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Nutritional composition of *gedi* (*Abelmoschus manihot*) leaves powder in comparison to common natural galactagogue plants in Indonesia

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Abstract. *Winata GM, Hardinsyah H, Marliyati SA, Rimbawan R, Andrianto D. 2024. Nutritional composition of* gedi *(*Abelmoschus manihot*) leaves powder in comparison to common natural galactagogue plants in Indonesia. Biodiversitas 25: 2583-2589.* Galactagogue is a substance believed to help initiate, maintain, and increase breast milk production. Low or no breast milk production and perceived insufficient milk are the most common reasons that cause a mother to stop breastfeeding earlier. To help this problem, natural galactagogue consumption is highly recommended. *Gedi* (*Abelmoschus manihot* (L.) Medik) plant is locally used in Indonesia as food ingredient and medicinal plant. The leaves have been believed for generations to increase breast milk production. This study aimed to evaluate the macro- and micronutrient content of *gedi* leaves powder, compared to *torbangun* (*Coleus amboinicus*) and *katuk* (*Sauropus androgynous*) leaves powder as common natural galactagogue plants in Indonesia. Clean fresh leaves were oven-dried and ground. Carbohydrates, crude fiber, protein, fat, ash, energy, water, vitamins A, B1, B2, B6, B9, C, E, and K, mineral calcium, iron, magnesium, sodium, zinc, phosphorus, and potassium were analyzed using standard methods. The analysis result showed that *gedi* leaves powder contained highest carbohydrate (51%), crude fiber (10.3%), vitamin K (1,110 µg/100 g), mineral magnesium (700 mg/100 g), sodium (89.6 mg/100 g), and calcium (2,671 mg/100 g) content, which were significantly different compared to *torbangun* and *katuk* leaves powder ($P<0.05$). Total energy (344 kcal/100 g), protein (25%), ash (13.6%), zinc (4.8 mg/100 g), potassium (2,314 mg/100 g), and iron (8.9 mg/100 g) content of *gedi* leaves powder were between *torbangun* and *katuk* leaves powder. This study showed that *gedi* leaves powder had a high carbohydrate, crude fiber, vitamin K, and mineral, especially calcium and magnesium, and sufficient protein and energy content, compared to *torbangun* and *katuk* leaves powder as common natural galactagogue plants in Indonesia. Further research in the extraction, bioactive compound, and in vivo study has to be carried out to scientifically prove the galactagogue effects of *gedi* leaf powder.

Keywords: *Abelmoschus manihot*, breast milk, *Gedi* leaves, milk production, natural galactagogue

INTRODUCTION

Plant utilization as an herb is based on the nutrient and non-nutrient content, which can have a pharmacological effect on human health. Indonesia rich in plants that can be used as alternative medicines to help improving human health based on empirical experiences, local traditions, and recipes for generations. Indonesian Minister of Health Regulation no. 6/2016 about native Indonesian herbal medicines formulary (Kemenkes 2016) stated that traditional medicines are ingredients or concoctions of ingredients from plants, animals, minerals, extracts (galenic) or mixture of these ingredients that have been used for medical treatment for generations, and can be applied in accordance to the norms in the society.

One of the native uses of Indonesian herbal medicine is as a galactagogue (Kemenkes 2016). Galactagogue is a substance believed to help initiate, maintain, and increase breast milk production (Brodribb 2018). Breast milk is the gold standard of nutrition for a baby during the first six months of life to guarantee the health and survival of the baby. Low or no breast milk production and perception of the mother that the breast milk production is not sufficient for the baby, so-called perceived insufficient milk (PIM), are the most common reasons that cause a mother stops breastfeeding earlier (Robert et al. 2014; Nandini et al. 2017; Huang et al. 2022). To help this problem, galactagogue consumption is highly recommended (Brodribb 2018). Galactagogue can be synthetic or natural. Synthetic galactagogues such as chlorpromazine, sulpiride, metoclopramide, and domperidone, are commonly used but they may cause undesirable side effects (Grzeskowiak et al. 2019). Therefore, the use of natural galactagogue from plant is highly recommended for the safety of mother and baby.

According to Indonesian Minister of Health Regulation no. 6/2016 about native Indonesian herbal medicines formulary, there are three herbal plants listed as natural galactagogues, which are *torbangun* (*Coleus amboinicus*

Lour.), *katuk* (*Sauropus androgynous* (L). Merr), and fenugreek (*Trigonella foenum-graecum* Linn.) (Kemenkes 2016). The parts used are fenugreek seeds, *torbangun* leaves, and *katuk* leaves. These parts have an estrogen effect to help increasing breast milk production (Handayani et al. 2020; Bumrungpert et al. 2018; Damanik et al. 2017). Widayanti (2015) mentioned several other breast milk-stimulating plants including red spinach leaves, cassava leaves, moringa leaves, papaya leaves, bitter melon, and green beans.

Apart from the plants above, *gedi* (*Abelmoschus manihot* (L.) Medik) plant is one of common plants locally used in Indonesia as food ingredient and medicinal plant. *Gedi* leaves are popularly consumed as a green vegetable, similar with cassava, papaya, spinach, kale, and others by Indonesian people, especially in Eastern Indonesia such as Manado in North Sulawesi, Halmahera in North Maluku, and Papua (Mapanawang et al. 2016). In North Sulawesi, *gedi* leaves are processed into vegetables by sauteing them, adding coconut milk, or simply boiling them with other spices, and also as a mixture for Manado porridge (*tinutuan*) that gives a different taste and thick texture to Manado porridge. The thick texture is caused by mucilage from the polysaccharide and protein content in *gedi* leaves (Mandey et al. 2015). Boiled and mashed *gedi* leaves are also suitable to be consumed with tubers as the breast milk complementary food for a baby (Lyons et al. 2015). Apart from being used as a food ingredient, *gedi* is also known as a medicinal plant for treating sore throat, stomachache, diarrhea, and preventing osteoporosis. The leaves have been believed for generations to increase breast milk production (Lyons et al. 2015; Prabawardani et al. 2016). The aim of this study was to evaluate the macro- and micronutrient content of *gedi* leaves powder, compared to *torbangun* and *katuk* leaves powder as common natural galactagogue plants in Indonesia.

MATERIALS AND METHODS

Abelmoschus manihot leaves powder preparation

Gedi leaves (*Abelmoschus manihot*) were collected from *Unit Konservasi Kebun Biofarmaka* (UKKB), *Pusat Studi Biofarmaka Tropika* (Trop BRC), *Lembaga Penelitian dan Pengabdian kepada Masyarakat* (LPPM), IPB University, Indonesia. More than 100 *gedi* plants were cultivated at UKKB and the leaves were harvested after 3 months of cultivation (Figure 1). *Torbangun* leaves were obtained from the "*Senen*" traditional market in Jakarta, Indonesia. *Katuk* leaves were obtained from "*Kramat Jati*" traditional market in Jakarta, Indonesia. Fresh leaves were washed with running water to remove soil and other impurities attached to the leaves (Pranowo et al. 2015). Clean fresh leaves were oven-dried at 50°C for 15 to 17 hours and ground for further use.

Nutrient content analysis

Macro- and micronutrient content of *gedi*, *torbangun*, and *katuk* leaves powder were analyzed at PT. SIG using the following methods.

Water content

Water content was determined gravimetrically according to SNI 01-2891-1992 (Badan Standarisasi Indonesia 1992) based on the principle that weight loss during heating at 105°C was assumed as the water content contained in the sample. A total of 1 to 2 g of sample was weighed and oven-dried at 105°C for 3 hours. After that, the sample was cooled using a desiccator and then weighed until a constant weight obtained.

$$\text{Water content} = \frac{(w+w1)-w2}{w1} \; x \; 100\%$$

Where:

w : empty container weight (g)

$w1$: sample weight before heating (g)

$w2$: container and sample constant weight after heating (g)

Total ash content

Total ash content was determined gravimetrically according to SNI 01-2891-1992 (Badan Standarisasi Indonesia 1992) based on the principle that in the ashing process, organic substances were broken down into water and CO_2 but inorganic substances were not. A total of 2 to 3 g of sample was weighed into a porcelain cup. The ashing process was carried out using a furnace at 550°C for 4 hours until completely ashing and the smoke disappeared. After that, the sample was cooled using a desiccator and then weighed until a constant weight obtained.

Figure 1. *Gedi* plant cultivation at UKKB IPB University, Indonesia

$$\text{Ash content} = \frac{w1-w2}{w} \; x \; 100\%$$

Where:
w : sample weight before ashing process (g)
$w1$: porcelain cup and sample weight after ashing process (g)
$w2$: empty porcelain cup weight (g)

Acid soluble ash content was determined gravimetrically based on the total ash and acid insoluble ash content analysis. The acid insoluble ash content was determined according to SNI 01-2891-1992 (Badan Standarisasi Indonesia 1992) based on the principle of the acid insoluble part of the ash. The ash resulting from the total ash content analysis was dissolved using 25 mL of 10% hydrochloric acid and boiled for 5 minutes. The solution was filtered using ashless filter paper and washed using chloride-free water. The filter paper was oven-dried, placed in a porcelain cup, and ashed. The cup was cooled using a desiccator and then weighed until a constant weight obtained.

$$\text{Acid insoluble ash content} = \frac{w1-w2}{w} \; x \; 100\%$$

Where:
w : sample weight before ashing process (g)
$w1$: porcelain cup and sample weight after ashing process (g)
$w2$: empty porcelain cup weight (g)

Acid soluble ash content = total ash content - acid insoluble ash content

Protein content

Protein content was determined titrimetrically (SIG 2021f) based on the principle that nitrogen compounds were converted into ammonium sulfate by concentrated sulfuric acid, then the ammonium sulfate formed was decomposed with sodium hydroxide, and the released ammonia was bound with boric acid and then titered with a standard acid solution. A total of 1±0.1 g of sample was weighed, put into a 300 mL Kjeldahl tube, added with 1 g of a mixture of selenium and 12 mL of concentrated sulfuric acid. The KjelDigester apparatus was heated to 420°C and the Kjeldahl tube containing the sample was stored in the KjelDigester apparatus. The scrubber unit was turned on and digestion was carried out at 420°C for 1 hour. After that, the KjelDigester tool was turned off, the tube rack was removed, and cooled to room temperature. The Kjeldahl tube containing the digestion sample was installed in the distillation unit, then approximately added with 50 mL of distilled water and 50 mL of 40% sodium hydroxide. A 250 mL Erlenmeyer flask containing 25 mL of 4% boric acid was installed as a reservoir in the distillation unit. The distillation process was carried out until the distillate volume reached at least three times of initial container volume or set the distillation time for 4 minutes. During distillation the color of the container changed from red to green. The distillate was titrated using 0.2 N hydrochloric acid solution until end point in which the color changed from green to red. For blank, the procedure was carried out every digestion cycle.

$$\text{Protein content} = \frac{(V1-V2) \; x \; N \; x \; 1{,}4007 \; x \; fk}{w} \; x \; 100\%$$

Where:
w : sample weight (g)
$V1$: 0.2 N HCl volume for sample titration (mL)
$V2$: 0.2 N HCl volume for blank titration (mL)
N : 0.2 N HCl normality
fk : conversion factor for food protein (6.25)

Fat content

Fat content was determined gravimetrically (SIG 2021g) using hydrolysis method (Weibull) based on the principle of free fat extraction with nonpolar solvents after the sample hydrolyzed in an acidic environment. A total of 1±0.1 g of solid sample was weighed and placed in a beaker. After that, 25% hydrochloric acid solution, distilled water, and several boiling stones were added. The beaker was covered with a cover glass and boiled for 15 minutes on a hot plate, then the residue was filtered using ash filter paper and washed with hot distilled water. The residue was oven-dried at 105°C for 1 hour, then put into filter paper sleeves (hulls) that have been plugged with cotton. The hulls were inserted into a Sokhlet apparatus, which was connected to a 300 mL boiling flask containing boiling stones and dried and weighed. After that, hexane was added until half of the boiling flask volume and all parts of the hulls in the Sokhlet were submerged. The Sokhlet apparatus was combined with condenser and water bath, then extraction was carried out for 3 hours. After that, the hexane was distilled and the fat residue was oven-dried at 105°C. The boiling flask containing fat residue was cooled using a desiccator to room temperature and then weighed until a constant weight obtained.

$$\text{Fat content} = \frac{w-w1}{w2} \; x \; 100\%$$

Where:
w : boiling flask and sample constant weight after heating (g)
$w1$: empty boiling flask weight (g)
$w2$: sample weight (g)

Carbohydrate content

Carbohydrate content was determined by difference calculation (SIG 2021h) as follows:

Total carbohydrate = 100% - (% protein + % fat + % water + % ash + % alcohol)

Energy level

Energy level was determined based on calculations of fat, protein, and carbohydrate content (SIG 2021h).

Total energy (kcal/100 g) = (% fat x 9 kcal/g) + (% protein x 4 kcal/g) + (% carbohydrate x 4 kcal/g)

Energy from fat (kcal/100 g) = % fat x 9 kcal/g

Crude fiber content

Crude fiber content was determined gravimetrically (SIG 2021a). A total of 1 to 2 g of sample was weighed and extracted to get the residue. A total of 100 mL of 1.25% sulfuric acid was added to the sample and refluxed using an upright cooler for 30 minutes until boiled, and then cooled. The solution was filtered with ashless filter paper using a Buchner funnel and manifold vacuum and rinsed with hot water. The residue was rinsed with 100 mL of 1.25% sodium hydroxide and collected in a 250 mL Erlenmeyer flask. After that, reflux was carried out using an upright cooler for 30 minutes until boiled, and then cooled. The solution was filtered with filter paper and rinsed with water, 25 mL of 1.25% sulfuric acid, 2x25 mL of hot water, and 25 mL of acetone. The filter paper was oven-dried at 105°C for 2 hours and cooled in a desiccator. The filter paper containing the residue was weighed to calculate the crude fiber content. If the crude fiber content is greater than 1%, the filter paper and residue must be ashed and weighed until a constant weight is obtained.

(i) If the crude fiber ≤1%:

$$\text{Crude fiber content} = \frac{w2}{w} \; x \; 100\%$$

(ii) If the crude fiber >1%:

$$\text{Crude fiber content} = \frac{w2-w1}{w} \; x \; 100\%$$

Where:

w : sample weight (g)
$w1$: residue ash weight (g)
$w2$: solid (crude fiber residue) weight on filter paper (g)

Vitamin content

Vitamin A (retinol) and vitamin E were analyzed using HPLC (SIG 2021b). A series of vitamin standard were prepared. A total of 10 g of solid sample was put into a beaker, added with a solution of 95% ethanol, 50% KOH, and pyrogalic acid, stirred until homogeneous. The solution was heated at 80°C for 45 minutes using a water bath. After that, added with glacial acetic acid, diluted with a 95% THF:ethanol solution (1:1) until tera mark, then homogenized. The solution was cooled to room temperature and put into a 100 mL measuring flask. The solution was filtered using a 0.45 µm syringe filter into a 2 mL amber vial and then injected into the HPLC system.

Vitamin B1, B2, and B6 were analyzed using UPLC (SIG 2021d). A series of vitamin standard were prepared. A total of 3 g of sample was put into a 25 mL amber volumetric flask, added with 0.05 M sodium dihydrogen phosphate pH 6.3 until tera mark, then homogenized. The solution was transferred into a 2 mL tube, centrifuged at 14,000 rpm for 3 minutes, filtered using a 0.2 µm syringe filter into a 2 mL amber vial, and then injected into the UPLC system.

Vitamin B9 was analyzed using UPLC (SIG 2021e). A series of vitamin standard were prepared. A total of 2±1 g of sample was weighed and put into a 40 mL amber test tube, then phosphate buffer solution was added and vortexed. The solution was homogenized with a mechanical shaker for 1 hour and transferred into a 50 mL volumetric flask, added with phosphate buffer solution, and then homogenized. The solution was centrifuged at 14,000 rpm for 3 minutes, filtered using a 0.2 µm syringe filter into a 2 mL amber vial, and then injected into the UPLC system.

Vitamin C was analyzed using HPLC (SIG 2021c). A series of vitamin standard were prepared. A total of 1 g of solid/semi solid sample was put into a 10 mL volumetric flask, added with metaphosphoric acid solution, sonicated for 15 minutes, added with metaphosphoric acid solution, and then homogenized. The solution was transferred into a 2 mL tube, centrifuged, filtered using a 0.45 µm syringe filter into a 2 mL vial, and then injected into the HPLC system.

Vitamin K was analyzed using LC-MS (SIG 2022). A series of vitamin standard were prepared. A total of 1 g of sample was put into a 60 mL amber test tube, added with distilled water, and vortexed. An enzymatic process was carried out using lipase and extraction process was carried out using hexane. The extract solution was evaporated until dry using a nitrogen evaporator. The dry extract was reconstituted using a mobile phase solution and then vortexed. After that, the internal standard 13C6-vitamin K1 was added and then vortexed. The solution was filtered using a 0.2 µm syringe filter into a 2 mL amber vial, and then injected into the LC-MS system.

Mineral calcium (Ca), iron (Fe), magnesium (Mg), sodium (Na), zinc (Zn), phosphorus (P), and potassium (K) were analyzed using ICP-OES (SIG, 2020). A total of 0.5 to 1 g of sample was put into the vessel and added with 10 mL of concentrated nitric acid. The vessel was closed and put into microwave digestion. The digestion result was transferred into a 50 mL volumetric flask, added with 0.5 mL of internal standard yttrium 100 mg/L, diluted using distilled water until tera mark, and then homogenized. The solution was filtered using filter paper and the sample was measured in the ICP-OES system.

RESULTS AND DISCUSSION

This study showed that *gedi* leaves powder had a high carbohydrate, crude fiber, vitamin K, mineral sodium, magnesium, and calcium concent, compared to *torbangun* and *katuk* leaves powder as common natural galactagogue plants in Indonesia. This result was in line with a previous study which found that fresh *gedi* leaves contained high level of micronutrients (calcium, iron, potassium, magnesium, manganese, sodium, zinc, copper, and folate), so that it is popularly consumed as a green leafy vegetable in Papua New Guinea (Rubiang-Yalambing et al. 2016).

Table 1 presented the analysis result of macro- and micronutrient, energy, water, and ash content of *gedi* leaves powder compared to *torbangun* and *katuk* leaves powder. *Gedi* leaves powder had the highest carbohydrate (51.11%), crude fiber (10.25%), vitamin K (1,110.31 µg/100 g), mineral magnesium (699.98 mg/100 g), calcium (2,671.10 mg/100 g), and sodium (89.59 mg/100 g) content compared to *torbangun* and *katuk* leaves powder. The statistic analysis showed that carbohydrate, crude fiber, vitamin K, magnesium, calcium, and sodium of *gedi* leaves powder were significantly different compared to *torbangun* and *katuk* leaves powder ($P<0.05$).

Table 1. Analysis result of macro- and micronutrient of *gedi* leaves powder compared with *torbangun* and *katuk* leaves powder

Parameter	Unit	Leaves powder		
		Gedi	***Torbangun***	***Katuk***
Water	%	6.04	7.51	5.84
Energy				
Total	kcal/100 g	344.02[a]	344.2[a]	382.50[b]
From fat	kcal/100 g	36.90[a]	58.05[b]	79.02[b]
Carbohydrate (*by difference*)	%	51.11[a]	46.98[b]	44.63[b]
Crude fiber	%	10.25[a]	8.46[b]	7.15[b]
Protein	%	25.17[a]	24.56[b]	31.24[b]
Fat	%	4.10[a]	6.45[b]	8.78[b]
Ash				
Total	%	13.58[a]	14.50[b]	9.51[b]
Acid insoluble	%	0.20[a]	0.29[b]	0.08[b]
Acid soluble	%	13.38[a]	14.21[b]	9.43[b]
Vitamin				
A (retinol)	µg/100 g	72.04[a]	154.17[b]	817.37[b]
B1 (thiamine)	µg/100 g	nd	nd	nd
B2 (riboflavin)	µg/100 g	nd	nd	nd
B6 (pyridoxine)	µg/100 g	nd	nd	nd
B9 (folic acid)	µg/100 g	nd	nd	nd
C (ascorbic acid)	mg/100 g	nd[a]	nd[a]	133.54[b]
E (α-tocopherol)	mg/100 g	12.87[a]	16.92[b]	45.00[b]
K (phylloquinone)	µg/100 g	1,110.31[a]	479.50[b]	629.22[b]
Mineral				
Potassium (K)	mg/100 g	2,314.21[a]	2,790.18[b]	2,140.88[a]
Magnesium (Mg)	mg/100 g	699.98[a]	488.49[b]	552.55[b]
Sodium (Na)	mg/100 g	89.59[a]	48.01[b]	23.21[b]
Phosphorus (P)	mg/100 g	2,263.45[a]	3,051.24[b]	3,420.12[b]
Zinc (Zn)	mg/100 g	4.78[a]	3.85[b]	6.76[b]
Iron (Fe)	mg/100 g	8.89[a]	93.27[b]	6.86[a]
Calcium (Ca)	mg/100 g	2,671.10[a]	1,791.64[b]	886.24[b]

Note: nd: not detected (vitamin B1 less than 0.03 µg/100 g, vitamin B2 less than 0.01 µg/100 g, vitamin B6 less than 0.06 µg/100 g, vitamin B9 less than 75.24 µg/100 g, vitamin C less than 0.35 mg/100 g. Different letters at the same row indicated significantly different to *gedi* leaves powder ($P<0.05$)

Prolactin is important for the initiation of breast milk synthesis. Lack of prolactin may inhibit lactogenesis process and cause failure of breastfeeding in the early stage. There is a correlation between macronutrient (carbohydrate, protein, fat) adequacy and prolactin level in breastfeeding mothers. Breastfeeding mothers with adequate macronutrient intake had a high average serum prolactin level compared to those with inadequate intake ($P<0.05$). Thus, breastfeeding mothers should maintain their macronutrient adequacy intake to improve their prolactin level and breast milk supply (Okinarum et al. 2021). Kemenkes (2019) also stated that breastfeeding mothers require 45 g/day or 12.5% additional carbohydrate higher than normal woman aged 19-49 years to support breast milk production in the first six months of postpartum period. Besides that, a low carbohydrate diet is not recommended during breastfeeding because it can affect the micronutrient adequacy and glucose requirement for lactose synthesis. Lactose is the main carbohydrate in breast milk, synthesized from glucose (New Zealand Ministry of Health 2006), and important for brain development of a baby (Segura et al. 2016).

Thyrotropin-releasing hormone (TRH), thyroid-stimulating hormone (TSH), triiodothyronine (T3), and tetraiodothyronine (T4), which are known as hormones from hypothalamic-pituitary-thyroid axis (HPT), influence the activity of vitamin-K dependent factors of blood coagulation (Negrev et al. 2008). Wang et al. (2023) also mentioned an increased risk of hypocoagulation (bleeding) and hyperfibrinolysis in hypothyroidism, and an increased risk of hypercoagulation (thrombosis) and hypofibrinolysis in hyperthyroidism. In the other hand, prolactin release from anterior pituitary gland is stimulated by TRH, coupled with calcium (Gershengorn et al. 1981). Thus, although no direct relationship has been further discussed between vitamin K and prolactin but there might be a potential relationship between them to help increasing breast milk production. Meanwhile, low vitamin K was found in a newborn baby, which is caused by i. difficulty to pass vitamin K through placenta so that only a small amount of vitamin K is transferred from the placenta to fetus during pregnancy, ii. low vitamin K content in breast milk (Segura et al. 2016; Araki and Shirahata 2020; Hand et al. 2022), and iii. a baby has a low absorption ability of vitamin K because of immature intestinal flora (Araki and Shirahata

2020). Vitamin K deficiency may cause hemorrhagic and intracranial bleeding in a newborn baby (Gluckman et al. 2015; Segura et al. 2016). Thus, adequate vitamin K should be maintained throughout pregnancy to avoid added risk to a newborn baby at birth and in the first few weeks of life. Vitamin K1, the most abundant dietary form of vitamin K, is mainly sourced from green leafy vegetables. Vitamin K1 has a short half-life and poorly retained in the body. Dietary fat may enhance vitamin K1 absorption thus green leafy vegetables should be eaten with dietary fat (such as vegetable oil and butter) during pregnancy to maintain or increase vitamin K store (Gluckman et al. 2015). Maternal diet enriched with vitamin K can also increase the vitamin K content in breast milk (Segura et al. 2016; Dominique Turck et al. 2017).

Magnesium plays an important role for muscle relaxation and constipation prevention in breastfeeding mothers (Jouanne et al. 2021). It regulates blood pressure and causes muscle relaxation within the vessel walls by affecting calcium channels in arterial muscle, and thus vasodilation (Khayat et al. 2017). Magnesium also has antidepressant-like effect by influencing nervous system through its actions on neurotransmitters release and metabolism (Botturi et al. 2020; Serefko et al. 2016). Magnesium modulation is important for oxytocin release by activating oxytocin receptor (Bharadwaj et al. 2022). Oxytocin is a hormone important for milk ejection (let-down reflex) during lactation, Previous studies also showed that magnesium deficiency may impair oxytocin release and cause delayed secretory activation. Continuous impaired milk ejection may decrease milk production due to incomplete breast emptying during each feeding, and lead to decrease exclusive breastfeeding duration. Maternal distress may also increase cortisol and decrease insulin sensitivity, which is associated with lower milk production (Nagel et al. 2022). So that, breastfeeding mothers are still recommended to consume magnesium-rich foods such as green leafy vegetables, especially for mothers with hypertension, as they are often also high in dietary fiber and potassium (Gluckman et al. 2015).

Previous studies showed important role of calcium to regulate prolactin release. Gick and Bancroft (1985) showed calcium involvement in dopamine inhibition of prolactin release. Besides that, calcium is important for breastfeeding mothers because increased maternal bone calcium resorption and reduced maternal renal calcium excretion (New Zealand Ministry of Health 2006; Segura et al. 2016) are important contributors of calcium content in breast milk (New Zealand Ministry of Health 2006). Moreover, calcium is important for bone mineralization of a baby (Xu et al. 2024; Shertukde et al. 2022). Breastfeeding mothers are recommended to consume sufficient amount of dairy products and vegetable calcium sources to maintain calcium requirements during breastfeeding (Gluckman et al. 2015).

Sodium is an electrolyte which concentration in breast milk is determined by an electrical potential gradient in the secretory cell rather than maternal nutritional status (Aumeistere et al. 2020). Sodium intake does not affect its content in breast milk but a small intake of salt enriched with iodine (I) is still recommended for a breastfeeding mother (Segura et al. 2016).

This study showed that *gedi* leaves powder had a high carbohydrate, crude fiber, vitamin K, mineral magnesium, calcium, sodium, compared to common natural galactagogue plants, *torbangun* and *katuk* leaves powder, used in this study. In general, natural galactagogues contain various phytochemical compounds such as alkaloids, isoflavones, polyphenols, tannin, and saponins, which may have estrogen effect to stimulate prolactin production and help increasing milk production (Mohanty et al. 2014). Previous study showed that *gedi* leaf extracts using different solvents contained different concentrations of phytosteroids (Winata et al. 2024) that may also act as phytoestrogens. Thus, further research in the extraction, bioactive component, and in vivo study have to be carried out to scientifically prove the galactagogue activity of *gedi* leaves and the possible mechanism plays role in it.

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