Effectiveness of Basil Leaf Nanoparticle Supplementation on Stress Levels and Breast Milk Adequacy in Postpartum

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| Abstract | The prevalence of stress events in postpartum increases every year, and the result can inhibit the adequacy of breastfeeding in postpartum. To overcome the problem of stress and adequacy of breast milk, basil leaves are an alternative plant that can function as a lactagogue and prevent stress complications, such as supplementing basil leaf nanoparticles. Increase the body's absorption of drugs. This study aims to determine the effectiveness of basil leaf nanoparticles on stress levels and adequacy of breast milk in post-partum. The research method uses quantitative research with quasi-experimental methods with probability sampling and design pre and post-tests with the control group. The results showed that the stress level in the intervention group was proven to reduce stress levels, with an average of 18.50 before treatment and an average of 11.18 after treatment. Administration of basil leaf nanoparticles showed a significant difference in reducing stress levels. In the indicator of adequacy of breastfeeding in the form of baby's weight ($p<0.005$), frequency of bowel movements ($p<0.005$), frequency of bowel movements ($p<0.005$), and frequency of breastfeeding ($0.369<0.005$) means that there are differences in baby's weight, frequency of bowel movements, frequency of urination, and the frequency of breastfeeding in the intervention group and the control group. |

| Keywords | Basil Leaf Nanoparticles; Mother's Milk; Postpartum; Stress |

1. INTRODUCTION

Breastfeeding is an activity carried out by mothers and babies that aims to provide nutrition through breast milk, which is useful for the baby's growth and development. World Health Organization (WHO) recommends that infants should be breastfed for six months and continued for up to two years, accompanied by complementary foods (Cindy 2016). Breast milk contains antibodies that protect babies from bacteria, viruses, fungal infections, and parasites, increase the baby's intelligence, prevent babies from allergies that usually arise due to formula milk consumption, babies can feel maternal love directly during the breastfeeding process, and when growing up will reduce the risk of hypertension, cholesterol, overweight and obesity. Breast milk contains all the nutrients necessary for the growth and development of the baby. Breast milk meets the nutritional needs of the baby, improves the baby's cognitive function and immunity, facilitates the development of the baby's nervous system, lowers the incidence of diabetes, allergies, and sudden infant death syndrome (Mohebi, Parham, and Zharifirad 2018).

The impact of infants not being given full exclusive breastfeeding until the first six months of life is a risk of death due to diarrhea 3.94x greater than babies who are exclusively breastfed. The risk is 30 times greater than in babies who are fully breastfed. Babies who are not exclusively breastfed have a greater risk of death due to malnutrition. According to the World, 42 percent of the world's leading causes of infant mortality are malnutrition (58%). One of the targets to be achieved in the SDGs (Sustainable Development Goals) is to stop all forms of malnutrition to create quality Human Resources (HR) that must be started early, especially with breastfeeding. WHO states that exclusive breastfeeding is giving breast milk alone without other foods and drinks, including medicines and vitamins, to the baby from birth to 6 months of age and continuing until the baby is two years old (Maziyah et al. 2018).

Data from Basic Health Research 2018 states that breastfeeding for mature newborns 0-5 months in Indonesia is 37.3% selective breastfeeding, 9.3% breastfeeding halfway, and 3.3% transcendent. Extraordinary breastfeeding is breastfeeding the child before being given a little water or water-based drinks, such as tea, as pre-lacteal food/drink before breast milk comes out (*Kementerian Kesehatan RI* 2018). Breast milk data in Central Java Province in 2019 was 66.0%, while in 2018, it was 65.57%. Although data every year shows an increase from the previous year, Central Java Province continues to make efforts to meet the target of the Indonesian Ministry of Health's program on exclusive breastfeeding.

The postpartum period is one of the most important periods in reproductive health. Postpartum mothers require special attention. This period lasts for 4-6 weeks after delivery and is one of the most sensitive; during pregnancy and puerperium, the mother undergoes many changes (Retno, Andayani, and Hidayati 2022). During this period, the mother experiences serious complications such as lack of milk production, postnatal stress, anemia, open wounds, lower back pain, sexual problems, urinary incontinence, and hemorrhoids. They sometimes last a lifetime (Rahnemaie et al. 2019). One of the problems of postpartum mothers is postpartum stress (Retno et al. 2022). Research shows that there are about 50-80% of postpartum women who experience postpartum distress syndrome. Primiparous mothers or mothers who give birth to their first child will experience postpartum stress in the immediate postpartum period, which will increase the incidence of postpartum depression. 14% of primiparous mothers experienced severe postpartum stress, while of 65 multiparous mothers, 12% experienced severe postpartum stress (Istighosah and Sari 2021). Mothers who experience postpartum stress experience a decrease in interest and interest in babies and are unable to care for their babies optimally, so they are not enthusiastic about breastfeeding, so hygiene, health, and baby growth and development are not optimal (Istighosah and Sari 2021; Retno et al. 2022).

Stress in nursing mothers can affect milk production by inhibiting the release of prolactin, milk production for 8-10 hours, causing a decrease in oxytocin levels and disruption of the sympathetic nervous system, while chronic stress can cause a decrease in milk production in the female breast alveolus so that prolonged milk production stops (Trisnawati and Widyastutik 2018). Decreased milk production in postpartum mothers sometimes occurs in the first week after giving birth; usually, the factors that cause it are the mother's concern about lack of milk, the absence of previous breastfeeding experience, reduced support from the closest person, pain, flat nipples, swelling of the breasts that often occur, nipple blisters and fatigue during labor. 29% of postpartum mothers stop breastfeeding due to lack of milk production, so replace it with formula milk (Trisnawati and Widyastutik 2018). One nonpharmacological therapy that has been shown to increase breast milk production is basil leaves (Panyya et al. 2023).

Basil leaves are leaves that we often find in Indonesia because basil leaves are plants that only grow in the tropics. However, many people still do not know the efficacy of basil leaves because many people do not like basil leaves that are eaten directly. Basil leaf processing was developed with the nanoparticle method based on pharmaceutical therapy considerations consisting of three main indicators: effective,

Suppress hazards if used, or safe and well acceptable (Uthia, Arifin, and Efrianti 2017). Basil contains polyphenols, tannins, saponins, and high flavonoids. Basil also contains chemical components, namely 1.8 cineol, apigenin, and aspartic acid, which serve to provide a relaxing effect and stimulate central nervous activity to dilate and facilitate capillary blood vessels (Inayati 2017; Surahmaida and Umarudin 2019). A study mentions that basil leaves relieve behavioral changes such as depression induced in rats after exposure to chronic mild stress (Ahmed et al. 2019; Thunder et al. 2021). The content in basil leaves also contains calories, protein, fat, carbohydrates, calcium, phosphorus, iron, beta-carotene, vitamin A, vitamin B, vitamin C, thiamine, riboflavin, ascorbic acid, and water; these substances are supporting substances that can be consumed by nursing mothers to meet their nutritional needs (Ahmed et al. 2019).

Basil leaves can be used in several preparations, such as vegetables, juices, sweet powders, and extract capsules, to increase milk production. Basil leaves served as vegetables and eaten by nursing mothers increased between 2-3 times more smoothly than mothers who did not consume basil leaves. Besides being given as a vegetable, basil leaves are also given in a serving of juice to nursing mothers twice a day for 14 days, proven to increase prolactin hormone levels and baby weight (Mohammed et al. 2020). Basil leaves for seven days in nursing mothers are proven to increase milk production, but in vegetable dishes, juice, and decoction, basil leaves have a distinctive bitter taste, so some people are reluctant to consume it (Ali et al. 2017). How to overcome the bitter taste can be used packaging with capsules; in previous studies, basil leaf extract capsules with a dose of 2 x 400 mg containing 17 mg QE flavonoids effectively increased breast milk production with indicators of increasing infant weight with an effect size value of 0.6 which means it is still lemma (Ali et al. 2017). Herbal processing in existing studies still has limited extraction. Some disadvantages of herbal medicine include low solubility and bioavailability, low oral absorption, and difficult-to-predict toxicity. To reduce the problem, nanoparticle preparations are given to increase maximum absorption.

Nanoparticles are particles measuring 1-100 nanometers in size, and most methods suggest a particle diameter of between 200 and 400 nm (Martien et al. 2012). As an advantage of nanoparticles, namely their small size and the surface of nanoparticles can be modified according to needs, with this nanoparticle method, benefits are obtained to control and maintain the release of active compounds during the distribution process in the body to reduce side effects (Nuryadin 2020). In addition, nanoparticles have been shown to increase drug effects and control particle size, drug surface properties, and release of active substances contained in drugs to obtain drug

specifications at drug regimen doses (Priyo 2017). With these advantages, researchers are interested in knowing the effectiveness of basil leaf nanoparticles on stress levels and the adequacy of breast milk in postpartum mothers.

2. METHODS

This study used an experimental quasi-design by selecting research subjects in Linggapura Village, the working area of the Tonjong Health Center, Brebes Regency, with a nonrandomized controlled design with a simple random sampling technique, Where the number of populations that met the inclusion criteria was randomly selected so that the number acarpelous in this study was 68 postpartum mothers who were divided into two groups, namely the control and intervention groups; where the intervention group was given basil leaf nanoparticles (Ocimum basilicum) at a dose of 458 mg and placebo standard care for postpartum and lactating mothers, while the control group was given placebo capsules and standard care for postpartum and lactating mothers. This research was conducted for 14 days at the Tonjong Health Center, Brebes Regency, Where on the first day the researcher explained the study and asked for respondents' consent to be used as a response and filled out the DASS 42 questionnaire, measuring the baby's weight; Then on the second day, the intervention of basil leaf nanoparticles was carried out in the intervention group and placebo capsules in the control group; Furthermore, on the 14th day, an evaluation was carried out by filling out the DASS 42 questionnaire, weighing the baby's body, the frequency of infant defecation and infant urination.

3. FINDINGS AND DISCUSSION

3.1 *Characteristics of Respondents*

Table 1. Characteristics of Postpartum Mothers Who Give Birth at Tonjong Health Center, Brebes Regency

Characteristics of Respondents	Ex. Intervention n = 34	Ex. Control n = 34	Homogeneity
Age			
Mean ± SD	26.32 ± 2,960	26.24 ± 2.583	0,167
Min – Max	20 – 31	20 – 31	
Education			
SD	3 (8,8%)	4 (11,8%)	
JUNIOR	7 (20,6%)	7 (20,6%)	0,932
SMA	18(52,9%)	20 (58,8%)	

PT	6(17,6%)	3 (8,8)	
Work			
Work	16 (52,9%)	12 (35,3%)	0,101
Not Working	18 (47,1%)	22(64,7%)	

The table above shows the frequency distribution of postpartum maternal age in this study in both groups on average in the healthy reproductive category, which is between 20-35 years. Many factors can affect the adequacy of breast milk in postpartum mothers, including age. Age will affect the ability and readiness of mothers to go through the puerperium and breastfeeding (Resounding 2020). An 18-year-old mother will be different in readiness from a 40-year-old mother. Reproductive age 20–35 years is safe for pregnancy, maternity, and puerperium. So the age of 20-35 years is a good reproductive age and supports giving Breast milk (Efriani and Astuti 2020).

The distribution of the average frequency of respondents' education in the study was a high category, namely high school graduation to advanced. The higher a person's education, the easier it is to receive information from various media and can filter which information is good for him. The higher a person's education, the higher his demands on the quality of health will be. In addition, mothers with medical or paramedical education backgrounds will certainly differ in readiness to carry out self-care during the puerperium and breastfeeding compared to mothers with non-educational backgrounds in medical (Gebeyehu et al. 2023).

The frequency distribution of respondents on average is non-working mothers, namely homemakers. Homemakers have 24 hours to take responsibility for themselves and have a new role as mothers to their children. Although she does not have outside work responsibilities, the housewife must be able to adapt to her new role to take care of her child, herself, and her husband (Resounding 2020). Working mothers who are on maternity leave, of course, within a few weeks after giving birth will be actively working again; it is very vulnerable for mothers to give extra food to their babies before six months, and this puts mothers and babies at risk of health (Gertosio et al. 2016).

3.2 *Effectiveness of Basil Leaf Nanoparticles on Postpartum Stress Level*

Table 2. Test of Differences in Stress Levels in Postpartum Intervention and Control Groups

Stress Level	Mean Rank		p-value
	Ex. Intervention	**Ex. Control**	
Pretest	31,63	37,37	0,214
Postest	17,50	51,50	0,000

The table above shows a decrease in stress levels in postpartum mothers after being given basil leaf nanoparticles with a p-value of 0.000 with a decrease in stress from 31.63 (severe stress) to 17.50 (mild stress). The difference in the control group given placebo capsules was an increase in stress in the control group with a p-value of 0.214, where the increase in stress levels from 3 to 7.37 (very severe stress) increased to 51.50 (very severe stress).

Increased stress levels in postpartum mothers can occur due to lack of milk production, mother's unreadiness in breastfeeding, lack of baby suction when breastfeeding, and others (Syari, Arma, and Mardhiah 2022). The provision of basil leaves can reduce the stress level of postpartum mothers (Haerani, Arman, and Patimah 2019). Basil can The active compound Eugenol has a mechanism of action as an antidepressant/antistress through the mechanism of inhibition of Monoamine Oxidase-A (MAO-A) and Monoamine Oxidation-B (MAO-B) so that it can help postpartum mothers from a psychological perspective so that they can perform their role as a mother (Ghasemzadeh et al. 2016; Haerani et al. 2019; Wahid et al. 2020). The content of eugenol contained in basil leaves functions as an antidepressant through inhibition of the catecholamine oxidative deamination process in mitochondria, which results in increased levels of norepinephrine, epinephrine, and serotonin in the brain (Timothy, Limanan, and Ferdinal 2021). Previous research has shown that giving basil capsules affects reducing the stress score of nursing mothers; However, there was no significant difference in stress levels in breastfeeding mothers given basil capsules (p-value 0.016 < 0.05) (Haerani et al. 2019).

Based on the results of qualitative phytochemical analysis conducted Kumalasari and Andiarna (2020) Basil leaves contain many compounds, such as flavonoids, alkaloids, saponins, and tannins. This compound is an antipyretic, antifungal, analgesic, antiseptic, antibacterial, hepatoprotective, immunomodulator, antireppelent, and anti-expectorant (Kusumadewi et al. 2020; Kusumastuti, Meilani, and Tawarnate 2021; Nadeem et al. 2022; do Prado et al. 2022).

3.3 *Effectiveness of Basil Leaf Nanoparticles on Postpartum Breast Milk Adequacy*

The adequacy of breast milk is divided into several parts as follows:

3.3.1 *Baby Weight*

Table 3. Differences in Baby Weight Before and After Treatment

Group	BB	n	Mean	SD	Difference	p-value

Intervention	Pretest	34	3008,82	182,769	544,118	0,000
	Postest	34	3552,94	207,781		
Control	Pretest	34	3070,59	140,409	164,706	0,000
	Postest	34	3235,29	160,741		

One indicator of the adequacy of breast milk can be seen through the increase in baby weight. Breast milk is considered sufficient if the baby's weight increases by 50-100 grams per day or the baby's weight drops not exceeding 10% of birth weight. This study found that administering basil leaf nanoparticle capsules for 14 days to nursing mothers obtained p = 0.000<0.05 with an average increase of 544.118 grams. This means there was a significant difference in infant weight in the intervention group before and after treatment. In the control group, the average increase in infant weight was 164.706 grams with a value of p = 0.000, which means there was a difference in baby weight in the control group before and after treatment.

Increased infant weight due to increased milk production as well as increased frequency of breastfeeding (Hartati and Megawati 2023). Previous research has shown that exclusive breastfeeding has been shown to increase infant weight (Retni et al. 2024). Other studies have shown exclusive breastfeeding in infants aged six months significantly increases infant weight (Astutik and Purwanti 2021). This is supported by previous research showing that exclusive breastfeeding in infants up to 4-6 months of age shows an increase in the body weight of exclusively breastfed babies (Hamzah, 2018). Giving basil leaves is proven to remind the release of breast milk (ASI) so that with the abundance of breast milk, mothers can meet breast milk needs in their babies to increase the baby's weight (Hartati and Megawati 2023; Kusparlina 2020; Lubis and Setiarini 2022).

3.3.2 *Frequency of Baby Defecation*

The results of different tests of infant defecation frequency in the intervention group and control group can be seen in the table below:

Table 4. Differences in Infant Defecation Frequency in the Intervention and Control Groups

Defecation	Mean Rank		p-value
frequency	Intervention	Control	
Pretest	35,00	34,00	0.760a
Postest	41,00	28,00	0.002a

Indicators of increased frequency of bowel movements can also show the adequacy of breast milk. Breast milk is Said to be Enough if the baby defecates at least

once per day, and generally, the baby will have bowel movements 1-5 times on the third day and Beyond, with color bowel movements green to yellowish seeded (Billeaud et al. 2022). The study's results found that giving basil leaf nanoparticle capsules for 14 days affected increasing the frequency of infant defecation with a Significance value of p = 0.002 < 0.05, so there is a difference in the frequency of bowel movements in infants between the intervention group and the control group after treatment. The results showed that there was an increase in the frequency of bowel movements in infants in the intervention group where before giving nanoparticles to the infant's mother, the frequency of bowel movements in infants averaged 35x/7 days increased to 41x/7 days, While in the contractor group given placebo capsules showed a decrease in the frequency of infant defecation from 34 x/7 days to 28 x/7 days.

A decreased frequency of bowel movements can occur due to the increasing age of the baby, and the maturase of the baby's gastrointestinal tract gets better as it ages (Salwan and Kesumawati 2016). Research supported by research Rochsitasari, Santosa, and Puruhita (2016) Showed a difference in the average frequency of infant defecation in the first week in infants given exclusive breastfeeding with a value of p = 0.000, and the highest average frequency of defecation occurred in infants exclusively breastfed in the first seven days.

This is because, in the first week, the milk that comes out is in the form of colostrum, which is a natural laxative for babies (Salwan and Kesumawati 2016). Breast milk also affects the frequency urinate and bowel movements. In infants, proteins and electrolytes in breast milk affect kidney excretion to regulate the removal of substances in the urine. The content of protein and oligosaccharides in breast milk cannot be digested, so it can increase volume, osmolarity, and excretion. When the baby breastfeeds, gastrocolic reflexes will increase in frequency (Cernadas 2018; Lind et al. 2018).

3.3.3 Frequency of Infant Urination (BAK)

The results of different tests of infant urination frequency in the intervention group and control group can be seen in the table below:

Table 5. Test of Differences in Infant Urination Frequency in the Intervention and Control Groups

Frequency of urination	Mean Rank		p-value
	Intervention	Control	
Pretest	34,93	34,07	0,832
Postest	40,38	28,62	0,008

One indicator of the adequacy of breast milk for postpartum mothers is the frequency of Baby urination. This research shows that the increased frequency of infant urination after the administration of basil leaf nanoparticles to infant mothers in the intervention group with a p-value of 0.008; the increased frequency of infant urination in the intervention group from 34.93x/7 days increased to 40.38x/7 days; While in the control group, there was no decrease in the frequency of infant urination after the infant mother was given a placebo capsule with a p-value of 0.832 with a decrease from 34.07x/7 days decreased to 28.62x/7 days. In the intervention group given basil leaf nanoparticles, the average frequency of urination per day is 6-8x/day, so the intervention group shows that the nutritional needs of breast milk in infants are met because one of the signs of adequate breast milk is the frequency of urination at least 6-8x/day, especially in infants aged < 6 weeks (Subekti and Faidah 2019).

This is supported by research (Subekti and Faidah 2019) There is a relationship between the frequency of urination and smooth milk production in normal postpartum mothers with a value of p = 0.002. The fulfillment of nutritional needs in infants is characterized by frequent urination, which indicates the fulfillment of breast milk in infants. Babies who meet the needs of breast milk are marked by babies secreting urination at least six times/day with a pale yellow concentration (Ambarwati and Wulandari 2009). Expense urination in infants <6 times/day can show a lack of nutrition or breast milk fulfillment in infants (Subekti and Faidah 2019).

4. CONCLUSION

Giving basil leaf nanoparticles (Ocimum bacillium) at a dose of 458 mg/day to nursing mothers was proven to reduce the stress level of nursing mothers. In addition, basil leaf nanoparticles can increase indicators of breast milk adequacy in postpartum mothers, characterized by an increase in infant weight, frequency of bowel movements, and frequency of urination in infants with nursing mothers given basil leaf nanoparticles.

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