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PHYSICOCHEMICAL AND SENSORY CHARACTERISTICS OF CALCIUM-ENRICHED SOY-RED RICE MILK

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ABSTRACT

A study on physicochemical and sensory characteristics of Ca-enriched soy-red rice milk has been done. Stabilized-Calcium Carbonate at different level of 0.1, 0.2, 0.3, 0.4 and 0.5% w/v was added into soy-red rice milk. Viscosity of Ca-enriched soy-red rice milks were in a range of 125 and 300 cP. The viscosity was higher as higher level of stabilized-Calcium Carbonate added. Ca-enriched soy-red rice milk at all stabilized-Calcium Carbonate level has an excellent colloidal stability (100%). There was no significantly difference of preference scores at different level of stabilized-Calcium Carbonate added which indicated that Calcium enrichment using Calcium Carbonate did not affect consumer preference to the soy-red rice milk. The preference scores were in a range of 3.9 and 4.7, which is categorized as likely enough. Calcium content which determined by using a flame photometer, showed that calcium content of Ca-enriched soy-red rice milk at stabilized-Calcium Carbonate 0.5% w/v level was 133 mg/100 mL, comparable to calcium content of cow's milk which in a range of 125-150 mg/100 mL.

Keywords: *physicochemical, sensory, calcium, soy milk, red rice*

1. Introduction

Currently, soy milk is one of non-dairy milks which increasing the popularity as an alternative to cow's milk. Soy milk contains no lactose and cholesterol. It may reduce the risk of heart disease and some cancers because it contains isoflavones [1, 2]. The combination of soy milk with other materials have been developed especially combination with cereals such as combination of soy and corn; and soy and red rice to produce a nutritious soy-corn milk and soy-red rice milk [1, 3, 4, 5, 6]. Legume-cereal combination can produce non-dairy product with balance amino acid composition than legume or cereal separately. Soy-corn milk, which using yellow corn, is rich in carotenoids which is good for combating vitamin A deficiency. While the soy-red rice milk is rich in anthocyanin, fibers and vitamin B contents. Ratio of soybean and red rice of 1:1 was the optimum combination to produce soy-red rice milk with the best physicochemical and sensorial characteristics [6].

Soy-red rice milk is poor of calcium i.e. about 8 mg/100 ml, extremely lower than cow's milk i.e. 125-150 mg/100 ml [7]. Calcium is an essential nutrient because it is important for health bones and teeth; an important cell marker with respect to metabolic regulation and the transport of metabolites from one compartment to another or from one cell to the bloodstream; involved in the structure of the muscular system and controls essential processes like muscle contraction (locomotor system, heart-beat), blood clotting, activity of brain cells and cell growth [8, 9]. Several concerns have been raised regarding the use of calcium-fortified foods and beverages [10].

Calcium enrichment of food and beverage products can be done by addition a calcium source compound, such as Calcium Chloride, Calcium Carbonate, Dicalcium Sacharate, Calcium Lactate, Calcium Gluconate and Calcium Lactogluconate into the product [7, 11]. Each type of calcium source compounds

has certain calcium content, solubility properties, sensorial characteristics and bioavailability. Calcium enrichment of protein containing beverages often caused problems of instability to heat and during storage which due to the interaction between calcium ions with protein. Study on the effect of calcium addition on soybean protein isolates showed that amounts of calcium (1.23–5.0 mg/g protein) induced the formation of α, α'

2. Materials and methods

Materials

Red rice, soybean and cane sugar were purchased from local market in Surabaya, Indonesia. Stabilized-Calcium Carbonate was obtained from PURAC Asia Pacific, Singapore. Chemicals for analysis included distilled water, Lanthanum Chloride (Merck) and standard of calcium (BWB Technology, UK) were obtained and purchased from local supplier.

Processing of soy-red rice milk

Processing of soy-red rice milk was carried out according to Stephanie (2007) through the following steps: soybean and red rice were washed to remove physical contaminants; then soaked the soybean and red-rice for 4 hours and 10 hours, respectively, in separate containers; soybean seed coat were removed; soybean and red rice were washed to remove soybean seed coat and contaminants; then drained until no water dripping. Red rice and soybeans were weighed with a total weight of 250 g with the ratio of soybean: rice red = 1:1. Red rice and soybean were mixed and crushed in a blender by adding water with ratio of soy-red rice : water = 1: 10, then filtered using filter cloth. The filtrate was added by cane sugar and stabilized calcium carbonate at different level i.e. 0.1; 0.2; 0.3; 0.4 and 0.5% w/v. After that the mixture was pasteurized at 85°C for 15 minutes then cooled and put in

soluble aggregates, whereas large amounts (5.0–9.73 mg/g protein) induced the selective insolubilization of the glycinin fraction. A decrease in the surface hydrophobicity of proteins with increasing calcium content was also observed [12].

This research objective was to study the physicochemical and sensory characteristics of Ca-enriched soy-red rice milk.

plastic bottles. Products obtained were analyzed for physicochemical characteristics i.e viscosity, colloidal stability and calcium content; and sensory characteristic i.e preference of color, taste and aroma. The experiment and analysis were conducted in three replicates.

Viscosity, pH and colloidal stability measurement

The viscosity was measured using viscometer (Brookfield model DV-E). 250 mL of soy-red rice milk in beaker glass was measured the viscosity using spindle 1 with minimum accuracy of 95%. The colloidal stability of soy-red rice milk was measured according to Srianta et al. (2010) with modification. 10 mL of soy-red rice milk samples were placed in graduated tubes held in racks in the refrigerator undisturbed at 4°C for 3 days. Changes in colloidal stability were indicated by separation into two layers. Level of visible line of demarcation between the settled and remaining portion of the milk solution was measured in daily during 3 days of storage.

Sensory evaluation

The sensory evaluation of the soy-red rice milk were done by 90 panelists who are familiar with the soymilk. Hedonic method was used with scale of 1 represent dislike extremely to 9 represent like extremely. The panelists were requested to evaluate the taste, aroma and

color of the soy-red rice milk. The test was conducted in sensory evaluation room.

Determination of calcium content

4 mL of sample was digested in digestion flask containing concentrated Hydrochloric Acid and Nitric Acid, then 5 mL of Hydrochloric Acid 4 N was added into the solution, adjusted until 100 mL with distilled water in measuring flask. Calcium content was measured by using a flame photometer (BWB XP, UK) after the

3. Results and discussions

Physicochemical characteristics

Table 1 show the physicochemical characteristics of soy-red rice milk at different level of stabilized-Calcium Carbonate. Calcium content was higher as higher stabilized-Calcium Carbonate level added. Range of calcium contents of Ca-enriched soy-red rice milk were between 41.78 and 133.00 mg/100 mL. Soy-red rice milk without addition of stabilized-Calcium Carbonate shows very low calcium content of 7.75 mg/100 mL, which indicated low calcium contents of soybean and red rice which was used as raw materials. Addition of 0.5% w/v level of stabilized-Calcium Carbonate produce soy-red rice milk with calcium content comparable to cow milk, i.e. 125-150 mg/100 mL [7].

Higher stabilized-Calcium Carbonate added higher viscosity of Ca-enriched soy-red rice milk. The viscosity of aqueous system depends on water binding and holding capacities of components of the system. Viscosity of Ca-enriched soy-red rice milk was higher as higher level of stabilized-Calcium Carbonate added. This indicated that free water in the system was bound and entrapped by gellan gum in the stabilized-Calcium Carbonate added.

⁵ Scilingo and Anon (2004) reported that calcium addition up to 5 mg ion/g isolate protein did not significantly affect

solution was added by 2 mL of Lanthanum Chloride 10%. Calcium solution (BWB Technology, UK) was used as calcium standard.

Statistical analysis

Data analysis was done by analysis of variance (ANOVA) with $\alpha = 5\%$ and followed by the Duncan's Multiple Range Test (DMRT) with $\alpha = 5\%$.

⁵ solubility, however from this calcium content upward, solubility of soy protein isolate decreased with calcium increase. Calcium induced the selective insolubilization of the glycinin fraction. However, this phenomenon was not occurred in the Ca-enriched soy-red rice milk. Colloidal stability of Ca-enriched soy-red rice milk was 100% (excellent) at all stabilized-Calcium Carbonate addition level. This might be due to the presence of gellan gum in the stabilized calcium carbonate, which form network by binding and entrapping free water and solid substances in the system.

Sensory characteristics

Table 2 show Sensory characteristics of soy-red rice milk at different level of stabilized-Calcium Carbonate. Calcium enrichment using stabilized-Calcium Carbonate at all concentration did not affect the preference scores of color, taste and aroma. Ca-enriched soy-red rice milk preference scores was in a range of likely enough. Soy-red rice milk is light pink which indicate anthocyanins presence in the product, as also reported by Stephanie (2007). Addition of stabilized-Calcium Carbonate did not affect the color of soy-red rice milk hence panelists provide the same score for all level of stabilized-Calcium Carbonate added. According to

Zhao et al. (2005), Calcium Carbonate has a chalky taste. However, chalky taste was not detected in Ca-enriched soy-red rice milk, even of the highest level of stabilized-Calcium Carbonate addition. This probably related to the sweetness of the product from cane sugar which was added into the product at 7% w/v. Aroma

of the product was combination of red rice and soybean. Addition of stabilized-Calcium Carbonate did not affected aroma of the soy-red rice milk. This might be due to stabilized calcium carbonate is odorless, as stated by Camara-Martos and Amaro-Lopez (2002).

Table 1. Physicochemical characteristics of soy-red rice milk at different level of stabilized-Calcium Carbonate

Stabilized-Calcium Carbonate (%)	Calcium content (mg/100 ml)	Viscosity (cP)	Colloidal stability (%)
0	7.75 ^a	100 ^a	100
0.1	41.78 ^b	125 ^b	100
0.2	61.04 ^c	175 ^c	100
0.3	79.89 ^d	200 ^d	100
0.4	101.46 ^e	250 ^e	100
0.5	133.00 ^f	300 ^f	100

Note: different character indicated a significantly difference at $\alpha = 5\%$

Table 2. Sensory characteristics of soy-red rice milk at different level of stabilized calcium carbonate

Stabilized-Calcium Carbonate (%)	Preference score		
	color	taste	aroma
0	4.1 ^a	4.2 ^a	4.2 ^a
0.1	4.2 ^a	4.2 ^a	4.0 ^a
0.2	4.2 ^a	3.9 ^a	4.0 ^a
0.3	4.2 ^a	4.0 ^a	3.9 ^a
0.4	4.0 ^a	4.7 ^a	4.0 ^a
0.5	4.2 ^a	3.9 ^a	4.1 ^a

Note: different character indicated a significantly difference at $\alpha = 5\%$

4. Conclusions

Viscosity and calcium content of Ca-enriched soy-red rice milk were affected by stabilized-Calcium Carbonate level added. Ca-enriched soy-red rice milk has an excellent colloidal stability (100%) at all stabilized-Calcium Carbonate level.

Sensory characteristics of Ca-enriched soy-red rice milk were not significantly different at difference level of stabilized-Calcium Carbonate added. Further research on calcium bioavailability of soy-red rice milk is recommended.

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