

**Keywords:** spreadable analogue cheese, cheese, optimization.



## INTRODUCTION

Cheese is one form of solid dairy products that require fermentation in the manufacturing process. The cheese has been consumed in Asia several thousand years ago and many ancient writings contain references that transform milk into cheese ace a method of preservation[8].

At present, although the cheese was consumed only above a certain economic level, but the last few years, demand for dairy products is quite large. In 1998, consumption of cheese reached 1.094.333 sinks, which from this amount of cheese produced in the country of about 34. 976 sinks, while the rest is met by imports.

Processed cheese of cheese that is made by mixing and destroying the natural cheese accompanied by heating, so ace to produce a uniform product and supple. Additional food ingredients commonly used in the manufacture of processed cheese emulsifying salts, dyes, water, and flavor[7].

Natural cheese type most used in the manufacture of processed cheese in Indonesia is the cheddar cheese, so often called Cheddar cheese processed. The shape also vary from block, slice, and sauce to spreadable[5].

Cheese market demand is increasing, but the increase in demand is note directly proportional to the selling price in the market. Processed cheese is still one imported products, then there must be a response to the phenomenon that occurs above, this can be realized by making a cheese analogue which has the same characteristics both from organoleptic and chemical properties of the original cheese.

Analogue cheese was first introduced in the United States in the early 1970-an. Making cheese analogue of various natural cheeses (eg, Cheddar, Monterey Jack, Mozzarella, Parmesan, Romano, Blue and Cream). Of the several types of cheese that is often used is the cheddar cheese and mozzarella.

Problems in the manufacture of cheese analogues, especially for Cheese Spreadable Analogue is to determine the mix of types of cheese and concentration of cheese used ace a filler to meet a protein source, a filler in the manufacture of cheese analogue usually using cornstarch, potato starch, rice flour, wheat flour, carrageenan and gelatine[4].
This using Response Surface Methodology (RSM) that is used to help optimize the product or process. Then using the method Central Composite Design (CCD) in order to find the right results. This program has the advantage compared to other programs such ace for example the program that this program will optimize the processes included in the manufacturing process Spreadable Cheese Analogue with some variables expressed in units of the response. Experimental CCD is a design consisting of a 2k factorial design with center added a couple of runs and axial run.

## EXPERIMENTAL

The materials used in this are the ingredients for the manufacture Spreadable Cheese Analogue and materials for the chemical response analysis. The materials used to manufacture Spreadable Cheese Analogue is Edam Cheese and Cheddar Cheese, Soy Protein Isolate, cornstarch, Vegetable Oil, Salt, Emulsifier (Trisodium Citrate, Disodium Phosphate), Acetic Acid.
The materials used for chemical analysis is distilled water, salt Kjeldahl, a solution of concentrated $H_2SO_4$, 30% NaOH solution, $Na_2SO_4$ solution, boiling stones, granules Zn, raw HCl solution, phenolptalein, N-hexane, alcohol and solution Baffer.
The tools used in this are the ingredients for the manufacture Spreadable Cheese Analogue and materials for chemical analysis. The tools used to manufacture Spreadable Cheese Analogue namely the scale, spoons, knives, slicer, spatula, mixers, hand blander.
The tools used for chemical analysis is erlenmeyer flask 100 ml, flask, rod stirrer, pipette volumetric, pipette, digital balance of, tool reflux, filter paper, beakers, funnels, flask, pumpkin Kjeldahl, stove, adapters, distillation equipment, the stand, clamps, burettes, reading copy bags, yarn mattress, sokhlet, stove, bath, pumpkin round bases, oven, and eksikator, pH metre.
Experimental Response Surface Methodology designs Central Composite Design methods that will be used.

Table-1: Determination of Design of Experiments CCD pts

| | Unit | -alpha | -1 | 0 | 1 | +alpha |
|---|---|---|---|---|---|---|
| Edam | % | 0 | 5 | 10 | 15 | 20 |
| Cheddar | % | 0 | 5 | 10 | 15 | 20 |
| ISP | % | -5 | 0 | 5 | 10 | 15 |
| cornstarch | % | -5 | 0 | 5 | 10 | 15 |

A middle value (0) default is the value and the average value of (-1) and (+1) for each factor. Due to the number of factors in this variable is the fourth factor, the value of a = vk = v4 = 2. Ace for the actual alpha is calculated by the equations:

$$-alpha = (0) - a [ (0) - (-1) ]$$
$$+alpha = (0) + a [ (0) - (-1) ]$$

The entire formulation of raw materials and excipients ace well ace the addition of other ingredients variables calculated using dependent ace significant balance, including moisture content, fat content, amino acid , and viscosity, appearance Test against aroma, flavor, and texture in each formulation. Results of the analysis incorporated will be into the data program table methods Response Surface Methodology Central Composite Design.

## RESULTS AND DISCUSSION

**Fat Content**

Estimated coefficient is the coefficient of each of these factors in the equation conded ace follows:

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Fat Content = $28.65 + 1.05A + 1.98B + 0.46C + 0.25D + 0.36AB + 0.55AC - 0.16AD - 0.16BC + 0.55BD + 0.36CD - 0.005A^2 - 0.04B^2 - 0.27C^2 - 0.090D^2$

Optimal Graph formulations based di atas the response levels of fat can be seen in the picture:

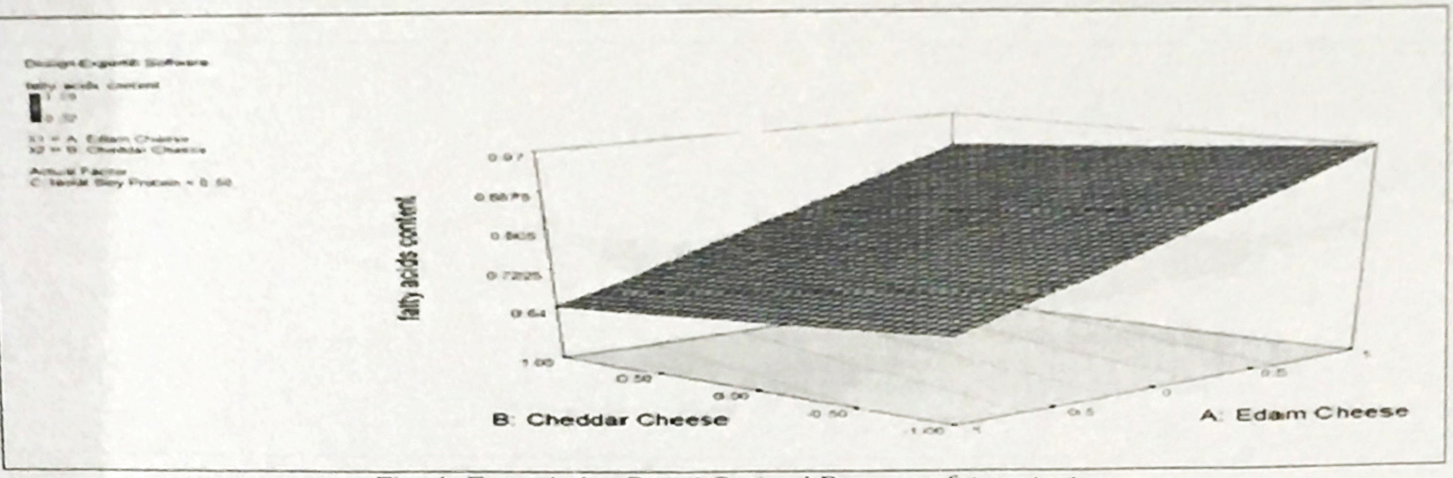


Fig.-1: Formulation Based Optimal Response fat content

Graph above show optimal formulation bases response level of fat, level of fat that predicted by this graph as high as 28.6506% where boundary under level of fat from entire formulation that is 22.7272% and upper limit as high as 32.582%. To reach value of level of fat is matching with the one which predicted by program at product Cheese Spreadable Analogue must uses Edam Cheese 10% and Cheddar Cheese 10% as the value X1 and X2 and Isolate Soy Protein 5%, cornstarch 5% as the actual factor, where X1 and X2 and second actual factor is variable changes.

Addition of filler materials can degrade level of cheese fat process, at product Cheese Spreadable Analogue filler materials Isolate Soy Protein and cornstarch more and more its use then level of fat will be growing downhill. This condition because more and more usage Isolate Soy Protein then product Cheese Spreadable Analogue that produced by will have level of high protein whereas more and more addition of filler materials Cornstarch then extract content more and more and level of fat growing downhill, content of vegetation fat from cornstarch by itself gyrate 3.59% while carbohydrate is biggest component that is 76.89%. Base this condition then will cause level of cheese fat Cheese Spreadable Analogue growing downhill.

**Moisture Content**

Base tables ANAVA model RSM level of water Cheese Spreadable Analogue, A state Edam Cheese, B state Cheddar Cheese, C state Isolatee Soy Protein and D cornstarch. Term that consist of one letter named single variable states linear effect whereas term that consist of two letters named two variables that state interaction effect.

Base ANAVA are referred as existed some terms that have significant influence to level of water Cheese Spreadable Analogue and there is also term that has no significant influence to level of water Cheese Spreadable Analogue. As for that have an effect on significant to level of water is term linear Edam Cheese, term linear Cheddar Cheese, terms linear Isolate Soy Protein and term linear cornstarch. Whereas term two variable and interaction effects not give significant influence to response produced and to know influence picture that given from each term referred, then must see coefficient estimation from each term.

Coefficient estimation that is coefficient of each factor that existed in equation conducted as follows-

Moisture Content = $51.37 - 3.29A - 3.67B - 5.23C - 3.83D - 0.61AB - 0.31AC + 0.65AD + 0.65BC - 0.31BD - 0.61CD + 0.061A^2 + 0.061B^2 + 0.32C2 - 0.22D^2$

Optimal Graph formulations based the response moisture content can be seen in the picture:

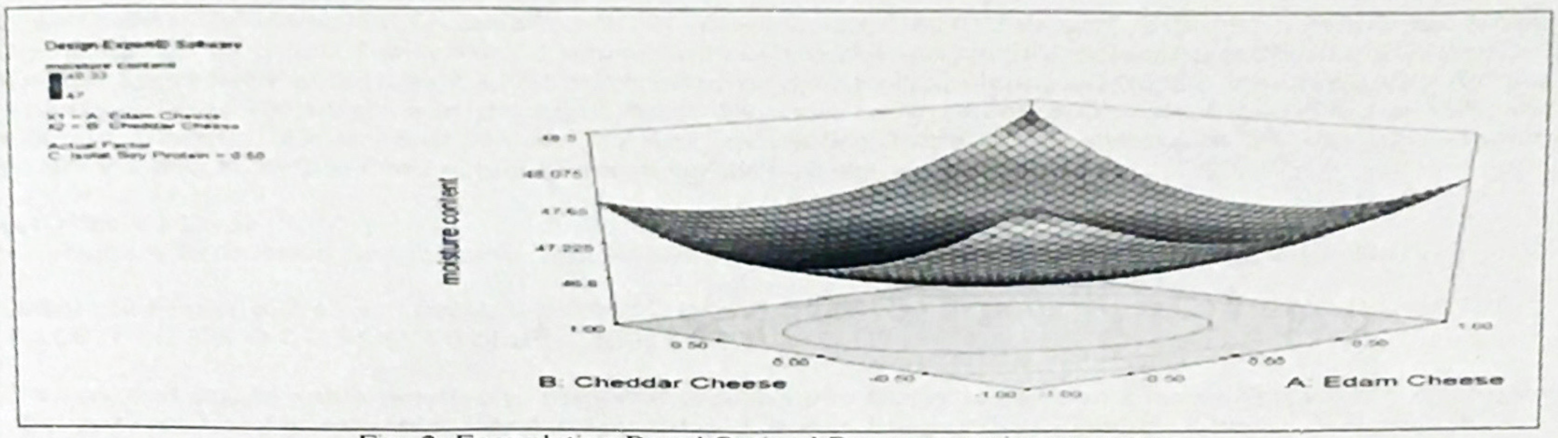


Fig.-2: Formulation Based Optimal Response moisture content

Graph above show optimal formulation bases response level of water, level of water that predicted is 51.3661% where boundary under level of water from entire formulation that is 35.6795% and upper limit as high as 67.445%. To reach value of level of water is matching with the one which predicted by program at product Cheese Spreadable Analogue must uses Edam Cheese 10% and Cheddar Cheese 10% the value X1 and X2 and Isolate Soy Protein 5%, cornstarch 5% the actual factor, where X1 and X2 and second actual factor is variable changes.

Salt Role in cheese making have 3 main functions, besides directly to flavor and sodium source, salt for preserves or pickling because have an effect on to reduction of level water. Gyration the usage of salt at cheese making is 1% to 10%, and will have an in with usage more than 2% to level of water.

**Attribute Aroma**

Optimal formulation Graph bases response organoleptic aroma can be seen in the picture-

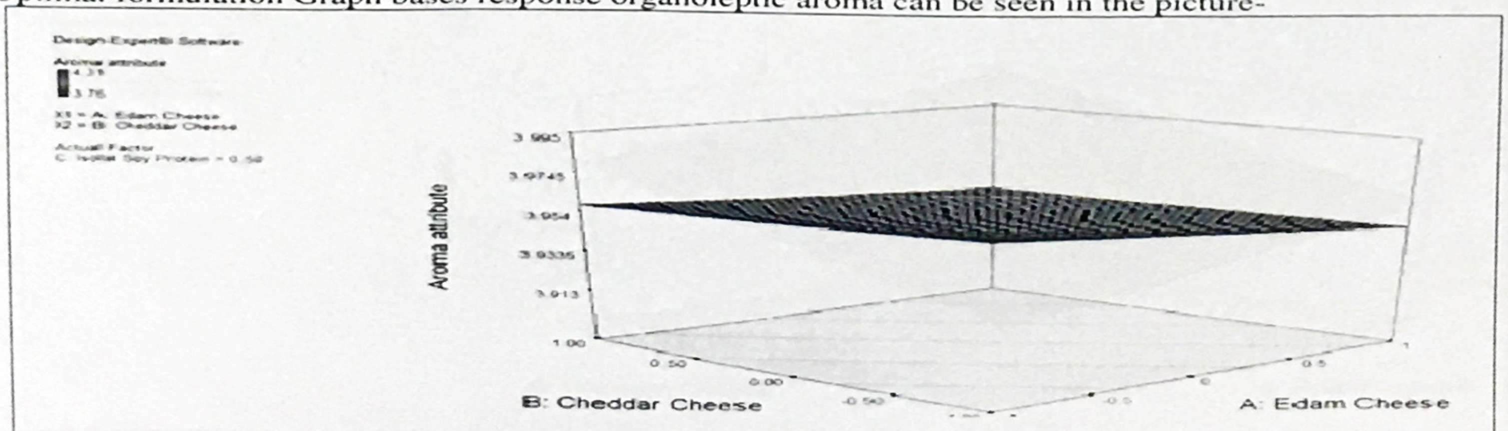


Fig.-3: Response Attribute Aroma

Coefficient Estimation that is coefficient of each factor that existed in equation conducted as follows-

Attribute Aroma = 7.40 + 0.12A + 0.043B - 0.35C - 0.04D – 0.45AB – 0.12AC – 0.22AD - 0.017BC - 0.13BD – 0.21CD – 0.40$A^2$ - 0.37$B^2$ – 0.41$C^2$ – 0.71$D^2$

Graph above show optimal formulation bases response organoleptic aroma, response organoleptic aroma that predicted by graph this is the 7.4 where boundary under assesses response organoleptic aroma that is 4.4 and upper limit as high as 7.4. To reach value response organoleptic aroma are matching with the one which predicted by program at product Cheese Spreadable Analogue must uses Edam Cheese 10% and Cheddar Cheese 10% as value X1 and X2 and Isolate Soy Protein 5%, cornstarch 5% the actual factor, where X1 and X2 and second actual factor is variable changes.

**Attribute Flavor**

Coefficient Estimation that is coefficient of each factor that existed in equation conducted as follows-

Attribute Flavor = 7.45 + 0.085A + 0.056B – 0.29C – 0.061D – 0.38AB – 0.23AC – 0.22AD – 0.03BC – 0.16BD – 0.32CD – 0.55$A^2$ – 0.60$B^2$ – 0.63$C^2$ – 0.60$D^2$

Factors that assign value positive to response organoleptic flavor to product Cheese Spreadable Analogue that produced by for example: linear effect Edam Cheese, linear effect Cheddar Cheese. Whereas factors that assign value negative to response organoleptic flavor shall be as follows: linear effect Isolate Soy Protein and linear effect Cornstarch effect quadratic Edam Cheese, effect quadratic Cheddar Cheese, effect quadratic Isolate Soy Protein and effect quadratic cornstarch.

No existed interaction 2 factors that is synergic interaction to response organoleptic flavor. All interactions 2 factors give interaction antagonis, as for interaction that give effect antagonis as follows: Edam Cheese and Cornstarch and interaction between Isolate Soy Protein and Cornstarch, interaction between Edam Cheese and Cheddar Cheese, interaction between Edam Cheese and Isolate Soy Protein, interaction between Cheddar Cheese and Cornstarch and interaction between Cheddar Cheese and Isolate Soy Protein.

Optimal formulation Graph bases response organoleptic flavor can be seen in the picture-

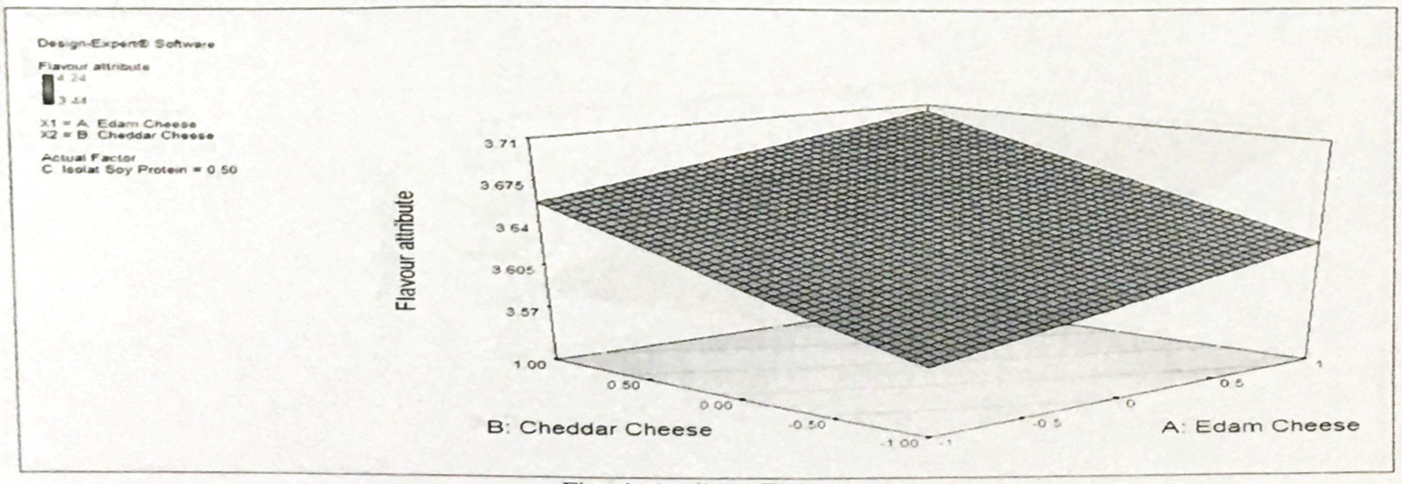


Fig.-4: Attribute Flavor

Graph above show optimal formulation bases response organoleptic flavors, response organoleptic flavors that predicted 7.45 where boundary under assesses response organoleptic flavors that is 4.05 and upper limit as high as 7.45. To reach value response organoleptic flavors matching with the one which predicted by program at product Cheese Spreadable Analogue must uses Edam Cheese 10% and Cheddar Cheese 10% the value X1 and X2 and Isolate Soy Protein 5%, Cornstarch 5% the actual factor, where X1 and X2 and second actual factor is variable changes.

Flavor cheese is formed especially by amino acids[2,6] enhance that flavor cheese is also formed by dispersion fat. Flavor from a large part of food materials usually unstable, that is can experience of change during handling and processing, in other hand texture change or viscosities can also alter flavor[4]. Flavor cheese tied to someone's apron string by level of fat, emulsifier materials, salt, amino acid (protein) and water that it contains[2].

Cheese Making is entered Cheese Spreadable Analogue that use mixture of cheese raw material Edam Cheese and Cheddar Cheese difference flavors referred to merely caused by Edam and also cheddar that used, but caused by amount of filler materials that is Isolate Soy Protein and Cornstarch and more and more Isolate Soy Protein and Cornstarch that used cheese Spreadable Analogue becomes growing less strong.

According to Frank (2004) in Septiarini[3] state that substrate that become determinant from flavor cheese is main component that indigenous to milk, that is carbohydrate (lactose and citrate) and substance metabolite (lactate, acetate, ethanol and acetone), protein (for example casein), peptide, amino acid and fat.

Law and Tamime[1] explain that other effect that maybe from salt emulsifier at cheese making covers flavor. Flavor that tend to like soap at cheese making is entered Cheese Spreadable Analogue is caused by sodium or potassium phosphate that consisted in at emulsifier salt.

### Attribute Texture

Coefficient Estimation that is coefficient of each factor that existed in equation conducted as follows-

Attribute Texture: $7.00 - 0.038A + 0.28B - 0.14C + 0.072D - 0.26AB - 0.087AC + 0.075AD - 0.48BC - 0.12BD - 0.061CD - 0.42A^2 - 0.47B^2 - 0.42C^2 - 0.60D^2$

Optimal formulation Graph bases response organoleptic texture can be seen in the picture-

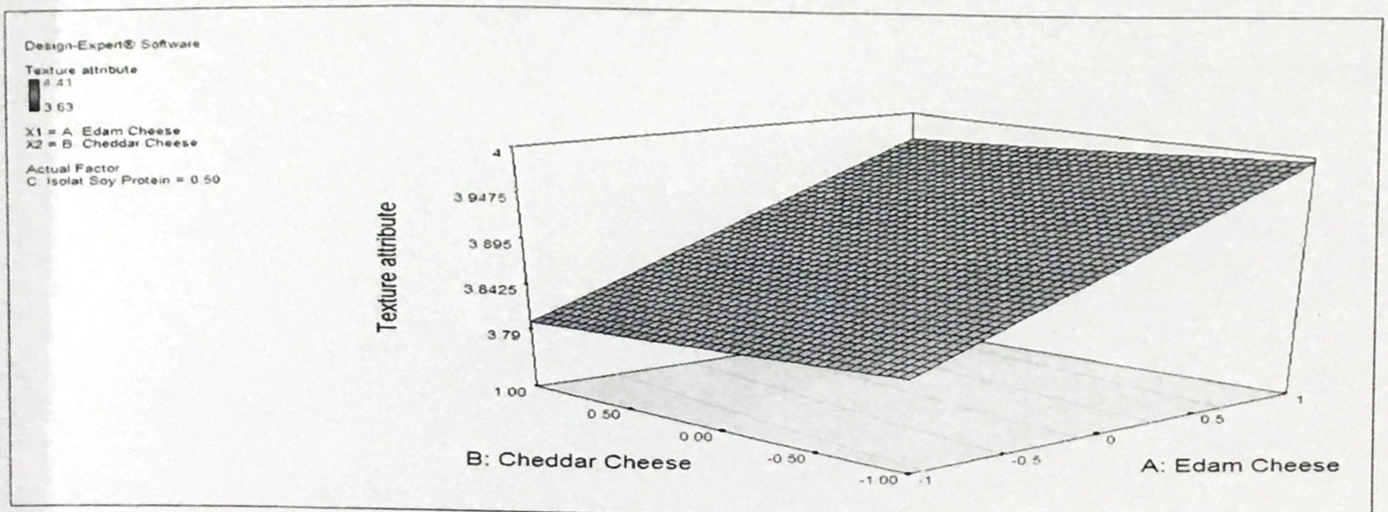


Fig.-5: Attribute texture

Factors that assign value positive to response organoleptic texture to product Cheese Spreadable Analogue that produced for example: linear effect Cheddar Cheese and linear effect Cornstarch. Whereas factors that assign value negative to response organoleptic texture shall be as follows: linear effect Edam Cheese, linear effect Isolate Soy Protein and effect quadratic Edam Cheese, effect quadratic Cheddar Cheese, effect quadratic Isolate Soy Protein and effect quadratic Cornstarch.

There is one interaction 2 factors that is synergic interaction to response organoleptic texture that is interaction between Edam Cheese and Cornstarch. Whereas interaction 2 factors that give interaction antagonis as follows: interaction between Isolate Soy Protein and Cornstarch, interaction between Edam Cheese and Cheddar Cheese, interaction between Edam Cheese and Isolate Soy Protein, interaction between Cheddar Cheese and Cornstarch and interaction between Cheddar Cheese and Isolate Soy Protein.

## CONCLUSION

1. Edam cheese, cheddar cheese and soy protein isolate by program design expert response surface methodology central composite design method can optimize spreadable cheese analogue formula.
2. Optimal formulations based on data from all 11 above for product formulations spreadable cheese analogue selected by using 11.66% edam cheese, cheddar cheese 9.75%, and 3.84% isolate soy protein.

## ACKNOWLEDGEMENT

We gratefully acknowledge the financial support of the Directorate General of Higher Education, National Ministry of Republic Indonesia for research grant of *Hibah Bersaing* 2015.

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[RJC-1519/2016]

RASĀYAN *J. Chem.*
Vol. 10 | No. 1 |99-110 | January - March | 2017
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

# PRE-FEASIBILITY OF THE ESTABLISHMENT VITAMIN A (RETINOL PALMITATE) INDUSTRY IN INDONESIA

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## ABSTRACT
The Government regard to the Ministry of health and Ministry of industry make policy in order to prevent an increase in vitamin A deficiency sufferers in Indonesia. The policy made in the Ministerial Regulation No. 87/2013 about SNI mandatory of Palm cooking oil with vitamin A (fortification). The problem is the whole vitamin A circulating domestically is imported products. With the enactment of this policy, then the needs of vitamin A in the country will be very large. Theoretically, Vitamin A can be generated from the content of certain commodities contained vegetable or animal sources available in the country. Until now, there has been no research that explains the availability of animal or vegetable sources as the industrial raw material of Vitamin A. Research shows that availability of animal and vegetable raw materials in Indonesia to support its industry is not sufficient. Delivered also alternative sources of raw materials that can be used as raw material for the manufacture of Vitamin A as Palm cooking oil. In addition, the results of the analysis of the economic establishment of techno-economic industries Vitamin A in Indonesia using Benefit Cost Ratio, showing that this plan is worthy of particular consideration.
**Keywords:** fortification, palm oil, techno-economic, Vitamin A.



## INTRODUCTION

The number of sufferers vitamin A deficiency in Indonesia reached 10 million. The sufferer is composed of a toddler by as much as 37%, 17% of pregnant women and nursing mothers13%[1]. Vitamin A deficiency or xerophthalmia cause disruption of the development organs of vision and increased the risk of pain and death from infections such as measles and diarrhea. Meanwhile, the World Health Organization[1] in 2008 exposed that the sufferer of measles in Indonesia reached 15369 cases that lead to 1.7 million child deaths under 5 years.

To overcome these problems the Government strives to implement programs that can reduce the problem of nutritional deficiency especially vitamin A through ditjenbina nutrition by providing vitamin A supplements to children across Indonesia. It was not until there, the Ministry of health delivered a letter proposal to Menteri Perindustrian regarding mandatory SNI Palm cooking oil with Vitamin A (GK/Menkes/280/VIII/2012)[2,3]. Vitamin A is specified in the form Retinol Palmitate is added into the cooking oil.

Replied to the proposal, the Ministry of industry has issued Ministerial Regulation No. 87/2013 about enforcement of Indonesia national standard (SNI) of cooking oil Palm (MGS) is mandatory[4]. Regulations promulgated on 24 December 2013 oblige the MGS every manufacturer in the form of packaging is required to add the content of Vitamin A.

Based on the combined data of Vegetable Oil industry of Indonesia (GIMNI)[5], national MGS needs by 2014 reach 5.22 million tons. The total needs of the MGS consist of 12% in the form of oil packaging, bulk form 25% and 63% in the form of precipitation. Meanwhile, BPS data's in 2014 shows that the national edible oil needs for direct consumption by 2013 reached 694,4 thousand tons, so need Vitamin A

to meet those needs reach 31.2 tons[2,6]. The value retrieved based on SNI cooking oil 7709:2012 explaining that 1 liter of cooking oil should contain 45 International units (IU) of Vitamin A/gram Retinol Palmitate conversion of 1 IU=0.3 mcg of Retinol Activity Equivalents (RAE)[3].
The impact of these policies has made the National Vitamin A needs as supplementary material (fortification) MGS rising. Coupled with the presence of producers of Vitamin A has not been in the country that produces Vitamin A in the form of Retinol Palmitate. Therefore, the entire needs of vitamin A as a fortification of the MGS to be imported. GIMNI (2014)[5] estimates that to meet the needs of the fortification of vitamin A on the MGS by way of import, then Indonesia will need to issue an import fee Rp525 Billion/year.
To answer these problems, then the research is to study raw materials producers of vitamin A, the technology used and pre-investment feasibility the establishment of Vitamin An industry in Indonesia.

## EXPERIMENTAL

The research is descriptive – quantitative problem – solving frame as shown in Figure-1.

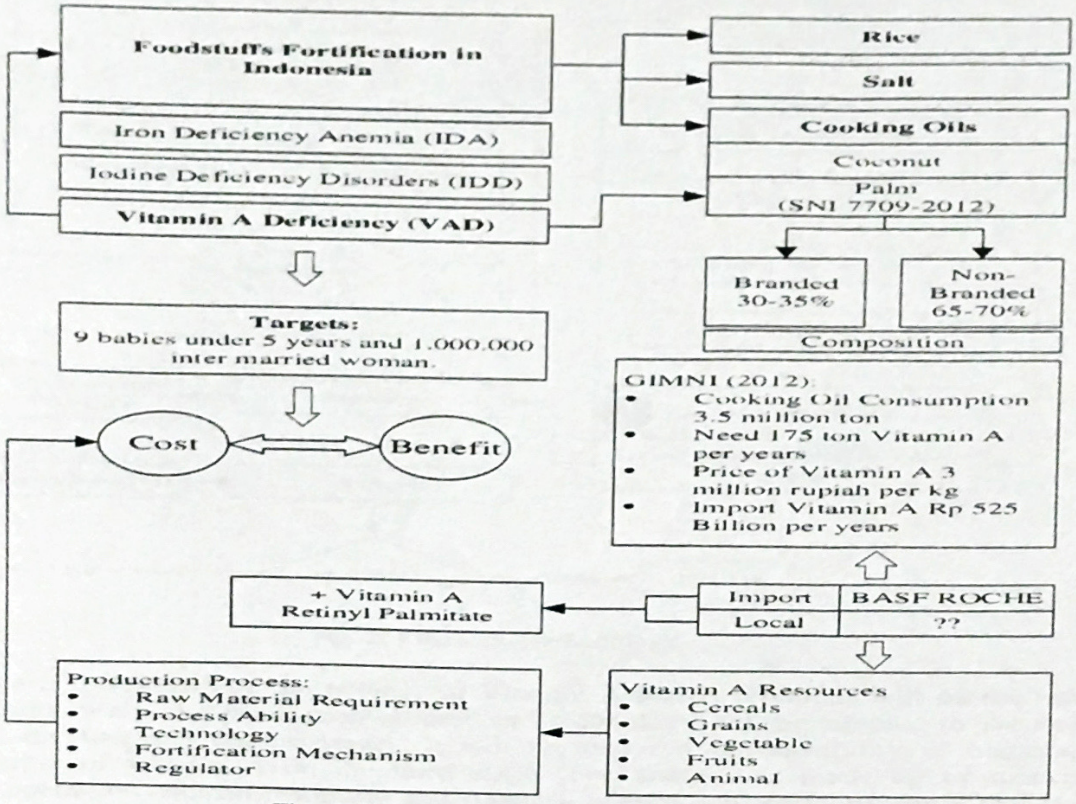


Fig.-1: Problem-Solving Framework

The framework describes a solution that can be done to enhance the Vitamin A consumption society by the fortification of Vitamin A in the form of Retinol Palmitate on foodstuffs. Foodstuffs referred to in this research is the Palm cooking oil.
Meanwhile, the methodology used to complete this study is shown in Figure-2. The first stage is to know the source of the animal and vegetable raw materials as a producer of Vitamin A in Indonesia. Vitamin A

is Pro-Vitamin A called Retinol Palmitate. Retinol Palmitate is a form of transformation of β-carotene. With the identification, it can be known to the potential production capacity of Vitamin A which can be generated. If the entire raw material identified do not meet production needs for Vitamin A fortification of MGS, then carried out the identification of advanced against other sources of raw materials, along with the availability of the technological process. According to the Technical Services Branch for the USDA National Organic Program (2011)[7], β-carotene can be generated through chemical extraction, biology, extraction and genetic engineering.

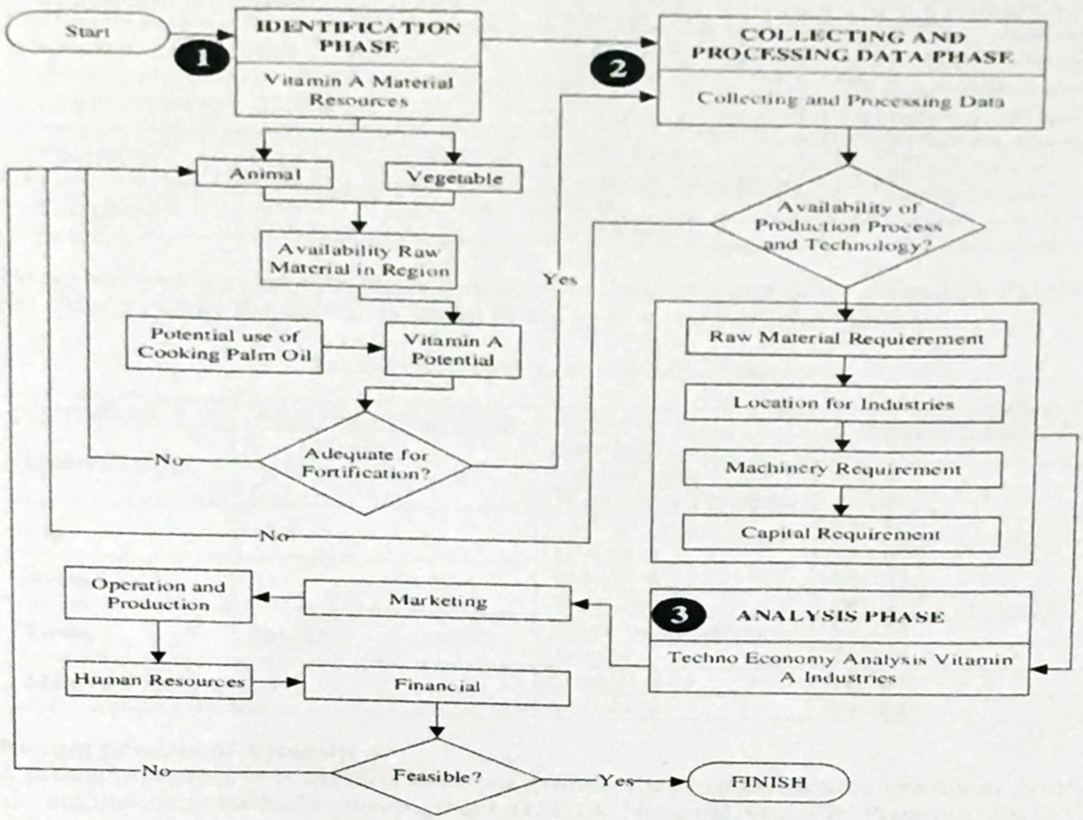


Fig.-2: Research Methodology

The second stage is a stage where the potency of Vitamin A that is produced will be the input for the industry to be built. While the production process and technology will be adapted to the raw material used. Based on the first and second stages, it will be analyzed the feasibility of manufacturing of industrial producers of vitamin A on the third stage. The analysis is made up of market aspects, production and operations, human resources and financial aspects will certainly show that the industry deserves to be built or not.

## RESULTS AND DISCUSSION

**Sources of Vitamin A Raw materials**

The survey results showed that the source of raw materials of animals and vegetables raw materials for Vitamin A comes from a source which has a high content of Vitamin A as shown in Table-1 and Table-2. The Raw vegetable is the raw material of commodity that is derived from carrots, spinach, palm oil

(CPO), tomatoes, Lemongrass, and sweet potatoes. While animal raw materials derived from beef liver, chicken eggs, cow's milk, tuna fish, chicken, and meat.
The amount of vitamin A in each source either animal or vegetable is calculated based on the content of vitamin A (RE) mcg/100 grams.

Table-1: Vegetable raw materials sources

| Comodities | Vit A (RE) mcg/100 gr | Provinces | Production/ years (ton) |
|---|---|---|---|
| Carrots | 835 | West Java | 1,213,730 |
| | | Central Java | 1,217,444 |
| Spinach | 469 | West Java | 40,972 |
| | | South of Sumatera | 13,864 |
| Crude Palm Oil | 23,700 | Riau | 6,421,288 |
| | | South of Sumatera | 4,182,052 |
| Tomatoes | 42 | West Java | 349,583 |
| | | South of Sumatera | 114,168 |
| Lemongrass | 6 | Aceh | 2,195 |
| | | West Java | 175 |

Data processing showed that the vitamin A based on the largest commodity owned by Palm oil (CPO), which is 237 mcg/gr, while the animal is found in the liver of cow is 49,68 mcg/gr.

Table-2: Source of raw materials of animal

| Comodities | Vit A (RE) mcg/100 gr | Provinces | Production/ years (ton) |
|---|---|---|---|
| Livers of Cow | 4,968 | East Java | 15,176 |
| | | Central Java | 6,277 |
| | | West Nusa Tenggara | 3,008 |
| Eggs | 160 | Central Java | 254,800 |
| | | East Java | 253,600 |
| Milks | 33 | East Java | 554,312 |
| | | West Java | 281,438 |
| Tunas | 556.75 | South of Sulawesi | 59,774 |
| | | Jakarta | 29,790 |
| Meat of Chicken | 24 | Central Java | 42,767 |
| | | East Java | 38,502 |

**The production process of Vitamin A**

Vitamin A production process is divided into four groups, they are extraction, chemical synthesis, biology and genetic engineering/ biomolecules/pigment (USDA National Organic Program, 2011)[7]. The whole process of this production will produce β-carotene that is processed back into retinol palmitate.
The production process with chemical synthesis approach is not recommended because it will generate non-natural products and will have an impact if taken in the long term. While for the extraction process is shown in Figure-3, Figure-4 biological processes and biomolecules are shown in Figure-5.
The third process requires two types of main engines, i.e., Fermenters Bioreactor for tissue culture process and Super Critical Fluid Extractor Equipment for the extraction process. While in the process of molecular biology there is a PCR machine serves to the fragmentation of the DNA into the cell.
The manufacture of vitamin A with the extraction process beginning with the extraction of raw materials such as carrots, sweet potatoes, etc. by adding solvents such as hexane, acetone, ethyl acetate, ethanol, and ethyl lactate to produce the desired β-carotene[8].
On the process of biological raw materials, which is derived from the fungus blakeslea trispora as microorganisms or β-carotene obtained from fermentation of blakeslea trispora two types of fungus which

further isolated from the biomass with solvent extraction[9]. Blakeslea Trispora is chosen as the main source of as many produce high β-carotene[10].

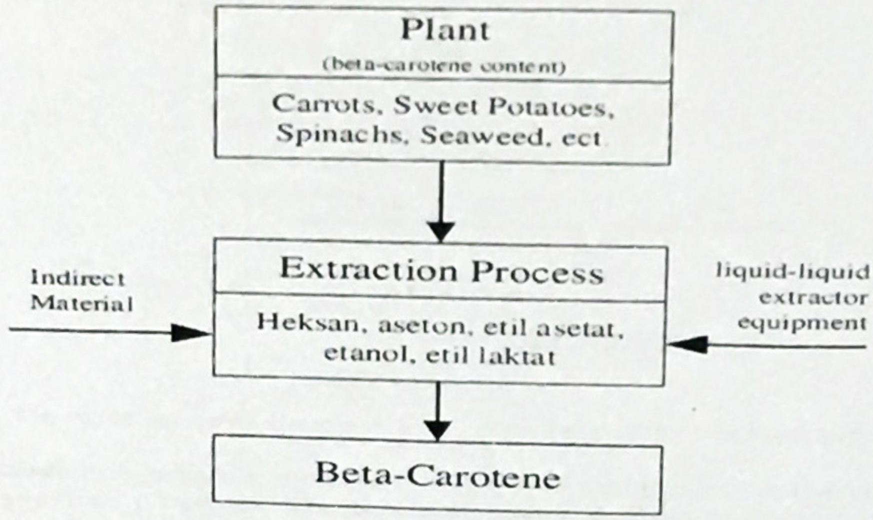


Fig.-3: The manufacture of vitamin A with the extraction process

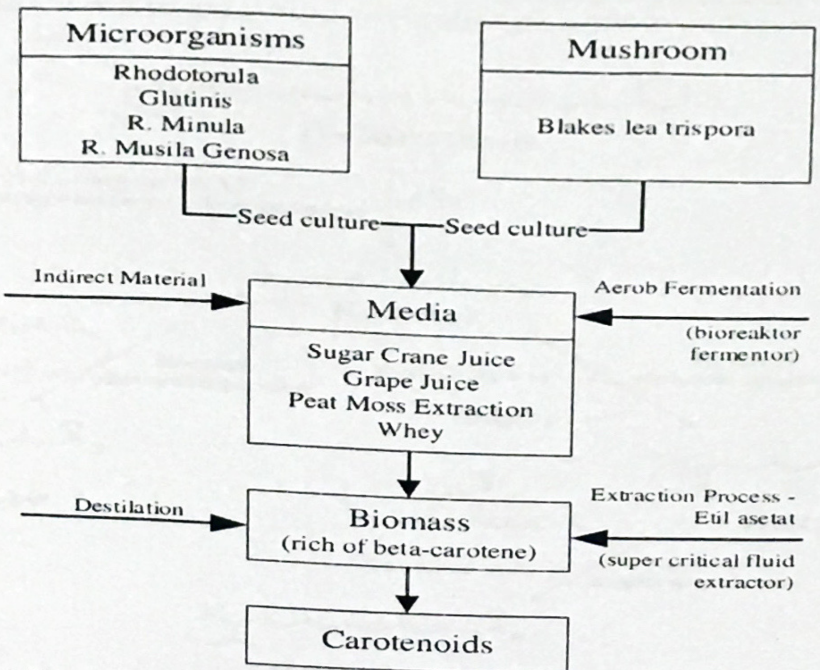


Fig.-4: The manufacture of Vitamin A by biological processes

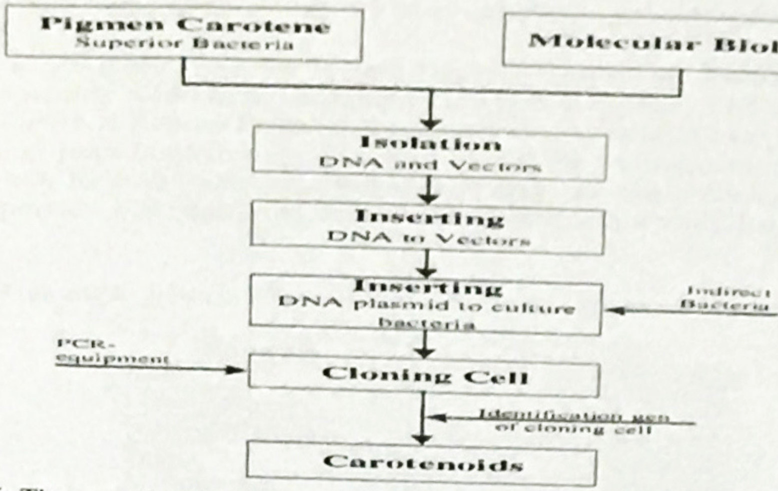


Fig.-5: The manufacture of vitamin A with molecular biology processes/pigments

The manufacture of vitamin A with the molecular biology of this process is the most difficult process compared to the two previous processes. The same raw materials used by biological processes, but the difference is the process of insulation and insertion vector DNA and DNA in the bacterial culture so that it will be acquired bacteria that produce a high β-carotene[11].
After the third b β-carotene obtained from the process, the next step is the process of synthesis or process enzymatic. Of this process, it will be generated retinol palmitate as shown in Figure-6.

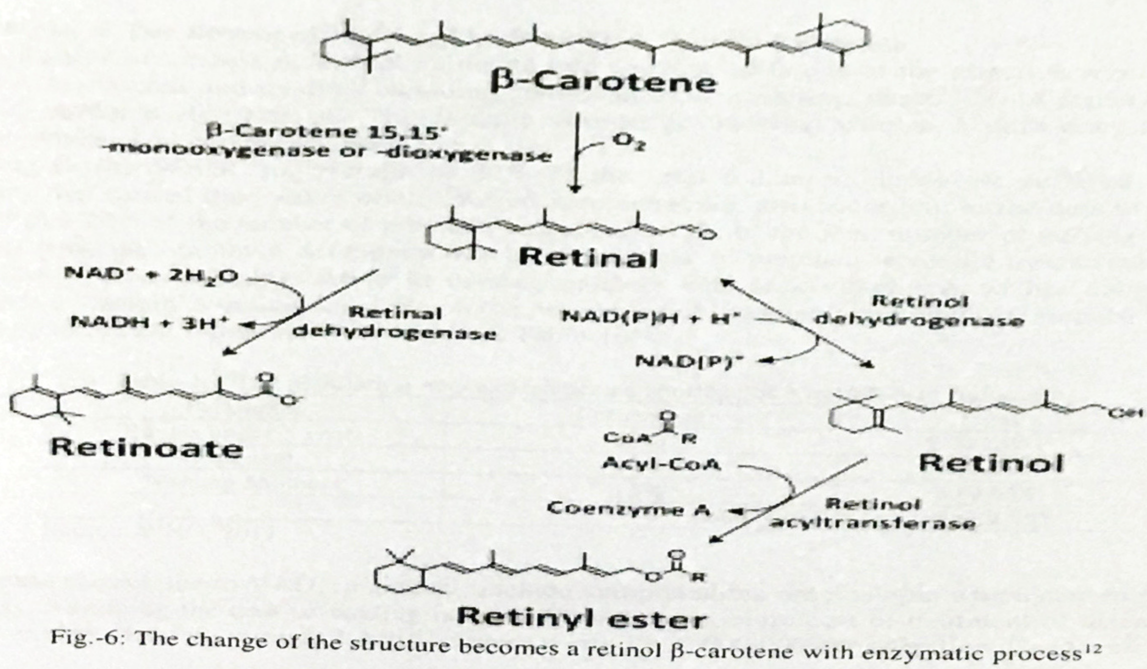


Fig.-6: The change of the structure becomes a retinol β-carotene with enzymatic process[12] ssumed the volume of fermenters is met by the molasses, so obtained the price of molasses of p12,845,560,000.

fter the β-carotene is produced from the second stage of the process, namely the process of recovery, arotene packaged in a bottle made from aluminum cans with a capacity of 5 pounds. The aluminum cans rotect carotene or vitamin A Retinol Palmitate because translucent so it can protect from heat, caused by ight at the storage. Unit price bottle capacity i.e. Rp105,000 for 5 kilograms, and to package the whole of -carotene or vitamin A Retinol Palmitate produced, it takes as much packaging of 29,501,991 bottles vith a capacity of 5 pounds. Calculation of cost of goods production with that explanation can be seen in Table-9.

Table-9: The price of the staple production manufacture of vitamin A with biological processes (MGS Branded)

| Indicators | Price (Rp) |
|---|---|
| Invest | 1,412,162,560 |
| Direct Material | 7,928,455,600 |
| Indirect Material | 3,097,709,018,424 |
| Salary | 198,000,000 |
| Maintenance | 60,000,000 |
| Overhead | 792,845,560 |
| Total | 4,119,035,390,424 |
| Tax (10%) | 411,903,539,042.4 |
| Total | 4,530,938,929,466.4 |
| Amount of Production | 1,560 |
| COGM/ton | 29,044,480 |
| COGM/ton | 29,044 |
| COGS (5 liters) | 290,444.8 |

Source: Analysis, 2014

**The Analysis of The Benefit of Making The Vitamin A Retinol Palmitate**

The fortification of vitamin A Retinol Palmitate into cooking oil is one of the effective ways to provide vitamin A to children and toddlers including communities, considering about 70% of society Indonesia every day consume vegetable oil. This is done in order for tackling vitamin A deficiency in toddlers, pregnant women, and nursing mothers.

According to the WHO[1], an average of 37% of the total toddler in Indonesia suffered vitamin A deficiency that caused the toddler often affected xerophthalmia, also according to the data of the World Bank[14,15] that 20% of the number of pregnant women and 13% of the total number of nursing mothers in Indonesia suffered vitamin A deficiency which causes a risk to pregnant women a miscarriage or infant who is born has a disability, while in nursing mothers who lack vitamin A so her baby will also experience a Vitamin A deficiency. Data on the percentage of the population who experienced Vitamin A Deficiency (VAD) in Indonesia, can be seen in Table-10.

Table-10: The population who experienced a shortage of Vitamin A in Indonesia

| Parameter | Percentage | Total |
|---|---|---|
| Babies under 5 years | 37% | 9,221,051 |
| Pregnant | 17% | 848,895 |
| Nursing Mothers | 13% | 619,648 |
| | Total VAD | 10,689,595 |

Source: WHO, 2011

The disease caused due to VAD, in general, include xerophthalmia ornyctalopia which caused permanent blindness. Assuming the cost of healing is taken from the maximum cost of treatment of diseases of the eye, for example healing through LASIK surgery worth Rp28,000,000 per operation.The benefits that can

Based on the third production process, it can be done an analysis of the assessment of raw material, materials, auxiliary machinery, products and prices of products in order to find out more economical production processes and can be implemented in Indonesia as seen in Table-3 and Table-4.

Table-3: The condition of the raw materials, materials, and auxiliary machinery

| Processes | Raw Material | | Auxiliary Material | | Machines and Tools | |
|---|---|---|---|---|---|---|
| | Int. | Dom. | Int. | Dom. | Int. | TTG |
| Chemical Syntheses | | v | v | | | v |
| Biology Process | v | | | | | v |
| Extraction | | v | v | | | v |
| Molecular Biology | v | | v | | v | |

Source: Research, 2014

Based on Table-3, the raw materials  for the extraction process, while all the helper is only found in foreign countries and availability of machinery does not exist in the country. As for quantity, a process that will generate a lot of β-carotene is a chemical process and the extraction process. However, the extraction process will produce a product price is more expensive compared to chemical synthesis process. Because the chemical process is not recommended by the Government, so the production process that may be done in Indonesia is the biological processes and the extraction process.

Table-4: The quantity and price of the product

| Processes | β-Carotene | |
|---|---|---|
| | Product Quantity | Price |
| Chemical Syntheses | Many | Cheap |
| Biology Process | A few | Expensive |
| Extraction | Many | Expensive |
| Molecular Biology | A few | Expensive |

Source: Analysis, 2014

**Market analysis of Vitamin A Retinol Palmitate**

Growing needs of the national edible oil amounting to 7%, it is predicted by 2013 needs cooking oil reached 5.6 million tons (Industrial Ministry of Indonesia, 2009 is being processed). This need consist of two types namely branded cooking oil and non-branded cooking oil as shown in Table-5.

Table-5: The national edible oil needs

| Cooking Oil | 2013 |
|---|---|
| Branded (37%) | 2,107,285.05 |
| Non Branded (63%) | 3,588,079.94 |

Source: Industrial Ministry of Indonesia, 2009, treated[2]

Based on those needs then the amount of vitamin A retinol palmitate needed for branded cooking oil (branded) as much as 147,509 tons/year. This value is retrieved from the conversion needs of vitamin A in 1 kg of MGS is as much 0.07 kg.

**Analysis of the selection process of the production of Vitamin A Retinol Palmitate**

Based on the previous explanation, vitamin A production process that may be implemented in Indonesia is the production process by means of extraction and biology. However, the production process chosen is the biological process because of consideration of the raw materials available in large quantities and the ease of the process.

**Analysis of the Techno-Economic of biological process**

The production process in biology it must meet the needs of the national vitamin A of 147,509 tons/year. To meet the needs of the machine/equipment needed are shown Table-6.

Table-6. Machine Needs

| Machine | Qty | Prices (Rp) |
|---|---|---|
| Fermentor Bioreactor | 13 | 3,000,000,000 |
| Super Critical Fluid Equipment Extraction (2000 Liter) | 1 | 120,000,000,000 |

Source: Analysis, 2014

In addition to the main equipment, also required infrastructure as well as supporting laboratory technology as shown in Table-7.

Table-7: Laboratory facilities and infrastructure

| Machines | Price (Rp) |
|---|---|
| High Performance Liquid Chromatography | 240,000,000 |
| Spectrophotometer UV – Visible | 40,320,000 |
| Glass Ware Equipment | 40,000,000 |
| Chemicals | 400,000,000 |
| Maintenance | 72,032,000 |
| Total | 792,352,000 |

Source: Analysis, 2014

Meanwhile, the average cost of production of Vitamin A is influenced by the price of the culture of blakeslea trispora for pure breeds and molasses which became the main ingredient in the manufacture of vitamin A with biological processes as shown in Table-8.

Table-8: The production cost of making Vitamin A with biological processes (MGS Branded)

| Direct Raw Material | Qty Fermentor | Price (Rp) (1000) | Total Price (Rp) (1000) |
|---|---|---|---|
| Mikroba | 13 | 60,000,000 | 780,000,000.00 |
| Molase | 13 | 988,120 | 12,845,560.00 |
| Indirect Raw Material | Qty (1000) | Price (Rp) (1000) | Total Price (Rp) (1000) |
| Packaging 5 kg | 29,501.99 | 14,500 | 427,778,864.43 |
| Total (Rp) | | | 1,220,624,424.43 |
| Direct Labor | | | 1,980,000.00 |
| Indirect Factory Cost | | | |
| Maintenance and Utility | | | 72,032.00 |
| Total Production Cost (Rp) | | | 1,222,676,456.43 |

Source: http://elisa.ugm.ac.id/[13]

Blakeslea trispora mold needs molasses to produce biomass. Biomass is needed as much as 100,000 liters every single fermenter, with the price of molasses per 1 kilogram i.e. Rp7,000. Based on the literature, heavy type of molasses that is 1.4116 g/l, so the mass of molasses needed for 1 of the fruit is as large fermenters 141,160 kg or if in rupiahs is Rp988,120.00. Same is the case with the needs of blakeslea trispora, in an effort to meet the needs of production 1,300 tons/72 hours then needed 13 fruit fermenters.

be generated when toddlers, pregnant women and nursing mothers consuming cooking oil fortified Vitamin A is the savings towards the cost of treatment which amounted to Rp299,308,654,961,655.

Based on the criterion of benefit, the reduction of benefits (disbenefit), and cost arising from the manufacture of Vitamin A Retinol Palmitate for the fortification of edible oil palm, then it can be calculated the feasibility of manufacturing of Vitamin A Retinol Palmitate. Criteria benefits derived from cost savings arising in the community affected by the lack of Vitamin A Retinol Palmitate can be anticipated.

Disbenefit criteria obtained from the impact caused from the fortification of Vitamin A Retinol Palmitate against edible oil that is consumed when suffering from cancer continued for 10-20 years. Meanwhile, the criteria of the cost are obtained from the production cost of making Vitamin A Retinol Palmitate as shown in Table-11.

Table-11: Feasibility analysis of BCR (side of the businessmen)

| No. | Parameters | Price (Rp) |
|---|---|---|
| 1 | Benefit (B) | 299,308,654,961,655.00 |
| 2 | Side Effect (E) | 293,673,120,806,120.00 |
| 3 | B-E | 5,635,534,155,535.12 |
| 4 | Cost (C) | 3,977,819,134,423.98 |
| 5 | (B-E)/C | 1.42 |

Source: analysis, 2014

From the table above, it can be shown that the value of the resulting ratio is 1.08 means making Vitamin A Retinol Palmitate for fortification is deserves to do. But it needs to be examined again because of the side effects resulting from fortification is very large, that are at risk of various diseases for consumers when consumed continuously.

From the side of the businessmen, B/C can be calculated by considering the cost of sales with profits investments is issued. If it is assumed that the selling price of Vitamin A Retinol Palmitate is Rp300,000 assuming that the advantage gained is 5 times the price of the staple production, then the value of B/C are shown in Table-12.

Table-12: Feasibility analysis of BCR (side of the businessmen)

| No. | Parameters | Price (Rp) |
|---|---|---|
| 1 | Benefit (B) | 4,282,251,396,000 |
| 2 | Side Effect (E) | - |
| 3 | B-E | 4,282,251,396,000 |
| 4 | Cost (C) | 3,977,819,134,423 |
| 5 | (B-E)/C | 1.08 |

Source: Analysis, 2014

## CONCLUSION

- The potential of the raw materials available from animal and vegetable sources amounted to 15078.14 tons/year. This value is the amount of vitamin A contained in the raw material after the extraction process. Based on that data, then the total availability of the commodity source of raw material for very small national vitamin A needs for the manufacture of vitamin A retinol palmitate.
- The process of making vitamin A grouped into the chemical and natural process, both groups divided into four processes, i.e. the process of chemical synthesis, biological processes, the process of extraction, and the pigment molecules and biological processes.
- The chemical process does not demand by the industry because the products are not produced naturally.
- The natural process basically revamps the structure of certain raw materials to produce a structure of retinol palmitate as needed. The preliminary research required and provision of an expensive high technology to be able to produce to industrial scale.

- Technology/tools needed for industrial-scale extraction process include: (a) Before the extraction: Conveyor Belt, i.e. Floating Washer, Dryer Drum, Disc Mill, Reflux, and Soxhlet, (b) Extraction process: Super Critical Extraction Plant Fluid, as well as packaging with Bottle Packaging Machine.
- The process of production β-carotene by using Palm oil, required different production processes with the production process in making CPO or biodiesel. Required oil palm processing specifically so that it can maintain the content of β-carotene in oil palm. Pigment research required in advance so that it takes a relatively long time and high costs for research and development, process scale-up.
- The process of the production of vitamin A with biological processes is not too dependent on the availability of raw materials. This is because the raw materials used are microorganisms (fungi, yeast or bacteria) that can produce with biological processes. The fungus that produces β-carotene is the fungus blakeslea trispora, as a filament (a variant of tropical plants) and phycomycosis blakesleanus. This process is in two stages, the first stage of which is fermented by yeast for approximately 72 hours. β-carotene produced is then isolated from the biomass with the extraction solvent (ethyl acetate) so β-carotene will crystallize from a solvent carrier. After purified by distillation process then it will result in Vitamin A retinol palmitate. The tools needed are Fermenters Bioreactor, Fluid Super Critical Extraction Plant, and Packaging Bottle Packaging Machine.
- Results of feasibility analysis with the benefits cost ratio for MGS-branded retrieved: (a) The analysis of the B/C ratio is applied to the process of making vitamin A in biology, (b) Costs arising from the need of Vitamin A in the edible oil palm branded (37%) i.e. 2.1 million tons[16]. By comparison 1:0.07 kg vitamin A, then it needs to meet the vitamin A fortification process was 147,509 tons/year or 12292.5 tons/month, (c) The proposed industrial Capacity comes on Best Available Technology is there, namely in the amount of 1300 tons/3 days, (d) The value of the resulting BCR is 1.42 (Government side) and 1.08 (entrepreneurs side) so it deserves to be continued, (e) The negative effects from the consumption of palm oil fry with the fortification of vitamin A with estimated disbenefit of Rp293,673,120,806,120.

**Recommendations**

From the problems of availability of raw materials, production process, and the technologies used, hence the recommendation that can be given are as follows:

1. **Raw materials**
   i. Optimizing raw material resources available taking into account the content of β-carotene in raw materials such as carrots, sweet potatoes, and spinach which have a high content of β-carotene.
   ii. Expand land extensification of production of the raw materials needed for industry, especially for Vitamin A Retinol Palmitate industries.
   iii. Extraction process with the raw materials of animal (eggs, milk, liver, tuna) has not much to do. Therefore, programs/activities that are recommended are doing further studies towards the extraction process with animal raw materials.
   iv. The cultivation of fungus Blakeslea Trispora as raw materials containing high β-carotene.

2. **Production process**
   i. Create a team reviewing the process of the production of vitamin A in biology, which is equipped with laboratory research and the tools needed to support the industrial development of Vitamin A Retinol Palmitate.
   ii. Production Equipment already available in the national/international market and can be developed accordance with national needs.

3. **B/C Ratio**
   i. The value of the Benefit Cost Ratio derived more than 1 means the manufacture of Vitamin A Retinol Palmitate worth doing. The value of the feasibility of BCR this Government considers value disbenefit of Palm cooking oil fortified Vitamin A Retinol Palmitate by society at

large. From the side of the employers, the suggested selling price is very low compared to imported products. If the enlarged approach product pricing imports, B/C it will become larger and become a very viable.

ii. Redenomination-done for implementation of fortification of Vitamin A in the edible oil palm, because the great benefit is directly proportional to the side effects (loss) arising in the future for the customers (Indonesia Society).

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[RJC-1547/2016]

RASĀYAN *J. Chem.*
Vol. 9 | No. 4 |889 - 895 | October - December | 2016
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

RJC

# THE EFFECT OF DRYING TEMPERATURE ON THE ANTIOXIDANT ACTIVITY OF BLACK MULBERRY LEAF TEA (*Morus nigra*)

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## ABSTRACT

This research is aimed at studying the effect of different drying temperatures on the characteristics of the brewed herbal tea from the mulberry leaves. The benefits of this research is to, provide new information about the processing of mulberry leaves, know the characteristics of brewed herbal tea from mulberry leaves, measure the antioxidant activity of brewed herbal tea from mulberry leaves, develop food diversification regarding herbal tea, increase the economic value of mulberry leaves and it is expected to become a branch of industry of herbal tea made from mulberry leaves. The method used is a randomized block design with a pattern of one factor drying temperature consisting of three (3) levels: at 40° C ($s_1$), 50° C ($s_2$), and 60° C ($s_3$). The results showed that the drying temperature influences the color organoleptic responses and antioxidant activity. The product processed in the drying temperature at 40° C is the best product because it has the value of $IC_{50}$ of 89.43 ppm and belongs to a class of strong antioxidant potential.

**Keywords:** black mulberry leaves, drying temperature, antioxidant.



## INTRODUCTION

Health is a precious thing that needs to be maintained and cared for. The increasing price of modern medicine encourages consumers to try other alternatives to maintain a good health. This problem leads to a new trend in the world of health, namely "back to nature". One of the effects of this trend is seen from the current consumer trend.

The herbal tea is a general term used for a beverage that does not originate from the tea plant, *Camellia sinensis*. The herbal tea is safer for consumption because it does not contain an alkaloid that can harm health as caffeine does. The herbal tea is made from flowers, seeds, leaves or roots of a variety of crops[8]. The herbal tea is consumed as beverage tea or brewed and served as regular tea. *Morus nigra* is the Latin name of the mulberry plant or black mulberry. This plant has a high economic value because the leaves are the main fodder for silkworms. It has been reported that a phenol derivative compounds are the main compounds of the genus *Morus*, namely *stilbene* group, 2-arilbenzofuran and flavonoids[6].

Mulberry leaves are commonly used as the fodder for silkworms. However, due to their rapid growth which is approximately every 30-60 days for the harvest, the mulberry leaves can be used as processed food, namely herbal tea.

In Indonesia, there are about 100 more species or varieties of mulberry, but there are only 6 of them which are well-known, namely *Morus cathayana, Morus alba, Morus multicaulis, Morus nigra, Morus asustralis* and *Morus macruora*. West Java province is one of the producing areas of mulberry plants, both leaves, and fruits.

Herbal tea of mulberry leaf has an antioxidant effect and can address the problem of diabetes mellitus[13]. Mulberry leaf extract also owns and produces a good anti-obesity substance because of its inhibitory effect on melanin bio-synthesis. There are many other phenolic compounds contained and identified in mulberry leaves. Flavonoid (quercetin and kaempferol) and its derivatives, quercetin 3-(6-malonylglucoside), quercetin-3-rutinoside, quercetin 3-glucoside and kaempferol-3-(6-acetylglucoside),