

Effects of fermented jamu on nutrient intake, milk production and udder health of dairy cows in smallholder farms

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ABSTRACT

Jamu is a word in the Javanese language, meaning traditional medicine made from plants. It is commonly used for humans but also has benefits for animals. The main objective of this study was to determine the effect of jamu containing *Calliandra calothyrsus* leaves, *Carica papaya* leaves, *Curcuma longa* Linn, fermented soybean (tempe) and molasses on nutrient intake, milk production and udder health. Jamu was given orally to the lactating dairy cow at a dose of 10 mL twice daily before milking. The study was conducted in Getasan, Central Java used 16 lactating Friesian Holstein crossbred cows with an average body weight of 455.12±40.32 kg and milk production of 10.65±1.95 l/day. This experiment used a 2x2 crossover design. The cows were grouped into control (fed basal ration) and treatment (fed basal ration and jamu oral). The parameters observed were in-vitro digestibility, nutrient intake, milk production, milk composition and somatic cell count. The results showed that jamu administration had no significant effect on in-vitro digestibility, nutrient intake, milk production and composition but significantly ($P<0.05$) reduced the somatic cell count from 8.6×10^5 to 5.1×10^5 . The conclusion of the study was that jamu did not increase nutrient intake and milk production but could improve the udder health of dairy cows.

Introduction

Milk production of the dairy cow is influenced by genetic and management factors, including health and nutrition (Nyman *et al.*, 2007). According to National Statistics (2024), milk production from dairy cows in Indonesia reached to 808,352,840 kg. The majority of milk production comes from smallholder farms, where farmers typically own fewer than six lactating cows (Guntoro *et al.*, 2016). However, the productivity of small-scale farms is generally limited by several problems, including inadequate cattle feed due to limited land area, insufficient farmer knowledge, and poor disease control and prevention, particularly for mastitis (Fadillah *et al.*, 2025; Utami *et al.*, 2025). According to Susanty *et al.* (2017), the incidence of mastitis in dairy cows in Indonesia has reached 83%. Efforts to control subclinical mastitis through post-milking teat disinfection, udder cleansing with soap, and antibiotic treatment have been evaluated and the result showed those treatments may contaminate milk and pose risks to consumers (Fadillah *et al.*, 2025). Antibiotic resistance may prolong illness, cause toxicity, or lead to death in livestock (Suherman *et al.*, 2023). Antibiotic resistance in cattle is considered one of the most severe global health threats (Nurhakim, 2021). The use of antibiotics in developing countries increased of 165% from 2000 to 2015, as reported by the World Health Organization.

In contrast, Jamu known as traditional Javanese herbal preparation is derived solely from plants and contains no synthetic chemical which has rich bioactive compounds including saponins, tannins, and flavonoid (Elfahmi and Kayser, 2014; Qomariyah *et al.*, 2020). These compounds serve as a diuretics, anti-inflammatory agent and antibacterial (Ritonga *et al.*, 2017; Ningsih *et al.*, 2020; Setyawati *et al.*, 2021; Alzanando *et al.*, 2022). The fermented jamu in this study is a made from *Calliandra calothyrsus*, *Carica papaya*, *Curcuma longa* L. (turmeric) and fermented soybean (tempe). Earlier research has demonstrated that extracts from *Carica papaya* leaves and turmeric could enhance dry matter digestibility around 7.33% and organic matter digestibility around 7.63% (Liizza *et al.*, 2018). In an-

other research, *Curcuma longa* L. has been employed to increase rumen bacterial populations and total volatile fatty acids and reducing NH₃ concentration and improving mammary alveolar cell permeability (Nurdin *et al.*, 2011). In current practices, jamu undergoes fermentation, a process shown by Hussain *et al.* (2016) that to enhance antioxidant capacity and lower anti-nutritional factors in herbs. Studying these effects could evaluate the potential of jamu in preventing mastitis in dairy cattle to examine the fermentation outcomes of various herbs and monitor their effects.

As practiced, we use Getasan which is one of center areas for dairy cows in Central Java. However, there is no scientific data on the effects of jamu administration on milk production and cow health in the area. This study aimed to evaluate the effects of jamu which was formulated from *Calliandra calothyrsus* leaves, *Carica papaya* leaves, *Curcuma longa* L., and fermented soybeans (tempe) on the antioxidant bioactivity, milk production, and its effect on udder health of dairy cows.

Materials and methods

The materials and method used in this study was approved by the Ethical Clearance Commission of the Faculty of Veterinary Medicine, Gadjah Mada University was release at April, 24th 2024 with number 29/EC-FKH/int./2024.

Animal and Management

The experiment was conducted in Getasan subdistrict, Central Java from August to November of 2024. It used sixteen lactating Friesian-Holstein crossbred cows in their third or fourth lactation with body weight of around 455 kg and milk production of 8.0 to 13.0 L/ day. The dairy cows were placed in individual stalls that have feed (Table 1) and water troughs. The cows were fed a ration consisting of 60% *Pennisetum purpureum* and 40% concentrate, which included rice bran, cassava pulp, palm kernel meal, copra meal, coffee husks, mung beans, molasses, minerals,

and vitamins.

Table 1. Composition of Basal Ration (%)

Composition of Basal Ration (%)		
Nutrient Content (%)	<i>Pennisetum purpureum</i> (60%)	Concentrate (40%)
Dry Matter	23.5	89.2
Crude Protein	7.73	12.24
Crude Fiber	29.23	13
Crude Fat	1.06	1.73
Total Digestible Nutrient	47.04	73.26
Ash	15.33	9.28
Total Flavonoid and Tannin in Jamu		
Bioactive Composition	Before Fermentation	After Fermentation
Flavonoid	93.46±1.84 ¹	179.23±5.75 ²
Tannin	674.81±0.26 ¹	971.75±0.72 ²

^{1,2}Means within a row with different superscripts significantly different ($P < 0.05$). The bio-active compounds, including both flavonoids and tannins, significantly increased in Jamu after fermentation

Samples were divided into control and treatment groups. The treatment group were given basal ration and 10 mL of jamu twice per day orally, while the control group only received basal ration. Jamu was administered after meals, in the morning at 7:00 a.m. and in the afternoon at 4:00 p.m. The experiment was conducted using a crossover design with two periods. Each period was measured for ten days, with 14 days adjustment period in between.

The jamu was made by mixing 50 grams each of *Calliandra calothyrsus* leaves, *Carica papaya* leaves, and *Curcuma longa* L. leaves, as well as fermented soybeans. All herbal plants were collected from Getasan. This mixture was combined with 200 mL of molasses and 200 mL commercial Effective Microorganisms (EM4). The mixture was diluted in 20 liters of distilled water, stirred until homogeneous, and fermented in a closed container at room temperature for seven days. During fermentation, the temperature and pH were measured, and the solution was stirred periodically. After fermentation, the jamu was filtered, and the filtrate was sampled for analysis.

Laboratory evaluations included determining antioxidant capacity using the 2,2-diphenyl-1-97-picrylhydrazyl (DPPH) assay (González-Montiel *et al.*, 2022) and quantifying total flavonoid content through the aluminum chloride method reconstructed from Shraim *et al.* (2021). The nutrient profiles of jamu, feed and milk were assessed via proximate analysis as AOAC standard (1999), meanwhile in vitro digestibility of jamu was analyzed using the grand theory from Tilley and Terry (1963) method cited by Valizadeh and Mesgaran, (2009). Feed consumption data were

measured by weighing the feed given and feed remaining after 24 hours. Milk yield was collected in two period, both morning and afternoon milking sessions that across two experimental periods. The collected milk sample were analyzed for protein, fat, lactose and total solids, while somatic cell count was determined using the theory by Breed Prescott and Breed (1910) method cited by Isobe *et al.* (2011).

In Breed method, 0.01 mL of milk is spread over a 1x1 cm² square area on a fat-free slide. The sample is allowed to dry, then fixed over a flame. The milk fat was dissolved by immersing the slide in alcohol ether and shaking it for two minutes. The specimens were stained with methylene blue for one to two minutes. Then, the specimens were placed in 96% alcohol to remove the residual dye. After drying, the specimen was observed under a microscope at 1,000x magnification to count the number of somatic cells per milliliter (SCC/mL) using up to five fields of view. The somatic cell count was calculated using the formula: SCC/mL = average somatic cells from five fields of view x microscope factor.

Statistical Analysis

The collected data were statistically analyzed using the cross-over method (ANOVA) with SPSS version 29.

Results

The nutrient composition of jamu after fermentation in this study consists of water (99.32%), protein (0.55%), carbohydrates (0.55%), and ash (0.09%). The results showed that the ingredients of jamu are highly diluted, resulted the concentrations of protein, carbohydrates, and ash in jamu are small. However, analysis revealed that the fermented jamu had an antioxidant activity of 9.55% and a total flavonoid content of 180.12 mg/L. These results indicated that fermented jamu contains bioactive compounds in the form of phenolic structures with antioxidant and anti-inflammatory properties.

The result of In vitro digestibility analysis showed no significant differences in digestibility of dry matter (DM), organic matter (OM), and crude protein (CP) between the basal diet and the jamu-supplemented diet. These data suggest that jamu does not improve nutrient digestibility in the rumen (Table 2) and consequently, there were no significant differences in feed and nutrient consumption (DM, CP, and total digestible nutrients) among the cow samples (Table 3).

There was also no significant effect of feeding fermented jamu on milk production and composition. The data also showed similar level of production and milk composition in the control and treatment groups. A significant effect of feeding jamu was found in somatic cell count. The somatic cell count was lower ($P < 0.05$) in the milk of the treatment group

Table 2. In-vitro Digestibility of Ration added with Jamu

In-vitro Digestibility (%)	Control (Basal Ration)	Treatment (Basal Ration+Jamu)	P-Value
Organic Matter	52.27±1.38	54.33±0.91	0.23
Dry Matter	57.83±1.16	59.44±1.33	0.33
Crude Protein	65.30±0.53	65.61±0.42	0.59
Crude Fat	55.98±0.12	56.74±0.37	0.11

Table 3. Effect of Jamu on Nutrient Intake (kg DM/d)

Nutrient Intake (kg DM/d)	Treatment		P-value		
	Control (Basal Ration)	Treatment (Basal Ration+Jamu)	Treatment	Period	Treatment x Period
DM	9.73±0.75	9.74±0.67	0.85	0.39	0.35
CP	0.92±0.05	0.93±0.05	0.81	0.34	0.35
CF	0.13±0.09	0.13±0.08	0.24	0.24	<0.001
TDN	5.57±0.35	5.58±0.31	0.85	0.39	0.35

DM = Dry Matter; CP = Crude Protein; CF = Crude Fat; TDN = Total Digestible Nutrient

Table 4. Effect of Jamu on Milk Production and Quality.

	Treatment		P-value		
	Control	Treatment	Treatment	Period	Treatment x Period
4% FCM Production (kg/d)	10.66±1.94	11.11±2.34	0.44	0.01	0.60
Total Solid (%)	11.97±1.66	11.99±1.31	0.97	0.33	0.29
Solid Non-fat (%)	8.19±1.59	8.17±1.33	0.98	0.52	0.94
Fat (%)	4.00±0.45	3.81±0.47	0.14	0.54	0.08
Protein (%)	2.71±0.43	2.88±0.35	0.22	0.43	0.15
Lactose (%)	4.37±0.36	4.29±0.42	0.48	0.64	0.05
pH	6.45±0.12	6.39±0.18	0.16	0.00	0.55
SCC (cells/mL)	865.625±352.003	510.625±263.070	0.00	0.27	0.71

SCC = Somatic Cell Count (cells/mL)

cows than in the control group, at 5.1 vs. 8.6×10^5 cells/mL (Table 4).

Discussion

The fermented jamu used in this study is a liquid form. The high water content of this jamu caused a low nutrient content. However, it has the advantage of being easier to administer orally or mix with drinking water. The important result of this study is that fermented jamu contains bio-active compounds as flavonoid and tannin with antioxidant activity. The flavonoids in this jamu are considered low when compared to that propolis, which was reported by Hudz *et al.* (2020) to range between 4784.31 mg/L and 6796.51 mg/L. Therefore, this jamu has the potential to improve the health of dairy cows. Fermentation is an important processing in this jamu. The *Lactobacillus*, *Saccharomyces*, *Rhodopseudomonas*, and *Streptomyces* species, as well as the yeast, found in fermented soybeans may enhance the degradation of active compounds in herbal ingredients and break down flavonoids and glucose for easier absorption. Similarly, Guo *et al.* (2020) declared that *Lactobacillus plantarum* could enhanced bacterial proliferation, also the fermented done by *Lactobacillus plantarum* facilitated chemical transformation in herbal extract from Chinese mixed herbs. Nonetheless, *Lactobacillus plantarum* could produce the enzyme known as β -glucosidase to hydrolyzes flavonoid compound, which breaks down flavonoid glucoside bonds into aglycones. Aglycones are readily to absorb by the body and exhibit higher biological activity, these noted by Sugiharto *et al.* (2018) that *Bacillus* species are lactose bacteria could enhance antioxidant content as prebiotics.

This research, jamu comprised *Calliandra calothyrsus* leaves, *Carica papaya* leaves and *Curcuma longa* L., combined with fermented soybeans with the fungus *Rhizopus oryzae*. *Rhizopus oryzae* is a fungus that produces enzymes to convert polysaccharides into simple sugar (Karmakar and Ray, 2010). Consequently, this suggest that fermentation may elevate the proportion availability of polysaccharide in dairy cattle feed.

According to the in-vitro digestibility results, addition of jamu to the basal feed of dairy cows had no effect on nutrient digestibility. The data indicated that jamu was not able to increase rumen digestibility. The total tannin content in the jamu may be the reason why in-vitro digestibility did not increase significantly. The total tannin content jamu after fermentation was 971.75 mg/L, which is higher than before fermentation around 674.81 mg/L. Tannins are anti-nutritional factors, which reduce feed intake and nutrient digestibility by binding to proteins in the rumen (Yusiati *et al.*, 2015). This binding can lead to the inhibition of rumen microbes (Cipriano-Salazar *et al.*, 2018), resulting in alterations to the rumen microbial population (Mushawwir *et al.*, 2010). Changes in the population and structure of rumen microbes influence their ability to degrade feed, as reflected by metabolites such as NH_3 and total volatile fatty acid (VFA) production (Tanuwiria and Rahmat, 2019). The presence of tannins in this study also produced opposite results compared to those reported by Kim *et al.* (2015). With a flavonoid content of 150 mg/g from pomegranate, dry matter digestibility increased from 41.59% to 46.17%, and also increased total VFA.

There was no different of feed and nutrient intake of dairy cow in Treatment and Control group due to the very low dosage of jamu, which is only 0.04% of body weight. Jamu contains tannins, which are predicted to act as anti-nutrients and therefore did not increase nutrient intake. Gerlach *et al.* (2018) found that the chemical structure of tannins affects binding capacity, give an impact on the nutritional value of the diet, rumen digestion, and feed intake.

Milk production and composition of the dairy cows in this study were not affected by jamu. This is related to no difference on nutrient consumption by the cows. The non-significant effect of jamu is possibly due to the very low dosage given to the cows. Setyawan (2023) reported that a dosage of 200 mL of jamu increased the milk production and fat content of dairy cows after they were cured of foot-and-mouth disease. This explains why the level of jamu in this study did not increase milk production or composition. The results of this study are similar to report by Herremans *et al.* (2020), who showed that flavonoids and tannins have little effect on milk composition.

The important finding of this study is that jamu depressed the number of somatic cells in milk from 8.6 to 5.1×10^5 cells/mL, so that the somatic cell count (SCC) close to normal. According to Youl and Nicholls (1987), the normal level of SCC in cow's milk is below 5×10^5 cells/mL. Moreover, high somatic cell count levels are a parameter of an inflammatory response in the udder (Marco *et al.*, 1994). Somatic cell count arises from leukocytes that relocate to the udder after bacteria infect the mammary glands. According to the results, the mammary gland after treatment has an effective effect for protecting the udder from mastitis. In the same research, it was found that applying treatment with herbal pate and powder based on turmeric diminished somatic cell count level from 2.75 to 1.93×10^5 cells/mL and from 2.75 to 1.95×10^5 cells/mL, respectively (Thangadurai *et al.*, 2017; Rathaur *et al.*, 2020). Other studies showed that treatment with turmeric supplementation reduced the somatic cell count from 1,000,000 to less than 400,000 cells/mL (Wójcik *et al.*, 2017).

Reduction in somatic cell count (SCC) in this treatment is suspected to be due to the antioxidant activities of jamu. Antioxidants protect immune cells from oxidative stress, which leads to a decline in somatic cell count level. In addition, the functions of flavonoid include antioxidant and anti-inflammatory effects by restraining cytoplasmic membrane function, bacterial cell wall formation, and nucleic acid synthesis (Sordillo, 2018; Cushnie and Lamb, 2005). Furthermore, the antimicrobial activity of flavonoids relying on the number and position of hydroxyl groups, along with the presence of aliphatic and glycosyl groups in their molecular structure. Based on results from Alcaraz *et al.* (2000), flavonoids are effective against methicillin-resistant *Staphylococcus aureus* (MRSA), which typically have a hydroxyl group at position 5 on their flavone or flavonoid rings. Based on the research from Olagaray *et al.* (2019) found that supplementation with *Scutellaria baicalensis* plants containing flavonoids decreased the number of somatic cells. In addition to flavonoids, *Curcuma longa* Linn. is one of the active constituents of anti-inflammatory herbs. Curcumin is thought to have anti-inflammatory effects by inhibiting the production of pro-inflammatory cytokines and suppressing their activation, thereby

reducing inflammation in mastitis (Fu et al., 2014).

Besides SCC, milk pH is also used to assess udder health. Based on Table 4. According to SNI (2011) normal milk pH is around 6.30-6.80. The pH value of the milk showed significant ($P < 0.05$) in the periods. Milk pH is influenced by milk hygiene. Kul et al. (2018) also reported that pH is positively associated with SCC.

Conclusion

Fermented jamu contain antioxidants, tannins and flavonoids. Supplementation with jamu could not increase rumen digestibility, no significant effect on feed and nutrient consumption, milk production and composition. Oral administration of jamu reduced the somatic cell count and could improve udder health status.

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Conflict of interest

The authors have no conflict of interest to declare.

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