

# The effect of addition of whey protein concentrate and emulsifier on characteristics of cheddar cheese analogue from corn milk

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## The effect of addition of whey protein concentrate and emulsifier on characteristics of cheddar cheese analogue from corn milk

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**Abstract.** Corn milk has been considered as the ingredient of cheddar cheese analogue. In cheddar cheese manufacturing, whey protein and stabilizer like Tween-80 and Span-80 are required. This study objectives are to determine the best proportion of whey protein concentrate (WPC) concentration and emulsifier types to produce analogue cheddar cheese with corn milk base and its effect on the physical, chemical, and sensory characteristics of analogue cheddar cheese. The experimental design was factory randomized block design with two factors, the WPC level (20, 25, 30%) and emulsifier type (Tween-80, Span-80, and Tween-80 combination: Span-80). The physicochemical and sensory variables data were analyzed on a 5% F-test, and the significant results were further analyzed with the multiple-range test of Duncan at a level of 5%. The results showed that changes in WPC level had effects on yield value, water content, dissolved protein content, and fat content. The variation of emulsifiers affected water content and protein content. The best proportion of the analogue cheddar was WPC 30% and emulsifier Tween-80 1% with yield value 63.23%, pH 5.7, total dissolved solids 31.75%, moisture content 59.24%, protein dissolve 10.07% bk, fat content 13.65% bk, and total acid 1%.

### 1. Introduction

Cheese is a common dairy product that contain of complete and balanced nutrition. Cheddar cheese, cottage cheese, and mozzarella cheese are mostly consumed. Cheese typically consists of cow's milk, but the rising price of cow's milk has led to higher milk sales rates. The public's understanding of the high fat and cholesterol content of health-causing animal products opened the door to vegetable milk as an alternative for cow's milk to other raw materials. In addition, the lactose content of cow's milk can cause allergies, known as lactose intolerance in some people [1]. It opens up opportunities to produce vegetable cheeses such as analogue cheese.

Cheese analogue is usually made from various nuts such as soybeans, many other types of nuts, and cereals [2]. One of the basic ingredients that can be considered to be used in a production of cheddar cheese analogue is corn milk [3]. In the process of making cheddar cheese analogue, additional ingredients are needed to improve texture and increase yield, one of which is whey protein concentrate. Whey protein has several advantages, including: having high solubility, being able to create viscosity through water binding, forming gels, emulsification, binding fat, acting as an emulsifier, foaming and aeration, improving color, taste, and texture, and having nutritional benefits [4]. The production of



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cheddar cheese analogue also requires ingredients to stabilize water and fat content, namely emulsifiers/emulsifying agents. Tween 80 and Span 80 are emulsifying agents that are often used together. In the interfacial film theory, the existence of a stable interfacial complex condensed film which is formed from the mixing of a water-soluble emulsifying agent and a fat-soluble emulsifying agent is able to form and maintain an emulsion more effectively than using a single emulsifying agent [5].

The concentration of whey protein concentrate (WPC) and emulsifiers was affected the character of the cheddar cheese analogue [6]. Thus, this research was conducted to determine the proportion of additional WPC and emulsifiers (Tween-80 and Span-80) in the production of cheddar cheese analogue which has high nutritional content and is acceptable to consumers. The purpose of this study was: 1) to find out the effect of WPC concentration on physical, chemical and sensory characteristics of cheddar cheese analogue; 2) identify the effect of variation in emulsifier concentration Tween-80 and Span-80 on the physical, chemical and sensory characteristics of manufactured cheddar cheese analogue; and 3) identify the best formula ratio of WPC and emulsifiers in the corn-based cheddar cheese analogue.

## 2. Experimental details

### 2.1. Ingredients

This study used several ingredients which include ingredients for production of cheddar cheese analogue and ingredients for chemical analysis. Ingredients for making cheddar cheese analogue consist of sweet corn obtained from Pasar Wage Purwokerto, WPC, virgin coconut oil (VCO), Tween 80, Span 80, Arabic gum, and papain. In addition, ingredients for conducting chemical analysis consist of distilled water, 0.1 N NaOH solution, PP (phenolphthalein) indicator, buffer solution pH 7.0, 1% CuSO<sub>4</sub> solution, 2% Na K Tartrate solution, NaHCO<sub>3</sub>, Bovine Serum Albumin (BSA) solution, and petroleum benzene.

### 2.2. Cheese analogue production

Cheese analogue production was referred to Aini et al. [3] with modification. There were two stages in the development of cheddar cheese, production of corn milk and production of cheddar cheese analogue. Corn milk was prepared for 30 minutes by steaming sweet corn. The steamed corn was then shelled and mixed for 3 minutes with the ration of corn:water of 1:2. The mixed corn was then filtered before corn milk was obtained. The analog cheese was developed by mixing 300 ml of corn milk with WPC and 9 grams of Arabic gum in one minute until homogeneous. The mixture was pasteurized for 15 second at temperature of 70°C. The pasteurized corn milk and WPC were then then cooled to 40°C. The treatment followed with the addition of emulsifier and 15 gr of papain with 45 ml of VCO which were stirred until homogenous. After rested for 5 minutes, the mixture was then heated for 15 seconds at 40°C, filtered, and refrigerated for 7 days. After the curing phase, the physicochemical and sensory characteristics of cheddar cheese were analysed.

### 2.3. Experimental design

This study used a randomized block design (RBD) method. There were 2 factors studied including the concentration of WPC consisting of 3 levels (20, 25 and 30 %), and type of emulsifier consisting of 3 types (Tween-80, Span-80, and combination of Tween-80: Span-80). Based on these two factors, there were 9 treatment combinations. The test was carried out three times, resulting in 27 experimental units.

### 2.4. Analysis of samples

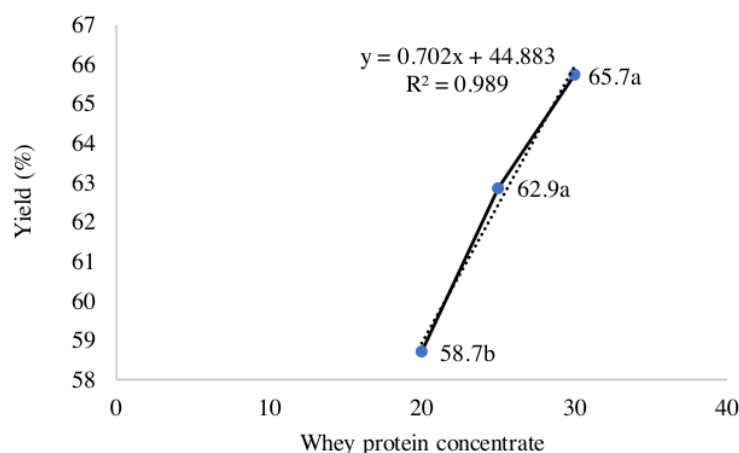
There were two variables studied: physicochemical and sensory variables. Physicochemical variables included yield, pH value, total dissolved solids, total titratable acidity, moisture content, fat content, and dissolved protein content while sensory variables included color, aroma, taste, texture, and preferences. Data obtained from physicochemical and sensory variables were tested using ANOVA test. If the analysis results showed a significant effect, it was then continued with the Duncan Multiple Range Test

with a confidence level of 95%. The best treatment was determined by the effectiveness index method based on the physicochemical and sensory properties of cheddar cheese.

## 3. Results and discussion

### 3.1. Characteristics of the product

**3.1.1. Yield.** Variations in concentration of WPC had a very significant effect on the yield; but variation of the emulsifier and interaction between them did not have a significant effect. Increase in the addition of variations in concentration of WPC caused an increase in the yield of cheddar cheese analogue produced. This corresponds to Zoidou et al. [7] that stated factor that affects the yield is the composition of milk, especially the levels of fat and protein. However, protein content is the main factor that affecting cheese yield. It indicates a linear correlation between the yield and the concentration of protein and fat, meaning that the higher protein and fat concentration, the higher the yield (Figure 1). It was indicated by the addition of 30% WPC which produced a higher yield than 25% and 20% WPC. The same result was reported by Abubakar and Usman [8] which found that the highest yield of low-fat white cheese was produced from the treatment of corn oil emulsion in skim milk with whey protein concentrate of  $15.31 \pm 0.21\%$ .



**Figure 1.** The yield of cheddar cheese analogue was affected by concentration of whey protein concentrate

More importantly, the yield of cheddar cheese analogue on the type of emulsifier did not have a significant effect. The yield in Tween 80 was 63.08%; the yield with Span 80 was 60.61%; and the yield the combination of Tween 80 and Span 80 was 63.60%. According to Hou and Papadopoulos [9], combination of Tween 80 and Span 80 has high compatibility to create a stable interface layer and provide good performance in the emulsification process. However, in this study, the addition of the combination of Tween 80 and Span 80 did not have a significant effect. This would possibly occur because the added emulsifier concentration in cheddar cheese analogue did not stabilize fat and protein.

**3.1.2. pH.** pH value is a parameter to determine the acidity condition of cheddar cheese analogue. The concentration of WPC, type of emulsifier and interaction between them had no significant effect on pH of cheddar cheese analogue. pH cheddar cheese analogue with the addition at 20, 25 and 30 % were 5.7, 5.7, and 5.8 respectively. The same results were obtained from research conducted by Abd El-Salam [10] which concluded the pH of cheese was not affected by an addition of sunflower oil and whey protein

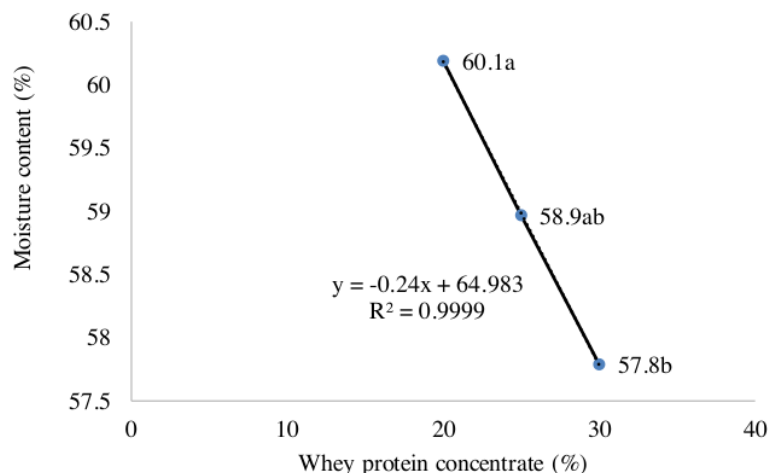
concentrate. The resulting average pH value was higher than pH value of cheddar cheese analogue (6.45 - 6.50).

Besides, the decrease in pH occurred due to the activity of lactic acid bacteria (LAB) in producing energy through the fermentation process by breaking down the substrate into simpler components [11]. This energy formation is intended for cellular metabolism. One of the substrates that exist is lactose which is contained in milk and WPC. Milk contains 5% sugar, while WPC contains 4-8% lactose which can be used by lactic acid bacteria (LAB) as a source of carbon and energy in the fermentation process. However, the process of making cheddar cheese analogue did not use LAB for the fermentation process, so there was no LAB activity in lowering the pH.

Additionally, the pH for various types of emulsifier, Tween 80, Span 80, and Tween 80: Span 80 were 5.6; 5.8; and 5.8 respectively. Abd El-Salam [10] claimed that type of emulsifier affects pH value of the resulting cheese. This is presumably due to the absence of large basic differences of the two types of emulsifiers.

In addition, there was curing process in making cheddar cheese analogue, but was done without using bacteria so that biochemical processes did not occur. According to González et al. [12], pH levels decrease during the curing process. The decrease in pH level of cheese is influenced by the amount of lactic acid produced by microorganisms. The higher the lactic acid, the lower the pH level. The decrease in pH value is due to the activity of bacteria in the cheese.

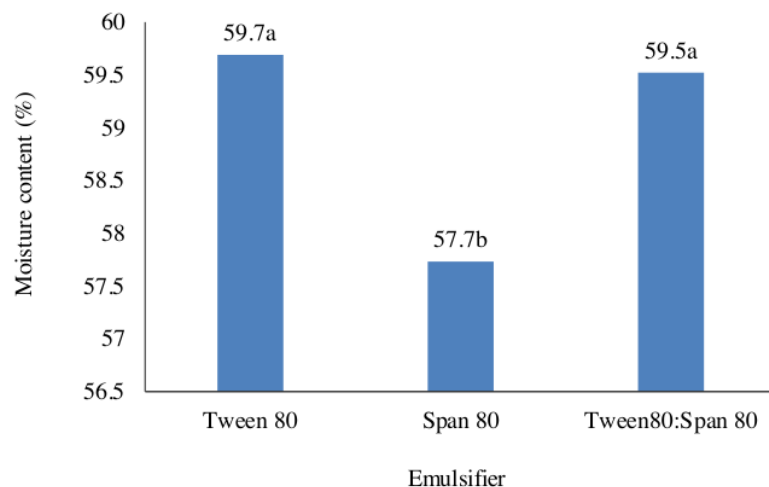
**3.1.3. Moisture content.** Concentration of WPC and in type of emulsifier had a very significant effect, but the interaction between them had no significant effect. The higher WPC addition, the lower the moisture content of cheddar cheese analogue (Figure 2). Moisture content of cheese is influenced by its fat and protein content. The higher the protein content, the greater the ability of the casein matrix to bind to water. Cheese with water-in-oil-in-water emulsion in skim milk (A4) and cheese with a 60% reduction milk fat (A1) had higher water content of  $53.96 \pm 4.26\%$  and  $53.01 \pm 3.12\%$  than other treatments. This is due to the high protein content found in A1 and A4 cheese.



**Figure 2.** The moisture content of cheddar cheese analogue was affected by concentration of whey protein concentrate

The moisture content of cheddar cheese analogue at various concentrations of emulsifier types is presented in Figure 3. The highest average value of moisture content was found in 1% Tween 80 (E1) (59.69% wb) and the smallest average value was found in 1% Span 80 (E2) (57.73% wb). The value of

moisture content of cheddar cheese analogue produced was not much different from the results of research conducted by Abubakar and Usmiati [8] in the treatment of corn oil emulsion in skim milk, which was  $51.51 \pm 2.84\%$  (%w/w).

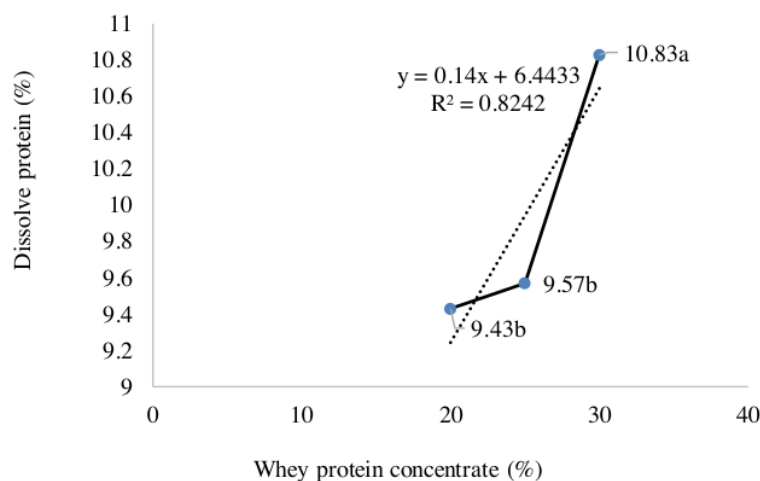


**Figure 3.** The moisture content of cheddar cheese analogue was affected by type of emulsifier

**3.1.4. Dissolved solid.** There was no significant effect in concentration of WPC, type of emulsifier and interaction between them on dissolved solids of cheddar cheese analogue. The dissolved solids of cheddar cheese analogue with addition of WPC 20, 25 and 30 % were 31.6, 31.8, and 31.9°Brix. Cheddar cheese analogue that use Span 80, Tween 80, and combination Tween 80 and Span 80 as emulsifiers have dissolved solids 31.83, 31.89 and 31.67°Brix.

The higher the addition of WPC and emulsifier concentrations, the higher the total dissolved solids of cheddar cheese analogue produced. This is in accordance with the statement of [13] that the addition of non-fat solids such as WPC and emulsifier can increase the total solids so that it can improve the characteristics of the resulting cheese.

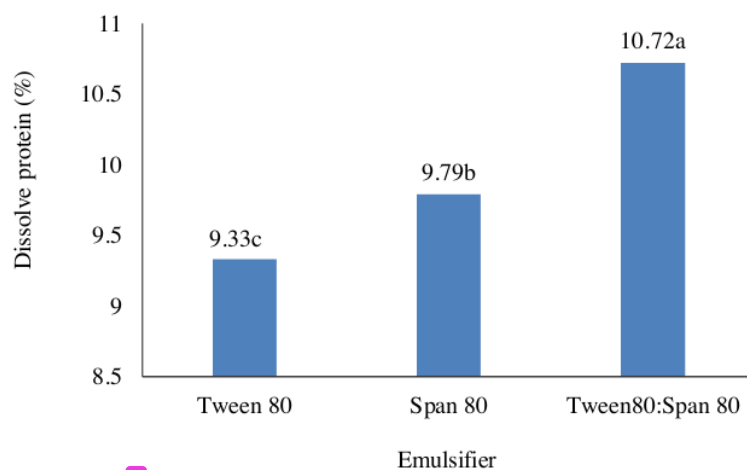
**3.1.5. Dissolved protein.** Concentration of WPC, type of emulsifier, and interaction between them had a very significant effect on dissolved protein content of cheddar cheese analogue. The more addition of WPC, the more the dissolved protein content of cheddar cheese analogue (Figure 4). According to Stankey et al. [14] based on protein content, WPC is divided into WPC34 (around 34% of protein content), WPC50 (around 50% of protein content) and WPC80 (around 80% of protein content). WPC used in this study was WPC which contained 80% protein content. The same result was expressed by Dhanraj and Jana [15] who found that cheese added by WPC as a fat replacer had the highest protein content. WPC contains a lot of bioactive components so that it is expected to increase the functionality of low-fat cheese. The use of single WPC has not produced cheese of the same quality as fat-dense cheese.



**Figure 4.** Dissolved protein of cheddar cheese analogue was affected by concentration of whey protein concentrate

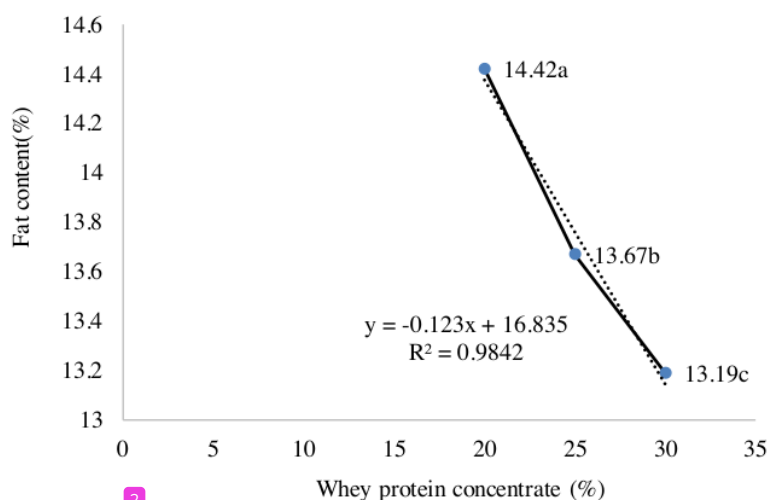
In line with the results of this study, Priadi et al. [16] also found that the concentration of fillers (*mocaf* and wheat flour) will have different effects. Increasing the concentration of fillers decreases the protein content of processed cheddar cheese. The same result is conveyed by Mounsey and Riordan [17] that stated an increase in the concentration of maize flour causes a decrease in protein content in cheese analogue.

The highest of dissolved protein content was found in 1% Tween 80: Span 80 was 10.72%, and the smallest was found in 1% Tween 80 (9.33%) (Figure 5). It is in line with results of research conducted by Khan and Masud [18] which found that the use of a stabilizer has an effect on the protein content of the product, because it has a hydrophilic group that will bind water. Thus, the more stabilizer is added, the higher the protein concentration in the product.



**Figure 5.** The moisture content of cheddar cheese analogue was affected by type of emulsifier

**3.1.6. Fat content.** The concentration of WPC and interaction between the concentration of WPC and type of emulsifiers had a very significant effect, but variations in the type of emulsifier had no significant effect on the fat content of cheddar cheese analogue. The higher addition of WPC, the lower the fat content of cheddar cheese analogue. This is in accordance with Perreault et al. [4] that increasing the concentration of WPC in milk causes a decrease in fat content in cheese. It is supported by who claimed that increased concentration of fillers in the form of *mocaf* and wheat flour had a significant effect on decreasing fat content. The addition of fillers increases the proportion of starch and decreases the proportion of fat in processed cheddar cheese. Fat in cheese can form complex bonds with starch, which can cause incomplete gelatinization process.



**Figure 6.** Fat content of cheddar cheese analogue was affected by concentration of whey protein concentrate

The average value of fat content in various types of emulsifier (E), namely Tween 80 (E1) was 13.64%, Span 80 (E2) was 14%; and Tween 80: Span 80 was 13.64%. These results indicate no significant effect on fat content in cheddar cheese analogue. It is different from Zoidou et al. [7] who stated that stabilizer concentration has an effect on fat content. The increase in fat content is due to the greater the concentration of lecithin, the higher the hydrophobic group, which affects the increase in fat content of apple cider margarine supplemented with peanut oil. It supports the results of this study due to the use of the same emulsifier concentration, so that it does not affect the fat content in the resulting cheddar cheese analogue.

Cheese in this study is categorized as low-fat cheese. The term low-fat cheese generally refers to cheese with a lower fat content than full-fat cheese. Based on wet weight, full-fat cheese in fresh form has a fat content of 24.5% [11]. According to Aini et al. [3], fat content in cheese really depends on the type of milk and other ingredients used as raw materials. Low-fat content in the results of this study is due to basic ingredients of cheese which do not fully use cow's milk but a mixture of corn milk. Aini et al. [19] stated that sweet corn has 1 g fat content per 100 g of ingredients, while fat content of milk was 3.4% [20]. This causes the fat content of the cheese to be low.

**3.1.7. Titratable acidity.** There was no significant effect between concentration of WPC, type of emulsifier and interaction between them on total titratable acidity of cheddar cheese analogue. The titratable acidity of cheddar cheese analogue with addition of WPC 20, 25 and 30 % were 1.46, 1.47 and

1.38 respectively. In addition, titratable acidity of cheddar cheese analogue that use emulsifiers Tween 80, Span 80 and combination of Tween 80: Span 80 were 1.36, 1.36 and 1.59. These results demonstrate that using 1 type of emulsifier produces the same total titratable acidity, but using 2 emulsifiers has a higher total titratable acidity.

More importantly, cheddar cheese analogue in this study was cured but did not use a fermentation process. This is different from Syamsu and Elshahida [21], who claimed that vegan cheese made from soybeans have a pH value in powdered soy milk and fresh soy milk which decreases with the length of fermentation, while the total titratable acidity inversely proportional to the pH value and increases with the length of fermentation. Powdered soy milk reaches the isoelectric point at the 16th hour, while the fresh soy milk reaches the isoelectric point at the 12<sup>th</sup> hour.

**3.1.8. Sensory variables.** Based on the results of diversity test, the attributes of color, taste, texture and preferences were significantly different. Color is a physical parameter formed when light hits an object and is reflected on the sense of sight (eye). Color assessment of food ingredients is very important since color is one of the parameters that determines the quality of the ingredients. The colors were significantly different between each formula. The higher the average value, the more preferable the cheese color will be. The highest average values were obtained from the treatment combinations of W2E2 (4.78); W1E1 (4.74); W3E1 (4.66); and W1E3 (4.64), which demonstrates that the color produced by cheddar cheese analogue is slightly yellowish. The smallest average value was obtained in W2E3 with a value of 3.92, which means that the resulting color is yellowish white.

The yellow color of cheese is presumably the result of the color of corn milk. Hassan [22] stated that yellowish color is due to carotene contained in corn. In addition, the color produced by cheddar cheese analogue is also influenced by the combination of treatment between WPC and the type of emulsifier used. The yellowish white color of the cheddar cheese analogue is the result of the WPC color. According to Dhanraj and Jana [15], WPC gives a yellowish white color to the liquid yogurt starter. Besides the addition of WPC, the addition of an emulsifier also affects the color of cheddar cheese analogue produced. Hou and Papadopoulos [9] added that Span 80 is a thick yellow liquid and Tween 80 is a yellow oil.

Aroma is an odor caused by chemical stimuli that are smelled by olfactory nerves in the nasal cavity [23]. The product with the best aroma is the product with the maximum or strongest characteristic cheese aroma. The analysis of variance on the aroma of cheddar cheese analogue showed a significantly different effect on each formula. The highest average value was obtained in W2E1 treatment (4.59 - strong distinctive aroma of cheese), while the lowest average value was found in W1E3 treatment (4.02 - slight cheese aroma). It occurred due to the differences in the concentration of WPC used, since WPC has a distinctive aroma like milk. According to Panthi et al. [24], whey is a semi-transparent liquid that is left during the precipitation process in cheese making which has a slightly fragrant aroma. The higher the average value produced, the more distinctive the aroma of the resulting cheese, such as cheddar cheese on the market.

Cheddar cheese analogue has a slight or mild distinctive cheese aroma. It is because the production of cheddar cheese analogue only uses corn milk, without any additional cow's milk. Changes in dairy products such as cheese are caused by the fermentation of lactose, citrate and other organic compounds which become a variety of acids, esters, alcohols and volatile flavor and aroma-forming compounds [3]. The process of making cheddar cheese analogue does not use a fermentation process so that cheese aroma does not have a distinctive aroma like cheddar cheese on the market.

Analysis of variance on the taste of cheddar cheese analogue showed a significantly different effect on each formula. The highest value of taste was produced in W1E2 treatment (5.85 - salty), while the lowest value was found in W2E2 treatment (5.15 - slightly salty). The taste produced from cheddar cheese analogue is the same as the results of research conducted by Abubakar and Usmiati [8] that low-fat white cheese has a taste that is close to very salty to salty.

The taste produced by cheddar cheese analogue is influenced by the combination of treatment between WPC and emulsifier (Tween 80 and Span 80). Damin et al. [25] stated that whey has a slightly

sour taste, while Hou and Papadopoulos [9] stated that Tween 80 has a bitter taste. However, the taste produced by cheddar cheese analogue is neither sour nor bitter. It presumably occurs due to the use of emulsifier concentrations which tend to be small so that the cheese does not taste bitter.

The quality of texture is very important in assessing the quality of cheese [8]. Analysis of variance on the texture of cheddar cheese analogue showed a significantly different effect. The higher the average value of the cheddar analogue cheese, the harder the cheese will be. The highest average value was found in formula 9 (W3E3) and 7 (W3E1) which were included in the slightly hard category, while the other formulas had an average value of 2 which showed that the resulting cheese was not hard. It can happen because formula 9 had the highest WPC concentration of 30%. The same results are found in a research conducted by El-Sheikh et al. [6] which found that treatment with WPC dispersion increases the hardness of cheese than other treatments. The addition of protein-based fat replacers such as WPC at certain concentrations can increase the hardness and elasticity, while the addition of protein causes interactions between proteins and forms a harder matrix.

Product with the best preference is based on the best scoring of the attributes that have been tested previously. Results of analysis of variance on the preference for cheddar cheese analogue showed a significantly different level of preference. The average value of panelists based on the scoring test showed that cheddar cheese analogue with the best preference was found in formula 9 (W3E3), while the lowest average value was found in formula 2 (W1E2). The higher the average value of cheddar cheese analogue produced, the higher the level of preference for the panelists to the resulting cheddar cheese. The level of preferences is also based on other sensory attributes such as color, aroma, taste, and texture.

### 3.2. Effectiveness Index

The efficacy index was used to determine the best formula based on physical, chemical and sensory properties. Due to the cumulative value of effectiveness index, it is concluded that W3E1 with 30% WPC and Tween 80 emulsifier is the best treatment. It has yield 63.23%, pH of 5.7, total dissolved solids of 31.75°Brix, moisture content of 59.24%, dissolved protein of 10.07%, fat content of 13.65%, titratable acidity of 1.53 with a yellowish white color, slight cheese aroma, slightly salty, not hard, and tend to be preferred.

The yield of cheddar cheese analogue was greater than yield of low-fat white cheese with the addition of corn oil emulsion in skim milk with whey protein concentrate, conducted by Abubakar and Papadopoulos [8], with a yield of  $15.31 \pm 0.21\%$ . Moreover, the protein and fat content was lower than dissolved protein and fat content in processed cheddar cheese added with modified cassava flour and tapioca flour, which was conducted by Priadi et al. [16]. Processed cedar cheese with the addition of modified cassava flour and tapioca flour had a protein content of 34.78% and a fat content of 45.79%. The moisture content in cheddar cheese analogue was not much different from the moisture content in low-fat white cheese with the addition of corn oil emulsion in skim milk with whey protein concentrate carried out by Abubakar and Usmiati [8] with a value of  $55.48 \pm 4.29\%$  (%). The pH of cheddar cheese analogue was not much different from the pH and sensory of spreadable cheese analogue that has been studied by [26]. The pH of spreadable cheese analogue was 5.4 and had similar sensory such as having yellowish white color, distinctive cheese aroma, and texture that is neither hard nor soft.

## 4. Conclusion

Different variations in concentration of WPC result in different yield, moisture content, dissolved protein and fat content, but there is no difference in pH, dissolved solids, and titratable acidity. Different emulsifier types result in different values of moisture content and dissolved protein, but there is no difference in yield, pH, dissolved solids, fat content, and titratable acidity. The best formula proportion of cheddar cheese analogue is 12% WPC and 1% Tween 80, since it has yield of 63.23%, pH of 5.7, dissolved solids of 31.75°Brix, moisture content of 59.24%, dissolved protein of 10.07%, fat content of 13.65%, titratable acidity of 1.53 with a yellowish white color, slight cheese aroma, slightly salty, not hard, and tend to be preferred.

### Acknowledgements

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### References

- [1] Mäkinen O E, Wanhalinna V, Zannini E and Arendt E K 2016 *Crit. Rev. Food Sci. Nutr.* **56** 339–349
- [2] Tamime A Y 2011 Processed Cheese and Analogues: An Overview *Processed Cheese and Analogues* (Oxford, UK: Wiley-Blackwell) pp 1–24
- [3] Aini N, Prihananto V, Sustriawan B, Romadhon D and Ramadhan R N 2019 *Int. J. Food Sci.* **2019** 1–8
- [4] Perreault V, Rémillard N, Chabot D, Morin P, Pouliot Y and Britten M 2017 *J. Dairy Sci.* **100** 5139–5152
- [5] Gulzar N, Sameen A, Huma N and Shahid M 2016 *Pakistan J. Agric. Sci.* **53** 209–216
- [6] El-sheikh M, Farrag A and Zaghloul A 2010 *J. Am. Sci.* **6** 321–325
- [7] Zoidou E, Andreadaki I, Massouras T and Kaminarides S 2016 *J Nutr. Med Diet Care* **2** 17–22
- [8] Abubakar A and Usmiati S 2016 *Bul. Peternak.* **40** 144
- [9] Hou W and Papadopoulos K D 1997 *Colloids Surfaces A Physicochem. Eng. Asp.* **125** 181–187
- [10] Abd El-Salam B A 2015 *Int. J. Dairy Sci.* **10** 117–125
- [11] Aini N, Sustriawan B, Prihananto V and Heryanti T 2019 *IOP Conf. Ser. Earth Environ. Sci.* **255** 012016
- [12] González M L, Sánchez H C, Franco F M J, Güemes V N and Soto S S 2018 *Food Res.* **2** 61–67
- [13] Nugroho P, Dwiloka B and Rizqiati H 2018 *J. Teknol. Pangan* **2** 33–39
- [14] Stankey J A *et al.* 2017 *Int. J. Dairy Technol.* **70** 481–491
- [15] Dhanraj P and Jana A 2017 *J. Food Sci. Technol.* **54** 822–831
- [16] Priadi G, Setiyoningrum F, Afiati F and Syarief R 2018 *J. Litbang Ind.* **8** 61
- [17] Mounsey J S and O’Riordan E D 2008 *J. Food Eng.* **84** 57–64
- [18] Khan R S and Masud T 2013 *Int. J. Dairy Technol.* **66** 396–401
- [19] Aini N, Prihananto V, Wijonarko G, Astuti Y, Maulina M R and Muthmainah M 2017 *Adv. Sci. Lett.* **23** 5796–5798
- [20] Metzger L E, Barbano D M and Kindstedt P S 2001 *J. Dairy Sci.* **84** 1357–1366
- [21] Syamsu K and Elshahida K 2018 *J. Teknol. Ind. Pertan.* **28** 154–161
- [22] Hassan M A M 2018 *World J. Dairy Food Sci.* **13** 63–73
- [23] Cunha C R, Dias A I and Viotto W H 2010 *Food Res. Int.* **43** 723–729
- [24] Panthi R R, Kelly A L, Sheehan J J, Bulbul K, Vollmer A H and McMahon D J 2019 *J. Dairy Sci.* **102** 177–189
- [25] Damin M R, Alcântara M R, Nunes A P and Oliveira M N 2009 *LWT - Food Sci. Technol.* **42** 1744–1750
- [26] Aini N, Sustriawan B, Sumarmono J and Prihananto V 2019 *IOP Conference Series: Earth and Environmental Science* **406** 012017

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# The effect of addition of whey protein concentrate and emulsifier on characteristics of cheddar cheese analogue from corn milk

GRADEMARK REPORT

FINAL GRADE

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GENERAL COMMENTS

Instructor

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## CLAIM

Take an arguable position on the scientific topic and develop the essay around that stance.

---

ADVANCED	The essay introduces a precise, knowledgeable, qualitative and/or quantitative claim based on the scientific topic or text(s), regarding the relationship between dependent and independent variables, and establishes the significance of the claim. The essay develops the claim and counterclaim fairly and thoroughly, distinguishing the claim from alternate or opposing claims.
PROFICIENT	The essay introduces a precise, qualitative and/or quantitative claim based on the scientific topic or text(s), regarding the relationship between dependent and independent variables. The essay develops the claim and counterclaim fairly, distinguishing the claim from alternate or opposing claims.
DEVELOPING	The essay introduces a qualitative and/or quantitative claim based on the scientific topic or text(s), regarding the relationship between dependent and independent variables, but it may be somewhat unclear. The essay may not present the claim and counterclaim evenly or objectively, failing to adequately distinguish the claim from alternate or opposing claims.
EMERGING	The essay does not clearly make a qualitative and/or quantitative claim based on the scientific topic or text(s), or the claim is overly simplistic or vague. The essay does not address counterclaims.

## EVIDENCE

Include relevant facts, definitions, and examples to back up the claim.

---

ADVANCED	The essay supplies the most relevant and appropriate qualitative and/or quantitative data and evidence related to the scientific topic or text(s) to support its claim and counterclaim.
PROFICIENT	The essay supplies sufficient qualitative and/or quantitative data and evidence related to the scientific topic or text(s) to support its claim and counterclaim.
DEVELOPING	The essay supplies some qualitative and/or quantitative data and evidence, but it may not be closely related to the scientific topic or text(s), thereby not effectively supporting the essay's claim and counterclaim.
EMERGING	The essay supplies very little or no qualitative and/or quantitative data and evidence to support its claim and counterclaim.

## REASONING

Explain how or why each piece of evidence supports the claim.

---

ADVANCED	The essay applies scientific ideas and principles in order to thoroughly explain how or why the cited evidence supports the claim. The essay demonstrates consistently logical reasoning and full understanding of the scientific topic and/or text(s), comprehensively stating the strengths and limitations of both the claim
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and counterclaim. The essay's explanations effectively anticipate the audience's knowledge level, concerns, values, and potential biases about this scientific topic.

PROFICIENT	The essay applies scientific ideas and principles in order to explain how or why the cited evidence supports the claim. The essay demonstrates some logical reasoning and understanding of the scientific topic and/or text(s) and states the strengths and limitations of both the claim and counterclaim. The essay's explanations anticipate the audience's knowledge level and concerns about this scientific topic.
DEVELOPING	The essay includes some reasoning and understanding of the scientific topic and/or text(s), but it does not effectively apply scientific ideas and principles to explain how or why the evidence supports the claim. The strengths and limitations of the claim and counterclaim may be unclear.
EMERGING	The essay does not demonstrate clear or relevant reasoning to support the claim or to demonstrate an understanding of the scientific topic and/or text(s).

## FOCUS

Focus your writing on the purpose and task.

---

ADVANCED	The essay maintains strong focus on the purpose and task, using the whole essay to support and develop the claim and counterclaims fairly while thoroughly addressing the demands of the prompt.
PROFICIENT	The essay maintains focus on the purpose and task, using most of the essay to support and develop the claim and counterclaims while thoroughly addressing the demands of the prompt.
DEVELOPING	The essay may not fully address the demands of the prompt or stay focused on the purpose and task. The writing may stray off topic at times.
EMERGING	The essay does not maintain focus on purpose or task.

## ORGANIZATION

Organize your writing in a logical sequence.

---

ADVANCED	The essay incorporates an effective organizational structure throughout that logically sequences the claim(s), counterclaims, reasons, and evidence. It also includes an effective introduction and a conclusion which follows from and supports the arguments presented. Transitional words and phrases are included to enhance the relationships between and among ideas (i.e. claim and reasons, reasons and evidence, claim and counterclaim) and to create cohesion and clarity throughout.
PROFICIENT	The essay incorporates an adequate organizational structure and transitional phrases throughout that establish clear relationships between and among the claim(s), counterclaims, reasons, and evidence, including an introduction and concluding statement or section.

DEVELOPING	The essay uses a basic organizational structure but relationships between and among ideas are not consistently clear. The essay moves from beginning to end; however, an introduction and/or conclusion may be overly formulaic, repetitious, or missing.
EMERGING	The essay does not have a clear organizational structure. An introduction and conclusion are not evident.

## LANGUAGE

Pay close attention to your tone, style, word choice, and sentence structure when writing.

---

ADVANCED	The essay effectively establishes and maintains a formal style and objective tone and incorporates language that anticipates the reader's knowledge level, concerns, values, and potential biases. The essay demonstrates a clear command of conventions, while also consistently employing discipline-specific word choices and varied sentence structure.
PROFICIENT	The essay generally establishes and maintains a formal style and somewhat objective tone with few possible exceptions and incorporates language that anticipates the reader's knowledge level and concerns. The essay demonstrates a general command of conventions, while also employing discipline-specific word choices and some variety in sentence structure.
DEVELOPING	The essay attempts a formal style and objective tone, and language inconsistently shows an awareness of the reader's knowledge or concerns. The essay may contain errors in conventions that interfere with meaning. Some attempts at discipline-specific word choices are made, and sentence structure may not vary.
EMERGING	The essay is not formal in style or objective in tone and employs language that does not anticipate the reader's knowledge or concerns. The essay may contain pervasive errors in conventions that interfere with meaning. Word choice is not discipline-specific, and sentence structures are simplistic and unvaried.