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# The Effect of Crude Papain as Coagulant on Chemical Characteristics and Energy Value of *Susu Goreng* Based On Goat's Milk

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**ABSTRACT:** Experiment aimed was determined the influence of using crude papain as coagulant on the chemical properties and energy value of *susu goreng* based on goat milk. The completely randomized design (CRD) with 4 treatments and 4 replications was applied in this experiment. The crude papain levels tested consist of $P_1$= 0.5%, $P_2$= 1.0%, $P_3$= 1.5% and $P_4$= 2.0% of milk volume. The variables measured was moisture, protein, fat, total sugar, lactose, calcium and energy value. *Susu goreng* obtained has moisture ranged of 52.99 to 54.08%; protein 24.88 to 29.05%; fat 22.30 to 25.75%; lactose 0.69 to 1.38%; total sugar 2.72 to 4.4%; calcium 0.68 to 0.77% and energy value 1989.28 to 2507.09 kcal/100 g. Analysis of variance showed that treatment had close significant effect (P<0.01) on total sugar, calcium and lactose, significant (P<0.05) on energy value but had no significant (P>0.05) on moisture, protein and fat. It can be concluded that the use of crude papain as a coagulant with a level of 0.5 to 2% produces susu goreng with varying chemical characteristics. The use of crude papain level 0.5% is the best where the susu goreng produced has the characteristics of the higher protein content, calsium and energy value, the lowest lactose content and total sugar.

**KEYWORDS:** chemical characteristics, crude papain, energy value, goat milk, *susu goring*.

## INTRODUCTION

The average milk consumption of Indonesians, according to statistical reports, is still low at 16.27 kg/capita/year, compared to neighboring countries such as Thailand 22.2 kg, Malaysia 36.20 kg and Myanmar 26.7 kg (Azanella, 2021)[1]. This low level of consumption is partly due to dislike due to the low culture of drinking milk and cases of lactose intolerance due to not consuming milk from an early age (Hatta et al., 2014)[2]. On the other hand, facts show that several regions in Indonesia have traditional dairy products including curd in West Sumatra, dangke in South Sulawesi, susu goreng in Rote and suspesi in Timor-East Nusa Tenggara (NTT). This is an indication that people are familiar with milk as a food ingredient, thus efforts to develop traditional dairy products are expected to increase milk consumption rates because they are more easily accepted, while adding functional food references and cases of lactose intolerance can be overcome.

Susu goreng as a traditional dairy product of the Rote community, has a unique physical appearance in the form of small amorphous chunks, brownish in color with a savory and sweet taste. The nutrients contained in susu goreng are 60.22% water content, 13.98% protein, 23.65% fat, with an energy value of 3400 cal/100g (Noach et al., 2005)[3]. Originally this product was made for limited consumption by families as a snack, but in its development susu goreng has been used as a typical ole ole from the island of Rote and can be found at souvenir stands around the sea port area.

Compared to curd and dangke, susu goreng made on the island of Rote has not been widely enjoyed by the public, because the process is still limited and is very dependent on buffalo milk production, namely the mud/swamp buffalo species (Bubalus bubalis), in addition to a small population and limited milk production. Based on data from the official website of Rote-Ndao Regency, the last mud buffalo population in 2017 was 15,627 heads (Rotendaokab.go.id, 2023)[4]. According to Matondang and Talib (2015)[5] generally the average milk production of mud buffaloes ranges from 0.5-2.5 liters/head/day under suboptimal rearing conditions.

Referring to the main ingredient used, namely milk, it is possible that in addition to buffalo milk, susu goreng can also be made from cow and goat milk as an effort to diversify food products of dairy origin, as long as the raw materials are available. One option is Peranakan Ettawa (PE) goat milk, which has potential and is currently being developed in Kupang Regency. The results of a field study conducted by Noach et al. (2020)[6] reported that PE goat milk production in Kupang ranged from 618.99 - 1144 ml/head/day. The advantages of goat milk, according to Nafiu et al. (2017)[7] has a proportion of small fat grains or fat with short

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and medium chains, making it easier to digest. Faizal and Wasiati (2018)[8] added that some people believe goat milk as a cure for various diseases.

The future development strategy of susu goreng as a typical dairy product of Rote-NTT, requires various research and development efforts which certainly require supporting data. In addition to raw materials, process modifications using coagulants such as crude papain from papaya sap to speed up the process should be studied scientifically. The utilization of crude papain in the milk processing process has been carried out, among others, in cheese making (Geantaresa and Supriyanti, 2010)[9], dangke (Rahman, 2014; Sulmiyati and Said 2018)[10,11]. Based on this concept, a study was conducted to study the chemical characteristics and energy value of modified susu goreng using goat milk by adding crude papain as a coagulant.

## MATERIALS AND METHODS

The research took place at the Laboratory of Animal Product Technology and Feed Chemistry, Faculty of Animal Husbandry, Marine and Fisheries,Universitas Nusa Cendana-Kupang for 4 months from June to September 2022.

The research materials included 16 liters of fresh goat milk obtained from the Installation of Goat Breeding and Animal Food Forage, Sumlili, West Kupang District, Kupang Regency. Crude papain was obtained from dried and pulverized papaya fruit sap, solid palm sugar (*gula lempeng*) and distilled water. The composition of goat milk used is 81.90% moisture content, 3.289% protein, 2575mg/100g total sugar, 3.65% lactose, 137mg calcium, 3825 calories energy and pH 7.58 (Bioscience Laboratoriun Results-UPT Integrated Laboratory, Undana, 2022). The tools used were analytical digital scales 100 g/0.001 g, pirex brand becker glass with a capacity of 1 liter, plastic measuring cup with a capacity of 500 ml, water thermometer, waterbath, Hanna brand pH meter, 20 ml syringe, 1,900 ml cup, hock stove, pan, pot, stirrer and filter cloth.

The study used a completely randomized design (CRD) with 4 treatments repeated 4 times, so there were 16 experimental units. Each experimental unit used 1 liter of fresh goat milk. The four levels of crude papain tested were P1 = 0.5%, P2 = 1.0%, P3 = 1.5% and P4 = 2.0% of milk volume.

### Research Procedure

The preparation of papain solution refers to Mansyur (2019)[12], namely 5 g of crude papain dissolved in 100 ml of distilled water, stirred for 5 minutes and let stand for 15 minutes, after which the solution is ready to be used as a coagulant.

Curd making refers to Pulungan et al. (2020)[13], namely milk is heated indirectly by putting milk in a pot and then placing it in a pan containing water that has been heated on the stove. Stir the milk until it reaches a temperature of 70 ° C and maintain that temperature for 15 seconds. Milk is poured into a separate container, cool to a temperature of 60ºC, add crude papain solution according to the treatment, namely P1 (0.5%), P2 (1%), P3 (1.5%), P4 (2%) and then stir until homogeneous. The mixture was allowed to stand until curd formed, then separate the curd from the whey using a filter cloth. The obtained curd was weighed and then ready to be processed into susu goreng.

Fine palm sugar (*gula lempeng*) as much as 10% of the weight of curd is mixed with curd poured in a pan and then heated using low heat. During heating, the mixture is constantly stirred to prevent scorching and the mixture will gradually change color to brownish to caramel brown, in the form of small chunks with a solid consistency and slightly dry. At this point, the flame is turned off and the susu goreng is ready.

### Variabel yang Diteliti

**1. Protein content**

Determination of protein content using the micro Kjeldhal method according to AOAC (2005) [14] procedures includes three stages, namely deconstruction, distillation and titration. The deconstruction stage begins with weighing 0.2 g of sample. The sample is then put into a 100 ml volumetric flask and then added 10 ml of concentrated $H_2SO_4$ with 2 g of catalyst and then the solution is deconstructed until it becomes clear and the deconstruction is continued for 10 minutes. The clear solution was cooled, diluted with distilled water as much as 3 ml, then added 5 ml of NaOH, 45% and a few drops of PP indicator and then distilled. The distillation results were collected in a 125 ml erlenmeyer containing 10 ml of 2% boric acid ($H_3BO_3$) containing 0.1% bromcherosol green and 0.1% methyl red indicators in a ratio of 2:1. Titration is done using 0.01 N HCl until the color of the solution in the erlenmeyer turns pink, then read and record the titration volume. Calculation of protein content using the formula:

**Protein content (%) =((V1-V2) x N x 0.0014 x fp x fk)/W x 100%**

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Notes: W = Sample Weight; V1 = Volume of 0.01 N HCl for blank titration; V2 = Volume of 0.01 N HCl for sample titration; N = Normality of HCl; fp = Dilution factor; fk = Protein conversion factor 6.25.

**2. Fat content**

Determination of fat content using the Soxhlet method according to the AOAC (2005)[14] procedure, namely as much as 1-2g (W1) of sample weighed in filter paper and put into the Soxhlet tube, then the fat flask that has been weighed by its fixed weight (W2) is connected to the Soxhlet tube. The Soxhlet tube was inserted into the Soxhlet tube extractor chamber and flushed with 250 ml of n-hexane. The extraction tube was attached to the Soxhlet distillation device and then distilled for 6 hours. At the time of distillation the solvent will be collected in the extractor chamber, the solvent is removed so that it does not return to the fat flask, then the fat flask is dried in an oven at 105 ° C, after which the flask is cooled in a desiccator until its weight is constant (W3). Calculation of fat content using the formula:

**Fat content (%) = (W3-W2)/W1 x 100%**

Description: W1= Weight of sample (g) W2= Weight of fat flask without fat (g) W3= Weight of fat flask with fat (g)

**3. Total sugar content**

The total sugar content of *susu goreng* is determined by the Luff Schoorl method, i.e. a mashed sample of 5 g is put into a 250 ml goblet, dissolved using 100 ml of distilled water, add Pb-acetate for clarification. Add $Na_2CO_3$ to remove excess Pb and then add distilled water to exactly 250 ml. Put 25 ml of the solution in Erlenmeyer then add 25 ml of Luff-Schoorl solution. Make a blank treatment by adding distilled water to 25 ml of Luff-Schoorl solution. Add a few boiling stones, connect the Erlenmeyer with a reverse cooler and boil for 10 minutes, after which it is immediately cooled and then add 15 ml of 20% KI and 2.5 ml of 26.5% $H_2SO_4$ carefully. The liberated iodine is titrated with 0.1N Na-Thiosulfate solution using 1% starch indicator as much as 2-3% (Titration is terminated after a milky beige color appears). Calculation of total sugar content using the formula:

Total sugar content (%): ((Blank Titration - Sample Titration) × Dilution Factor)/(mg sample) × 100

**4. Lactose content**

Determination of lactose content of *susu goreng* according to Sudarmadji et al. (1997 [15] is done as follows: 1 g sample is put in a 100 ml volumetric flask, dissolved with 100 ml of hot water. Precise with distilled water until the limit mark. Pipette 10.0 ml of the solution into a stop erlenmeyer and add 15.0 ml of distilled water and 25.0 ml of Luff Schoorl solution then cool with reverse cooling and heat for 10 minutes after that cool and then add 15.0 ml of $H_2SO_4$ 6N and 15.0 ml of KI 20% and titrate with $Na_2S_2O_3$ 0.1 N until yellow. Add 1 ml of 1% amylum and titrate again until the TAT which is the exact blue color disappears. Calculation of lactose content using the formula:

**Lactose content (%) = (Sample x dilution factor)/(sample weight) x 100**

**5. Calcium (Ca) content**

The calcium content of *susu goreng* was determined by the titration method. A 4 mg sample was added to 100 ml of distilled water. The addition of 2N NaOH was done so that the pH was 12-13. The indicator used is murkesid 0.2% (w/b), then titrated using Na2EDTA solution that has been standardized in the previous stage. The end point of the titration is marked by a change in color, which becomes purple with an initial color of pink. Calcium content was calculated with the formula:

Calcium content (mg/100 mg) = (M x Vb x 40 x 100)/(Vc)

Description:

M= Molarity of $Na_2EDTA.2H_2O$ solution (M)

V*b*= Volume of $Na_2EDTA$ used for titration

V*c*= Volume of beverage pipetted (ml).

**6. Energy value**

The energy value of *susu goreng* was determined using a bomb calorimeter expressed in kcalories/100g.

**Data Analysis**

The data obtained were tabulated and processed using analysis of variance to determine the effect of treatment on the variables studied and continued with Duncan Multiple Range Test (DMRT), to determine differences between treatment pairs (Nuryadi et al., 2017) [16].

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## RESULT AND DISCUSSION

The chemical characteristics and energy value of goat milk-based *susu goreng* obtained in this study are presented in Table 1.

**Table 1.** Chemical characteristics and energy value of *susu goreng* made from goat milk.

| Variables | Treatment | | | | P value |
|---|---|---|---|---|---|
| | $P_1$ (0.5%) | $P_2$ (1%) | $P_3$ (1.5%) | $P_4$ (2%) | |
| Protein content (%) | 28.35±2.22 | 29.05±3.78 | 24.89±0.70 | 26.25±4.27 | 0.25 |
| Fat content (%) | 22.77±4.28 | 23.59±8.30 | 25.75±3.97 | 22.30±2.53 | 0.78 |
| Total sugar content (%) | 27.19±0.15$^b$ | 28.33±0.21$^b$ | 37.14±0.21$^b$ | 43.97±0.17$^a$ | 0.00 |
| Lactose content (%) | 0.69±0.003$^a$ | 1.38±0.052$^b$ | 1.33±0.050$^b$ | 1.32±0.02$^b$ | 0.00 |
| Calcium content (mg/100mg) | 0.77±0.02$^a$ | 0.70±0.02$^b$ | 0.68±0.01$^b$ | 0.70±0.03$^b$ | 0.00 |
| Energy value (kcal/100g) | 2287.67±105.65$^a$ | 2505.21±113.10$^a$ | 1989.28±425.80$^b$ | 2507.09±194.76$^a$ | 0.04 |

Note: different superscripts on the same line indicate differences (P<0.05); P1= crude papain level 0.5%; P2= crude papain level 1%; P3= crude papain level 1.5%; P4= crude papain level 2%.

### Protein Content

The protein content of *susu goreng* obtained in this study ranged from 24.89-29.06% with an average of 27.14%. Table 1 shows an increase in protein content at the use of 1% crude papain and then decreased at the level of 1.5 and 2%. However, the results of variance analysis showed that the treatment had no significant effect (P>0.05) on the protein content of *susu goreng* produced. This means that the use of crude papain with a level of 0.5 -2.0% produces *susu goreng* with protein levels that tend to be the same.

The protein content of *susu goreng* made from goat milk obtained from this study is much higher than susu goreng made from buffalo milk reported by Noach et al. (2005)[3] which amounted to 13.98%. It is suspected that in this study crude papain as a coagulant was added as well as the appropriate temperature at the time of coagulant addition which allows the protease activity of papain to work optimally in the process of coagulation and protein aggregation. The high protein content obtained in this study indicates that *susu goreng* is one of the food sources of protein. According to Balai POM (2016)[17] a food can be claimed as a source of protein if it contains or has a protein content of at least 20%.

Based on the value of protein contained in the *susu goreng* produced from this study, this product can be relied upon as one of the sources to fulfill the Nutritional Adequacy Rate (AKG) of Indonesians. The recommended protein adequacy at various ages and statuses include children 7-9 years as much as 40g, adolescent boys 16-18 years = 75g, adult men 30-49 years = 65g, elderly men 65-80 years = 64g, adolescent girls 16-18 years = 65g, adult women 30-49 years = 60g, elderly women 65-80 years = 58g, pregnant women in the third trimester = 90g and nursing mothers in the first 6 months 80g (Permenkes RI, 2019)[18]. Based on this AKG, by consuming 100g of *susu goreng* made from goat milk with a protein value of 27.14%, it can fulfill around 30.2 - 67.9% of the protein adequacy rate for the age group and status as mentioned above.

### Fat Content

The fat content of *susu goreng* obtained in this study ranged from 22.30-25.75% or an average of 23.6%. Table 1 shows that the fat content of *susu goreng* increased as the level of crude protein usage increased up to the level of 1.5%, but decreased again at the level of 2% usage. The results of variance analysis showed that the treatment had no significant effect (P>0.05) on the fat content of *susu goreng* produced. This means that the use of crude papain with a level of 0.5 -2.0% produces *susu goreng* with fat content that tends to be the same.

The fat content of *susu goreng* made from goat milk obtained from this study is lower than the fat content of *susu goreng* made from buffalo milk, which is 31.13 - 34.09% (Siwe et al., 2011)[19]. This difference is due to not only different milk raw materials, but also milk composition, especially fat content. Goat milk has a fat content of 4.5% (Yusa et al., 2017)[20]. while buffalo milk has a higher fat content of 7-10% (Cruz, 2010)[21].

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Based on the fat content, *susu goreng* made from goat's milk produced is one of the good fatty food sources. Wikipedia Indonesia states that 1 gram of fat contributes 9.3 kcal of energy. According to Zurriyati et al., (2011)[22] that the fat content in milk is the most important component besides protein, but excessive fat consumption can lead to obesity.

**Total Sugar Content**

The total sugar content of *susu goreng* obtained in this study ranged from 27.19 - 43.97% or an average of 34.16%. Table 1 shows an increase in total sugar content as the level of crude papain use increases where the lowest total sugar content is at the use of 0.5% crude papain and the highest at the 2% level. The results of variance showed that the treatment had a very significant effect ($P < 0.01$) on the total sugar content of *susu goreng* produced. Duncan test results showed that the total sugar content of *susu goreng* in the treatment pair P4-P3; P4-P2; P4-P1 was different, while the treatment pair P3-P2; P3-P1; P2-P1 was not different.

The increase in total sugar content in *susu goreng* is due to, in addition to reducing sugars, namely lactose which is trapped in the curd during coagulation, also due to the addition of palm sugar to the curd before processing into *susu goreng*. The greater the amount of curd obtained from milk coagulation, the more sugar is added as a result the total sugar content in *susu goreng* increases. Lehninger (1982)[23] stated that generally the reducing sugar produced is closely related to enzyme activity, where the higher the enzyme activity, the higher the reducing sugar produced.

**Lactose Content**

The average lactose content of *susu goreng* obtained in this study ranged from 0.69-1.38% or an average of 1.18%. Table 1 shows an increase in lactose content at the level of 1% crude papain usage and decreased again at the level of 1.5 and 2%. The results of variance showed that the use of papain enzyme had a very significant effect ($P<0.01$) on the lactose content of *susu goreng* produced. Duncan test results showed that the lactose content of *susu goreng* in the treatment pair P1-P2; P1-P3; P1-P4 was different, while the pair P2-P3; P2-P4; P3-P4 was not different.

The presence of lactose in dairy products is often associated with one of the health problems, lactose intolerance. Milk or dairy products that contain high lactose content are usually avoided for consumption by certain groups of people because they often cause problems, such as stomach pain and diarrhea. This is one of the reasons for the low milk consumption rate in Indonesia. People with lactose intolerance are advised to choose milk or dairy products with low lactose content. Some dairy products with low lactose content according to Aunulloh (2020)[24] such as butter, probiotic yogurt, hard cheese, kefir and heavy cream.

The *susu goreng* made from goat's milk produced in this study has a low lactose content with an average of 1.18%. This indicates that this product can be recommended for people with lactose intolerance. Demirbas et al. (2018)[25] stated that people with lactose intolerance should be encouraged to limit rather than avoid lactose in terms of how to consume milk, through good education about the comparison of dairy and non-dairy products in meeting daily nutritional needs.

**Calcium Content**

The calcium content of *susu goreng* obtained from this study ranged from 0.68-0.77mg or an average of 0.71mg/100mg or 0.71%. Table 1 shows a decrease in calcium levels up to the level of using 1.5% crude papain and back up at the 2% level. The results of variance showed that the treatment had a very significant effect ($P<0.01$) on the calcium content of susu goreng produced. The results of Duncan's test showed that the calcium content of *susu goreng* in the treatment pairs P1-P2; P1-P3; P1-P4 was different, while the P2-P3; P2-P4; P3-P4 pairs were not different. The use of crude papain with a level of 0.5% produced *susu goreng* with the highest calcium content compared to levels of 1%, 1.5% and 2%. This indicates that 0.5% crude papain level has more optimum activity in precipitating calcium during coagulation of milk casein in curd formation.

The calcium content of *susu goreng* made from goat milk obtained from this study is lower than that of susu goreng made from buffalo milk, which is 0.82% (Siwe et al., 2011)[19]. This difference is more due to the different characteristics of the milk used.

**Energy Value**

The energy value of *susu goreng* obtained in this study ranged from 1989.28 to 2507.09 kcal/100g with an average of 2322.31 kcal/100g. Table 1 shows that the energy value of *susu goreng* produced varies with a fluctuating pattern, namely increasing at the level of 1% use, then decreasing at 1.5% and increasing again at level 2%. The results of variance showed that the treatment had a significant effect ($P < 0.05$) on the energy value of *susu goreng*. This means that the use of crude papain with different levels

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produces *susu goreng* with varying energy values. Duncan test results showed the energy value of *susu goreng* in the treatment pair P3-P1; P3-P2; P3-P4 was different, while P1-P2; P1-P4; P2-P4 was not different.

Based on its energy value, *susu goreng* made from goat's milk can be relied upon as one of the sources to fulfill the Nutritional Adequacy Rate (RDA) for Indonesians. The recommended energy/calorie adequacy of Indonesians according to the AKG is for children 7-9 years old: 1650 kcal, adolescent boys 16-18 years: 2650 kcal, adult male 30-49 years old: 2550 kcal; elderly men 65-80 years: 1800 kcal, adolescent girls 16-18 years: 2100 kcal, female adults 30-49 years: 2150 kcal, female seniors 65-80 years: 1550 kcal, third trimester pregnant women: 2480 kcal and breastfeeding mothers in the first 6 months: 2450 kcal (Permenkes RI, 2019)[18]. Based on this RDA, consuming 100g of *susu goreng* made from goat's milk with an energy value of 2322.31 kcal can cover the energy adequacy for the age groups and status as mentioned above, except for adolescent boys 87.6%; adult men 91.1%; third trimester pregnant women 93.6% and 6-month breastfeeding mothers 94.8% of the intended adequacy.

## CONCLUSSION

It can be concluded that the use of crude papain as a coagulant with a level of 0.5 to 2% produces *susu goreng* with varying chemical characteristics. The use of crude papain level 0.5% is the best where the *susu goreng* produced has the characteristics of the higher protein content, calsium and energy value, the lowest lactose content and total sugar. Consuming 100g of goat's milk-based *susu goreng* can contribute 30.2 – 67.9% to the protein sufficiency rate and almost fullfil the recommended energy sufficiency rate for Indonesians.

## RECOMENDATION

To process *susu goreng* from goat milk by adding coagulant in the form of crude papain should be used at a level of 0.5% and the *susu goreng* produced needs to be tested publicly to determine the level of consumer acceptance of the product.

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Profil of *Susu goreng* made from goat's milk

**Fig. 1.** using crude papain 0,5%

**Fig. 2.** using crude papain 1,0%

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**Fig. 3.** using crude papain 1,5%

**Fig. 4.** using Crude papain 2,0%

**Fig. 5.** The original *susu goreng* made from buffalow milk