



Fortification of Goat Milk with Purple Sweet Potato (*Ipomea batatas* L.) Extract and Its Effects on Functional Cheese



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Abstract

This study was undertaken to analyze the quality of goat milk based cheese particularly its potential high antioxidant content through fortification of goat milk with purple sweet potato extract. A completely randomized design was used to determine the characterization of goat milk based cheese quality through five levels i.e. 0% (A); 2% (B); 4% (C); 6% (D) and 8% w/v (E) of purple sweet potato extract fortification in goat milk. The results showed that the increased level of fortification by purple sweet potato extract in goat milk based cheese significantly increased the pH value of the cheese ($P < 0.05$) where the highest pH was 6.20 at the level of 4% w/v. Meanwhile, the yield and total of cheese acid were not affected by the fortification. The content of cheese protein significantly decreased ($P < 0.05$) by the increasing level of fortification by purple sweet potato in goat milk. Goat milk-based cheese on the E treatment contained the lowest protein (19.42%). Functional potency of the cheese increased significantly ($P < 0.05$) when the level of fortification was increased. The highest antioxidant content in goat milk based cheese was 114.47 mg/L. GAEAC at 8% w/v level. In conclusion, by increasing fortified goat milk by purple sweet potato extract up to 8% w/v was able to potentially produce cheese containing a high antioxidant.

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1. Introduction

Cheese is one of the fermented milk products. Widodo (2003), stated that cheese products were occurred due to the coagulation of casein protein by the activity of rennet. Bacterial cultures used to produce lactic acid were mesophilic cultures such as *Streptococcus cremoris*, *Streptococcus diacetylactis* and or *Leuconostoc citrovorum* and *Streptococcus lactis*. All the bacteria mesophilic cultures were in biomass containing polysaccharides and proteins (Farnworth & Mainville, 2008). That is why this cheese could also have potency as a functional food. Besides, the other beneficial potency of functional foods i.e. goat milk based cheese had to be improved particularly its antioxidant content. So goat milk based cheese containing high antioxidant could be produced.

Antioxidants compounds inhibited reactive oxygen species, reactive nitrogen species and other free radicals that prevented damages of normal cells, fat, protein and DNA thus ultimately prevented degenerative diseases (Wrasiati, 2011). Purple sweet potato (*Ipomea batatas*) is a potential source of natural antioxidants (Husna *et al.*, 2013; Karnata & Putra, 2017; Afiati *et al.*, 2018). The purple color of the cassava is caused by the presence of natural color called anthocyanin. An anthocyanin is a group of pigment causing reddish color that is located in the liquid cell and soluble in water (Nollet, 1996). Afiati *et al.*, (2018), reported that the usage of purple sweet potato in yogurt production has provided its characteristic that is liked by consumers. Therefore, the presence of anthocyanin in purple sweet potato that fortified goat milk before fermenting with rennet has improved the functionality of goat milk based cheese containing a high antioxidant. The objective of this study was to evaluate the quality of goat milk based cheese that was fortified with purple sweet potato extract to improve its antioxidant content.

2. Materials and Methods

Research Materials and Equipment

Goat milk, purple sweet potato, and rennet were used in this study. The chemical used for the analysis was 95% alcohol, distilled water, concentrated HCl, concentrated H₂SO₄, the solution I, I-diphenyl-2-picrylhydrazyl (DPPH), PP indicator, pH 4.00 buffer, pH 7.00 buffer, pH 9.00 buffer and Whatman 42 filter paper. Other equipment used including thermometer, desiccator, oven, water bath, analytic scales, aluminum pan, plastic bucket, blender, stove, and baking pan.

Research Procedure

The ingredients of purple sweet potato extract were added to goat milk based on the five levels i.e. 0% (A); 2% (B); 4% (C); 6% (D) and 8% w/v (E) of treatment. The cheese making process was carried out according to Chairunnisa (2007). Fresh goat milk and purple sweet potato extract were pasteurized at 85°C for 15 minutes. After that, the cooling procedure was carried out to decrease the temperature to 28-30°C. Inoculation of the rennet as much as 5% (w/v) into the material that has been prepared and then fermented at 28-30°C for 24 hours. Goat milk-based cheese making procedure including screening of fermented products that was to separate between solid curds and liquid whey then adding with 5% salt and ripening the cheese. The variables observed including pH, yield, total acid (%), moisture (%), protein (%) and antioxidant content (%) of goat milk-based cheese.

A Completely Randomized Design with five levels i.e. 0% (A); 2% (B); 4% (C); 6% (D); and 8% (w/v) (E) of fortification of purple cassava extracts was used in this study. All data obtained were analyzed by analysis of

variance (ANOVA) at 5% level. If there was a significant difference then tested with Duncan's Multiple Range Test (Steel & Torrie, 1991).

3. Results and Discussions

Fortification of purple sweet potato extract in goat milk and its fermentation process produced functional cheese products that potentially contained antioxidant. The potency for containing antioxidant in the functional cheese is presented in Table 1 below.

Table 1
The Characteristic of Cheese Resulted in Fortified Goat Milk with Purple Sweet Potato Extract

Variable	Levels of purple cassava used in fortified goat milk				
	0% w/v (A)	2% w/v (B)	4% w/v (C)	6% w/v (D)	8% w/v (E)
Value of pH	6.05 ^a	6.10 ^{ab}	6.20 ^c	6.15 ^{bc}	6.05 ^a
Yield (%)	15.1	16.08	15.82	15.50	14.49
Moisture (%)	42.2 ^b	41.7 ^b	46.10 ^c	42.66 ^b	40.00 ^a
Total Acid (%)	0.05	0.04	0.06	0.04	0.05
Protein (%)	29.35 ^d	26.88 ^c	23.48 ^b	19.98 ^a	19.42 ^a
Antioxidant (mg/L.GAEAC)	45.08 ^a	103.68 ^b	108.40 ^c	112.39 ^d	114.47 ^d

Note: Means in the same row with different superscripts are differed significantly ($P < 0.05$)

Results of the variance analysis showed that increase in the percentage of purple sweet potato extract up to 6% w/v (D) in fortified goat milk increased significantly the pH of cheese ($P < 0.05$). The highest pH of cheese was 6.20 when 4% w/v (D) purple sweet potato extract was used to fortify the goat milk ($P < 0.05$) (Table 1). Amylose content in purple sweet potato extract caused a strong bond in the structure of cheese protein thus it increased its pH significantly ($P < 0.05$). The pH of cheese in the present study was higher than pH 5.3 reported by USDA (2005). However, the pattern of increase in the pH of cheese due to the increased levels of purple sweet potato extract in fortified goat milk was not followed by the pattern of increase in yield of the cheese (Table 1). These results were higher than reported by Hartono & Purwadi (2012), who produced cheese yields ranging from 11.05 to 12.24%. The cheese yield is an important indicator in assessing the effectiveness of fortification by purple sweet potato extract in its formulation from goat milk into cheese products.

Results of the present study showed that the fortification by purple sweet potato extract in goat milk significantly affected the moisture content of the cheese ($P < 0.05$) (Table 1). The increasing water content of the cheese in the present study was probably due to strong binding between the chemical structure of amylose in purple sweet potato extract and chemical structure of goat milk protein. However, the pattern of increasing water content of the cheese due to the increasing level of purple sweet potato cassava extract fortification in goat milk markedly decreased at 8% (w/v) i.e. 40% moisture of cheese compared to 46.10% when fortified with 4% (w/v) purple sweet potato extract (Table 1). When fortified goat milk with 8% (w/v) purple sweet potato extract, the cheese had the highest water content of 46.10% ($P < 0.05$) possibly weakened the chemical structure of goat milk protein thus milk-based weakened the chemical structure of cheese protein in binding the amylose of purple sweet potato extract that reduced water content of the cheese to 40%. This result was confirmed by McMahon (2007), who mentioned that water content in the cheese decreased when goat milk was fortified with 6-8 % w/v with purple sweet potato extract. Total acid of cheese in the present study was not affected significantly by the increasing level of purple sweet potato extract fortification in goat milk (Table 1). Afiati *et al.*, (2018), reported that nutrition content of purple sweet potato particularly it high carbohydrate (86.28%) and in this study probably did not affect the total acid in cheese.

The average protein content of cheese significantly decreased as the level of purple cassava extract fortification in goat milk increased ($P < 0.05$) (Table 1). The high amylose content in purple cassava extract probably has strengthened the binding of the chemical structure of protein between fortified milk goat and cheese (Afiati *et al.*, 2018). However, this strength of proteins binding was not automatically able to protect

goat milk protein from coagulation due to the strong acidity in the fermentation of goat milk into cheese process. Furthermore, Afiati *et al.*, (2018), reported that 4.65% protein content in purple sweet potato and did not increase the protein content of goat milk-based cheese. Meanwhile, the increasing concentration of purple sweet potato extract in fortified goat milk thus the increasing concentration of purple sweet potato extract in the cheese significantly increased the antioxidant content of the cheese (Table 1). The high anthocyanin content in purple sweet potato not only was acting as a fortification in goat milk but it also is acting as an antioxidant providing high quality of functional goat milk based cheese (Husna *et al.*, 2013). Antioxidants are compounds that can inhibit reactive oxygen species, nitrogen species, and other free radicals so as to prevent degenerative diseases, such as cardiovascular disease, carcinogenesis, and aging (Wrasiati, 2011). The characteristics of anthocyanin in different concentrations of purple sweet potato extract in goat milk in cheese making process are shown in Figure 1. The purple colors of goat milk based cheese increased gradually from broken white when goat milk was fortified with 0% w/v (A) purple sweet potato extract to the thick dark purple when the milk was fortified with 8% w/v (E). This thick dark purple in goat milk based cheese provided interesting prevalence to consumers. This was proven by Afiati *et al.*, (2018), who reported that the use of purple sweet potato extract in the yogurt making process had attracted consumers for their specific interesting purple colors.

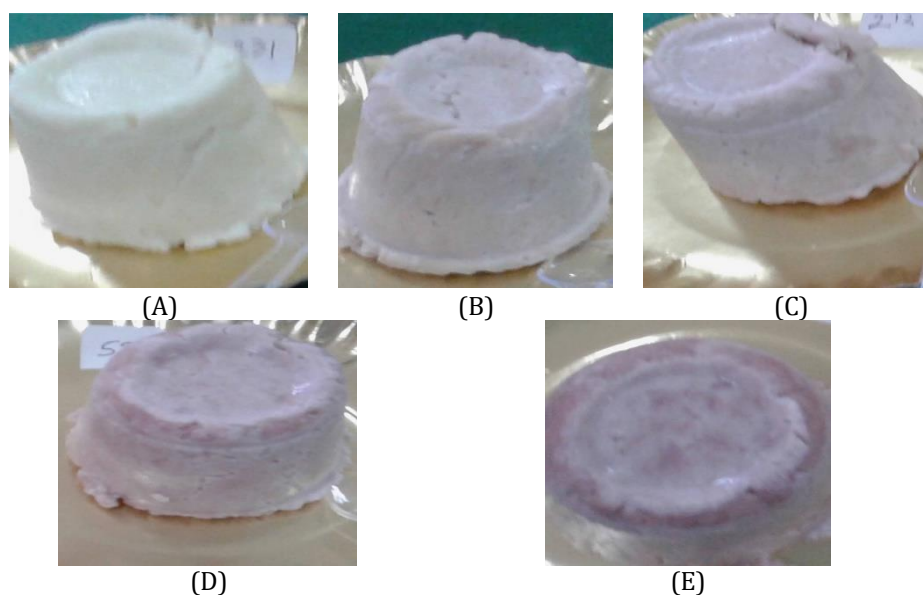


Figure 1. The appearance of Goat Milk based Cheese (A) control and (B); (C) (D) and (E) when goat milk was fortified with 0%; 2%; 4%; 6% and 8% w/v Purple Sweet Potato Extract, respectively

4. Conclusion

Increasing the fortification goat milk with purple sweet potato extract causes a high antioxidant content in goat milk cheese (the purplish color of cheese becomes concentrated). Goat milk fortified with purple sweet potato extract to a level of 8% can produce cheese with high antioxidant potential. However, this increase did not change the yield and total acidity of cheese. This fortification causes a decrease in cheese protein content. The pH value and water content of cheese increased at 4% fortification level and subsequently decreased.

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