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by Nur Aini

Submission date: 09-Feb-2022 09:06PM (UTC+0700)
Submission ID: 1758478145
File name: isi_iop_iclas_2018.pdf (565.06K)
Word count: 3746
Character count: 18621

IOP Conf. Series: Earth and Environmental Science **255** (2019) 012016 doi:10.1088/1755-1315/255/1/012016

Characteristics of cheese analogue from corn extract added by papain and pineapple extract

N Aini[1,2], B Sustriawan[1], V Prihananto[1], T Heryanti[1]
[1]Department of Food Science and Technology, Jenderal Soedirman University, Purwokerto, Indonesia

Email : nur.aini@unsoed.ac.id

Abstract. Corn extract is an alternative ingredient which can substitute cow's milk in making cheese analogue. The addition of pineapple and papain extract aims to produce cheese analogue with the physical and chemical desired. This study aims to 1) find out the optimum formula of additional papain and pineapple extract to produce extract corn-substituted cheese analogue, 2) Knowing the sensory, physical and chemical characteristics of cheese from corn milk produced from the best formula. The experimental design in this study was determined by Response Surface Methodology (RSM) using Central Composite Design with 2 factors studied, which are the amounts of pineapple extract (31.72-88.28 ml) and papain extract (89.64-150 mg). Variables observed include yield, moisture content, soluble protein, soluble solid and sensory variables. The optimum formula for producing cheese analogue substituted by corn extract is the addition of 40 ml pineapple extract and 130.82 mg papain extract. The yield of the formula is 19.2%. The cheese analogue has 5.908% of dissolved protein content, 12°Brix of dissolved solids and 24.3% of moisture content. The sensory characteristics (scale 1-5) of cheese analogue are whitish yellow (3.44), typical corn aroma (3.5), good taste (3.5), easy to spread (4.28) and preferred (3.5)

Keyword: corn extract, pineapple extract, papain, spread analogue cheese

1. Introduction

Spread cheese is usually made by the coagulation of cow's milk or the other milk, for example is goat's milk. The lifestyle of today's consumers who want a balanced consumption of plant and animal foods raises innovation in cheese making by replacing a part or all of cow's milk with vegetable ingredients [1]. The cheese is called as cheese analogue. Cheese analogue, also called as cheese imitation, is defined as a cheese-like product, made from ingredients such as milk fat, vegetable fat, protein with the addition of emulsifiers, and also made through heat and mechanical energy [2].

Sweet corn extract is an alternative ingredient which can substitute the cow's milk in making cheese analogue. The type of cheese analogue which is widely made and used is spreadable cheese analogue because its manufacture is relatively easy and simple [3].

The coagulation process is an important stage which determines the texture and flavour of the cheese [4]. In order to help the coagulation process, rennet enzyme is added as the coagulant [5]. The rennet enzyme used as the coagulant of cheese is expensive; therefore it needs an alternative of rennet enzyme. According to [6] protease enzyme from plants can be used as an alternative in cheese making. One of the enzymes that can be used as the substitute

of rennet enzyme is papain from papaya gum. The use of papain in cheese making can produce high yields and the characteristics of its cheese are similar to cheese made using rennet enzymes [7].

Cheese making requires an acidulant which aims to reduce pH. The decrease of pH is important in order to reach the isoelectric point which plays a role in the formation of the cheese texture. Pineapple has a pH of 2.3 and the presence of bromelin enzyme in pineapple can help the coagulation process in cheese making [8], [9]. According to [10] the addition of pineapple extract can coagulate milk in the production of soft cheese.

The objectives of this study are: 1) To find out the optimum formula for adding papain and pineapple extract to produce corn-substituted cheese analogue, 2) Knowing the sensory, physical and chemical characteristics of cheese from corn milk produced from the best formula.

2. Experimental details

2.1. Ingredients

The ingredients used in this study are sweet corn and pineapple bought from Wage Market, Purwokerto, fresh cow's milk (CV Tiga Putra), commercial papain (Paya(®)), *Lactobacillus casei* from the Biotechnology Research Center, Indonesian Institute of Sciences in Cibinong, West Java, Indonesia.

2.2. The making of cheese analogue

The cheese making includes the preparation of ingredients, corn steaming and corn seeds shelling. The next step is refining corn seeds by adding water (twice the weight of corn) to obtain the corn extract. The corn extract obtained was mixed with cow's milk which was then pasteurized for 30 minutes. The pasteurization was left to a temperature of 40 C and added with 1 ml of *Lactobacillus casei* liquid, 30g of sucrose, and 2Cl of $CaCl_2$ then incubated for 2 hours. The incubated milk was added by pineapple and papain extract. The curd formed is then separated by filter cloth and pressed, so that a semi-solid curd is produced. The curd was then cooked at 52 C for 15 seconds and added with 2g of NaCl and 4g of sucrose.

2.3. Experimental design

The experimental design in this study was determined by Response Surface Methodology (RSM) using (Central Composite Design) with 2 factors studied, which are the amount of pineapple and papain extract. The pineapple extract used was 31.72-88.28 ml; while the papain extract was used 89.64-150 mg. Based on the results of the randomization, 13 formulas were obtained (Table 1).

Table 1. The formula of spreadable cheese analogue

Run	Pineapple Extract(ml)	Papain (mg)
1	80.00	100.00
2	60.00	125.00
3	60.00	125.00
4	80.00	150.00
5	40.00	150.00
6	60.00	125.00
7	88.28	125.00

8	60.00	160.36
9	31.72	125.00
10	60.00	125.00
11	60.00	125.00
12	60.00	89.64
13	40.00	100.00

2.4. Analysis of samples

Variables observed include yield [11], moisture content [12], soluble protein [12], soluble solids [3], and sensory variables (scale 1-5) on color, taste, aroma, topical power, and preference [13]. The data obtained were analyzed by response analysis with Design Expert v.7 software.

3. Result and Discussion

3.1. Initial product characteristics

The yield of cheese analogue produced was 8.32-9.28% (Figure 1). This yield has a quadratic model with R-squared value of 0.35937 or not significant with the F value of 0.79 and p-value of 0.5912. This yield is almost the same as soft cheese from cow's milk using fruit extract which is 7.75 -10.29% [14]. The yield of this cheese analogue is lower than the cheese produced with acidification using fruit extract by [15] which states that cheese making using a fruit extract produces a yield of 14-18%. The cheese yield is also lower than the results [16] which states that the yield of cheese made using papain is 20.4-23.4%. According to [10], yield is affected by raw materials and composition, type of acidulant, as well as pasteurization and pressing method.

Increasing the amount of papain in cheese analogue making increases the yield of cheese. According to [17], the higher the protease enzyme added the more increase the yield.

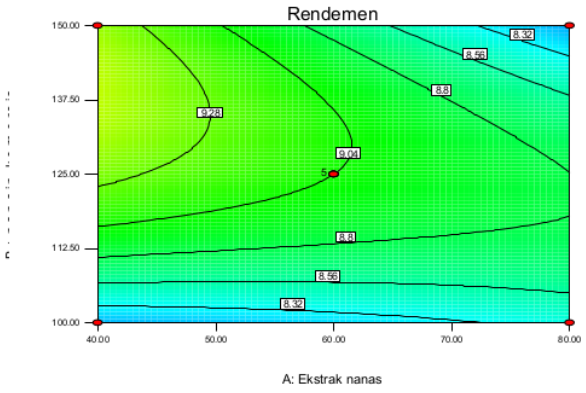

Figure 1. The yield of cheese analogue with additional of pineapple and papain extract

The more pineapple extract is added, does not affect the yield of cheese. This is different from [15] who states that the higher the concentration of fruit extracts, the lower the yield of

the cheese obtained. The more fruit extracts can cause excessive proteolysis so that the casein more dissolves in whey. The cheese analogue result of this study has dissolved solids of 2.09-4.76 Brix (Figure 2). The more addition of pineapple extract, the higher the dissolved solids. Pineapple extract contains the bromelin enzyme and is acidic so that it can reduce pH so that it reaches an isoelectric point. At the isoelectric point, milk clots occur which will separate whey and curd proteins. This will increase the dissolved solids in the cheese.

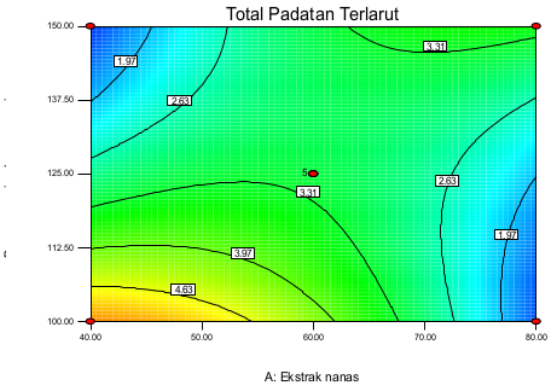

Figure 2. Cheese analogue dissolved solids with the addition of pineapple and papain extract

The moisture content of this cheese analogue is 57.11% - 76.87% (Figure 3). This is consistent with [15] that the moisture content of soft cheese without the ripening process has a moisture content of 52 - 80%.

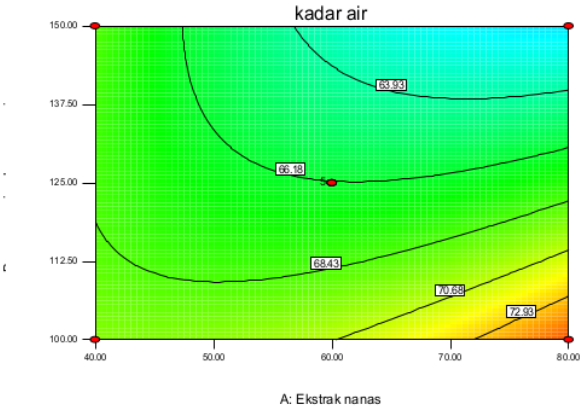

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Figure 3. The moisture content of cheese analogue with the addition of pineapple and papain extract

The addition of papain concentration does not significantly affect the moisture content. This is slightly different from [18] who states that the more addition of papain the more increase the moisture content of the cheese.

The more addition of pineapple to cheese making will reduce the moisture content of cheese. The addition of acid to cheese making will accelerate the process of decreasing the pH. The lower pH the more acidic; so that the whey is easier to be separated from the curd. The ease of separating whey and curd results in low moisture content in the curd so that the moisture content of the resulting cheese is also low [18].

The cheese analogue produced has dissolved protein levels of 2.18-3.24% (Figure 4). The addition of papain increases the level of protein dissolved in cheese analogue. This is consistent with [16] that the higher the concentration of the papain enzyme is used, the higher the level of protein in traditional cheese produced. Papain is a type of protease enzyme, thus the more papain the more increase the proteolytic activity. Increasing the proteolytic activity will increase the breakdown of protein into peptides and amino acids so that the dissolved protein levels in cheese analogue increases [17]. This dissolved protein level is lower than the cheese analogue from cow's milk using papain, which is 12.14-22.56% [7]. This difference is caused by the differences in the materials used, because in this study the material used is cow's milk plus raw corn extract, where sweet corn has lower protein content than cow's milk.

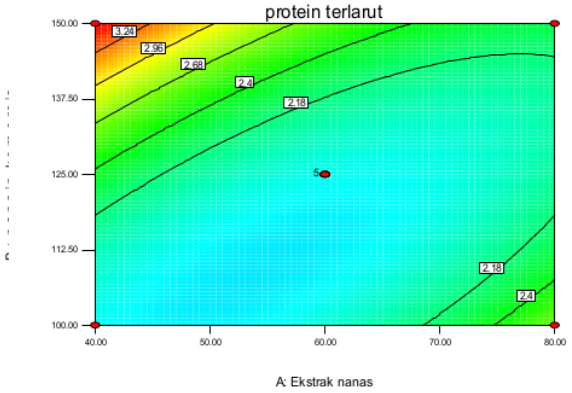

Figure 4. Dissolved protein level in cheese analogue with the addition of pineapple and papain extract

The increase in the amount of pineapple extract added does not significantly affect the level of cheese protein. This is slightly different from [19] that increasing the concentration of pineapple extract added will increase the protein content in cheese. This is because pineapple has a low pH which helps clump the protein so that in the process of separation, the level of protein in curd which is then processed into cheese is also high.

Topical cheese analogue making in this study did not use stabilizers. According to [19], the addition of stabilizers can increase dissolved protein level in cheese making.

3.2. The optimum formula and its verification

The optimization stage was done to get a formula with the most optimal response adjusted to the product characteristics desired. The most optimal response was obtained if the value of the desirability is close to 1. Weighting is done on each component to achieve the desired goal (Table 2).

Table 2. Optimization criteria for each factor and response

Response	*Goal*	Limitation		*Importance*
		Bottom	Top	
Pineapple extract	*In range*	40	80	-
Commercial papain	*In range*	100	150	-
Dissolved solid	*maximize*	1	6	4
Dissolved protein	*maximize*	1.36	3.5	5
Moisture content	*minimize*	57.11	76.87	4

Explanation: The score of 1-5 shows that the higher the score, the more it is preferred to be optimized

Based on the optimization with the criteria in Table 2, the optimum formula recommended is 40 ml of pineapple extract and 130.82 grams of commercial papain. The formula can produce topical cheese analogue with the prediction set. The desirability value predicted from the optimum formula is 0.507. This value is actually very small, but this is the maximum result of the desirability that can be obtained in this study. The optimization result is then made the product and analysed to determine its accuracy, and the result can be seen in Table 3.

Table 3. Analysis result of optimum formula compared to PI (Prediction Interval)

Response	Actual value	Prediction value	95% PI		Verification
			Low	High	
Yield	19.2	9.46	6.742	12.173	Not exactly
Soluble solid	12	3.06	-1.412	7.337	Not exactly
Dissolved protein	5.91	2.13	1.095	4.046	Not exactly
Moisture content	24.37	68.16	53.492	82.836	Not exactly

The product verification produces data which does not match the prediction, but the result is better than the prediction. The yield of topical cheese produced was 19.2% greater than the predicted results (9.46%) (Table 3). This yield is almost close to the results of [7] which makes cheese using papain and get cheese yields of 20.4-23.4%.

The optimized protein content was higher (5.91%) compared to the prediction (2.13%) (Table 3). This dissolved protein level is lower than cheese analogue from the cow's milk using papain by [7] which is equal to 12.14-22.56%. This difference is caused not only by the raw material but also by the hydrolysis process using the bromelin enzyme in imperfect pineapple. According to [19], the low level of protein in cheese made using pineapple extract can be due to the low hydrolysis process. This results in wasted proteolysis and protein in whey.

The soluble solid of the optimization result was higher (12°Brix) compared to the prediction (3.06°Brix) (Table 3). The high total dissolved solid indicates the quality of good topical cheese. Total dissolved solid is the component of dissolved solids consisting of total sugars, pigments, organic acids and proteins [20].

The optimum colour cheese analogue formula has a value of 3.44 which is whitish yellow. The yellow colour of the cheese analogue is thought to be due to the presence of beta-carotene from corn, but this article does not discuss beta carotene in cheese analogue. According to [21], sweet corn has beta carotene level of 400 SI.

The optimum aroma of cheese analogue the formula has a value of 3.5 which is typical of corn aroma. Aroma is affected by the components of volatile compounds present, which are dominated by the corn aroma.

The cheese analogue taste in this study was obtained from good optimum formula with a score of 3.5. The taste is dominated by the distinctive taste of corn and the panelists like the taste. This is in accordance with [21] who makes probiotic corn extract and increased corn extract solids can increase the consumer preference because of the typical corn flavour.

Ease of spreading is an important parameter in this study because the cheese analogue made is topical cheese analogue. The optimum cheese analogue formula has easy characteristics to be spread with a score of 4.28. This spread easiness characteristic is also supported by the results of testing, which is cheese that is easily attached to bread.

The favorite topical cheese produced from the overall optimum formula with a score (3.5), which is preferred. The assessment of the level of preference by panelists is a combination of the attributes (color, aroma, taste, topical power) which have the best value.

This is the initial research of the development of cheese analogue substituted with corn extract. The yield of cheese analogue produced is still low so further research is needed to increase the yield, for example by adding fillers and stabilizers.

4. Conclusion

The optimum formula for producing the cheese analogue substituted with corn extract is the addition of 40 ml of pineapple extract and 130.82 mg of papain extract. The yield of the formula was 19.2%. The analog cheese has 5.908% of dissolved protein content, 12°Brix of dissolved solids and 24.3% of moisture content. The sensory characteristic (scale 1-5) of cheese analogue is whitish yellow (3.44), typical corn aroma (3.5), good taste (3.5), easy to spread (4.28) and preferred (3, 5).

Acknowledgement

This study was supported by Jenderal Soedirman University under *Riset Unggulan Pengembangan* in 2018 grant number 2045/UN23.14/PN/2016.

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