ORIGINAL ARTICLE

Moringa oleifera and *Phoenix dactylifera* L. effects on cortisol and breast milk in postpartum depression: A randomized controlled trial

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ABSTRACT

Postpartum depression affects 10-20% of new mothers globally, potentially disrupting breast milk production. This study aimed to provide valuable insights into effective interventions to improve the health and well-being of Postpartum Mothers with depression. This study used a randomized controlled trial design with three groups: intervention 1 (dates), intervention 2 (*Moringa oleifera*), and a control group. A total of 363 postpartum mothers participated, and data were collected through salivary cortisol levels (ELISA) and Beck Depression Inventory (BDI) scores to measure depression levels and breast milk production (ACIS AC-15X digital scale and Crown electric breast pump) before and after the intervention for 28 days. Data analysis was performed using paired sample t-test and the independent t-test. The findings showed that both intervention groups experienced significant decreases in BDI scores and cortisol levels as well as increased breast milk production. Intervention group 1 showed a decrease in the BDI score from 3 to 1.5 ($p < 0.001$) and an increase in breast milk production from 159 mL to 471 mL ($p < 0.001$). Intervention group 2 also showed a decrease in the BDI score from 3.2 to 1.7 ($p = 0.003$) and an increase in breast milk production from 103 mL to 396 mL ($p = 0.007$). In conclusion, nutritional intervention with *Moringa oleifera* and *Phoenix dactylifera* L. is effective in reducing depressive symptoms and increasing breast milk production in postpartum mothers. The integration of these interventions into maternal health programs may provide a natural and effective solution to address mental health and lactation challenges in the postpartum period.

Keywords:
Moringa oleifera Leaf, *Phoenix dactylifera* L., salivary cortisol, breast milk, postpartum mother, depression

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INTRODUCTION

Postpartum depression (PPD) is prevalent among new mothers, affecting approximately 10-20% of women globally, with significant implications for maternal and infant health.[1] The hormonal fluctuations that occur during and after pregnancy can exacerbate depressive symptoms, as evidenced by studies indicating that rapid changes in estrogen and cortisol levels are linked to the onset of PPD.[2] Studies indicate that elevated cortisol, particularly flattened diurnal cortisol patterns, correlate with increased depressive symptoms during the peripartum period.[3] High levels of cortisol during pregnancy correlate with an increased risk of developing PPD shortly after childbirth, emphasizing the role of the hypothalamic-pituitary-adrenal (HPA) axis in this process.[4] Elevated cortisol levels, often a response to stress, can negatively impact both mental health and physiological processes, including lactation.[5]

Moringa oleifera, commonly known as *Moringa*, has garnered attention for its nutritional and medicinal properties. It is rich in vitamins, minerals, and antioxidants, which can potentially mitigate oxidative stress and inflammation, both of which are implicated in depression.[6,7] Studies have indicated that *Moringa oleifera* supplementation can positively influence breast milk production due to its galactagogue properties, which are believed to increase the secretion of prolactin, a hormone critical for lactation.[8,9] The presence of phytosterols and other bioactive compounds in *Moringa oleifera* leaves has been associated with increased milk volume, suggesting that this natural supplement could serve as an effective intervention for postpartum mothers struggling with insufficient milk supply.[8] However, it is vital to note potential side effects associated with Moringa consumption. These include moderate cytotoxicity at higher doses, with studies indicating adverse effects from doses around 5000 mg/kg.[10]

Phoenix dactylifera L., on the other hand, is rich in phytoestrogens, which can influence hormonal balance and potentially enhance milk production. A study by Kinasih et al. highlights that the consumption of soy milk can stimulate the secretion of oxytocin, a hormone crucial for milk ejection, thereby improving breast milk production.[11] The hormonal interplay between prolactin and oxytocin is vital for effective lactation, and interventions that support this balance are essential, especially for mothers experiencing postpartum depression.[12] The relationship between cortisol levels and lactation is also interesting. Elevated cortisol levels, often associated with stress and depression, can negatively impact milk production.[13]

The relationship between stress, cortisol levels, and lactation is well documented. Elevated salivary cortisol levels, often indicative of stress, can negatively impact milk production and maternal-infant bonding.[14] Therefore, interventions that can mitigate stress and promote hormonal balance are crucial for improving breastfeeding outcomes. *Moringa oleifera* and *Phoenix dactylifera* L. supplementation may not only enhance nutritional status but also contribute to lower cortisol levels, thus supporting a more favorable environment for lactation. Moreover, the psychological benefits of these supplements should be considered. The nutritional status of pregnant woman has been shown to correlate with their mental health, and adequate intake of essential nutrients can help alleviate symptoms of depression.[15]

By investigating the effects of *Moringa oleifera* leaf capsules and *Phoenix dactylifera* L. supplementation on salivary cortisol levels and breast milk production,

this study aimed to provide valuable insights into effective interventions to improve the health and well-being of postpartum mothers with depression. This research is timely and relevant as it addresses the dual challenges of maternal mental health and lactation, providing insights into potential nutritional interventions that could support mothers during this critical period. The findings of this study have significant implications for clinical practice and public health strategies related to postpartum care.

METHODS

Design

The research design was a randomized controlled trial (RCT). In this study, three study groups (intervention 1, intervention 2, and control) were randomized to reduce bias and ensure that differences in results can be attributed to the intervention. This research was conducted in Kendari City, Southeast Sulawesi, Indonesia, using five sub-districts as focal points: *Abeli, Baruga, Kadia, Kambu,* and *Wua-wua*.

Sampling

Sample selection was conducted using the Randomized Controlled Trial (RCT) method to ensure that every postpartum mother had an equal chance of being included in intervention group 1, 2 or control. The sample selection process began by identifying the total population of registered postpartum mothers, namely, 3,952 postpartum mothers. Using the Slovin formula, the required sample size was determined to be 363 postpartum mothers, with a significance level of 5%. After determining the sample size, postpartum mothers who met the inclusion criteria were randomly assigned to one of three groups: intervention 1, intervention 2, and the control group, each consisting of 121 postpartum mothers. Randomization was executed using SPSS 29 statistical software, which is equipped with algorithms for generating random numbers, thus ensuring that each mother within the eligible population had an equal opportunity to be assigned to any of the groups. In this way, RCTs aim to reduce bias and ensure the validity of the research results, as well as allow for fair comparisons between the effects of different interventions. This study was conducted in five sub-districts in Kendari, Southeast Sulawesi, and involved 30 skilled midwives as research assistants.

Sample Criteria

Inclusion criteria included individuals aged 18-35 years who had babies aged 2 weeks to 6 months, with a Body Mass Index (BMI) of more than 18.7, met the criteria for depression based on the Beck Depression Inventory (BDI) questionnaire from mild to severe, and had a breast milk production of less than 300 g/day. On the other hand, exclusion criteria were designed to eliminate factors that could affect the results of the study, including mothers with endocrine disorders, acute or chronic diseases, and certain conditions such as hypoplastic breast tissue and the use of combined estrogen contraceptives. In addition, mothers who smoked or consumed alcohol were also excluded.

Data Collection

This study was designed to evaluate the effects of two types of nutritional interventions, *Phoenix dactylifera* L. consumption and *Moringa oleifera* capsules, on selected health variables. The three study groups comprised of 1. Intervention Group 1: Participants received 120 g of *Phoenix dactylifera* L. per day, divided into three doses (morning, afternoon, and evening), for 28 days. *Phoenix dactylifera* L. is rich in nutrients and has potential health benefits, including antioxidant and fiber properties. 2. Intervention Group 2: Participants

consumed *Moringa oleifera* capsules at a dose of 1000 mg per day, divided into two times per day (morning and evening) for the same 28-day period. *Moringa oleifera* has been studied for its high nutritional content and therapeutic effects in various health conditions. 3. Control Group: Participants received no additional intervention and only consumed food three times a day for 28 days, serving as a baseline to compare the effects of the intervention. Outcome measurements were carried out before and after the intervention using instruments that have been tested for validity and reliability, ensuring that the data obtained are accurate and accountable.

Saliva was collected from depressed breastfeeding mothers by observing several important procedures to ensure the validity of the results. Samples were taken in the morning between 07.00 - 08.00, with the condition of not eating, drinking, or brushing teeth 30 min before collection. A total of 1 ml of saliva was collected in a special tube, centrifuged for 15 min at 1500 rpm, and stored at a temperature of ≤ -20°C for cortisol analysis. Cortisol examination was performed using the ELISA immunosorbent assay. Reagents and working standards were prepared, and 50 µL of standard solution and streptavidin-HRP were added to the standard well. A 40 µl sample was added together with CORTISOL-antibody and streptavidin-HRP to the test well. After incubation for 60 min at 37°C and subsequent washing, chromogen solutions A and B were added and incubated for 10 min at the same temperature. The reaction was stopped with a stop solution, and the resulting color change was measured using an ELISA Reader at a wavelength of 450 nm. This procedure ensures accuracy in measuring salivary cortisol levels.

Instrument

In this study, the tools and materials used played an important role in measuring the relevant variables. The salivary cortisol examination tool uses the enzyme-linked immunosorbent assay (ELISA) method with the reader organism model 680 (Bio-Rad), which allows the accurate measurement of cortisol levels in saliva samples. The Beck Depression Inventory (BDI) questionnaire, a psychometric tool that has been tested for validity and reliability, was used to assess the level of depression in the participants. Depression scores based on the BDI-II manual are categorized into four categories: a score of 0-13 indicating minimal depression, a score of 14-19 indicating mild depression, a score of 20-28 indicating moderate depression, and a score of 29–63 indicating severe depression. An ACIS AC-15X digital scale with a 1 gram scale was used to measure the volume of daily breast milk production, providing precise results. The Crown electric breast pump also facilitates efficient collection of breast milk. The research materials included Tunisian Degleed Noor dates as much as 120 g per day and *Moringa oleifera* leaf extract TN 57 as much as 1000 mg (2 capsules) per day, both consumed for 28 days. The cortisol kit used in this study included standard solutions, microELISA strip plates, and other reagents, which were needed to carry out the ELISA procedure effectively.

Analysis

The frequency distribution of respondents was analyzed using an Excel table to provide a clear picture of the demographic characteristics and variables studied. This table allows researchers to identify patterns and trends in the collected data. To analyze the differences in the pre-test and post-test values within one group, a Paired Sample T-Test was used. This test was designed to compare two sets of data

from the same subject; in this case, the pre-test and post-test values from the same intervention. An independent t-test was used to compare the outcomes of two different groups (intervention 1 and control or intervention 2 and control).

Homogeneity Sample

The homogeneity test for the sample regarding the BDI Pre-test score, salivary cortisol level, and breast milk volume across the three sample groups using Levene's test for equality of variance showed p-values of 0.892, 0.854, and 0.718, respectively. A p-value greater than 0.05 indicates that there is no significant difference in variance between groups for the three variables tested, which means that the assumption of homogeneity is acceptable.

RESULTS

Table 1 presents the characteristics of the respondents, covering three main variables: maternal age, infant age, and maternal Body Mass Index (BMI). 1. Maternal Age: The mean maternal age was 28.8 years with a standard deviation (SD) of 2.82 years. The median maternal age was 28.5 years, indicating that half of the respondents were younger than this age. Maternal age ranged from 24 to 33 years. 2. Infant Age: The mean infant age was 3.40 months with an SD of 1.09 months. The median infant age was three months, indicating that half of the infants were less than three months old. The infant age ranged from 2 to 5 months. 3. Maternal BMI: The mean maternal BMI was 22.18 with an SD of 1.31. The median BMI was 22.4, indicating that half of the mothers had a BMI below this number. BMI values ranged from 19.7 to 24.5, indicating that all respondents were in the normal weight category according to the WHO standards.

Table 1. Respondent Characteristics

Characteristics	Mean ± SD	Med	Min	Max
Mother's age	28.8 ± 2.82	28.5	24	33
Baby Age	3.40 ± 1.09	3	2	5
Mother's BMI	22.18 ± 1.31	22.4	19.7	24.5

Table 2 shows the changes in depression levels of breastfeeding mothers based on Beck Depression Inventory (BDI) scores, cortisol levels, and breast milk production in three groups: intervention 1, intervention 2, and the control group. From the data presented, it can be seen that both intervention groups showed significant decreases in BDI scores, with Intervention 1 having 117 mothers experiencing a decrease and Intervention 2 having 109 mothers. In contrast, the control group showed significantly higher numbers, with 21 mothers experiencing a decrease, 78 remaining the same, and 22 experiencing an increase in BDI scores. Cortisol levels also showed a similar pattern, with the intervention group having more mothers with decreased cortisol levels than the control group. Breast milk production showed different results, with the intervention group experiencing a significant increase in the number of mothers producing breast milk (121 for Intervention 1 and 115 for Intervention 2), whereas the control group showed lower numbers.

Table 2. Changes in Depression Levels of Breastfeeding Mothers (Based on BDI Scores), cortisol levels and breast milk production in each group

Group	Variables						Total
	Decrease		Still		Increase		
	N	%	N	%	N	%	
BDI Score							
Intervention 1	117	32,2	4	1,1	0	0,0	
Intervention 2	109	30,0	12	3,3	0	0,0	100%
Control	21	5,8	78	21,5	22	6,1	
Cortisol level							
Intervention 1	114	31,4	7	1,9	0	0,0	
Intervention 2	107	29,5	14	3,9	0	0,0	100%
Control	19	5,2	76	20,9	26	7,2	
Breast Milk Production							
Intervention 1	0	0,0	0	0,0	121	33,3	
Intervention 2	0	0,0	6	1,7	115	31,7	100%
Control	17	4,7	83	22,9	21	5,8	

Table 3 presents a comparison of changes in depression levels of breastfeeding mothers as measured by the Beck Depression Inventory (BDI) score, salivary cortisol levels, and breast milk production in the three groups: intervention 1, intervention 2, and control. In intervention group 1, there was a significant decrease in BDI scores from pre-intervention (median 3) to post-intervention (median 1.5) with a p-value < 0.001, indicating improvement in depression. Salivary cortisol levels also decreased from pre-intervention (16.1 μg/dL) to post-intervention (11.7 μg/dL) with a p-value of 0.001, and breast milk production increased significantly from pre (159 mL) to post (471 mL) with a p -value < 0.001. Intervention group 2 showed a decrease in BDI scores from pre-intervention (3.2) to post-intervention (1.7) with a p-value of 0.003, and cortisol levels also decreased from pre-intervention (18.6 μg/dL) to post-intervention (13.3 μg/dL) with a p-value of 0.005. Breast milk production increased from pre-intervention (103 mL) to post-intervention (396 mL), with a p-value of 0.007. The control group showed no significant changes in the BDI scores and cortisol levels, and there was no significant increase in breast milk production.

Table 3. Comparison of the magnitude of changes in the level of depression in breastfeeding mothers (based on BDI scores), salivary cortisol, and production in intervention groups 1 and 2 and the control group.

Group	Variables						
	BDI Score						
	Pre Post	Median	(Min-Max)	Mean+SD	P Value Pre Post between Groups	P value (Intervention 1 and control)	P value (Intervention 2 and control)
Intervention 1	Pre	3	(2-4)	-	0.000		
	Post	1.5	(1-2)	-			
Intervention 2	Pre	3.2	(2-4)	-	0.003	0.000	0.001
	Post	1.7	(1-2)	-			
Control	Pre	3.8	(3-4)	-	0.251		
	Post	2.9	(2-3)	-			
Salivary Cortisol Levels (µg/dL)							
Intervention 1	Pre	16.1	5-52	22.05 ± 14.53	0.001		
	Post	11.7	4-28	12.60 ± 5.6			
Intervention 2	Pre	18.6	7-55	25.07 ± 15.36	0.005	0.000	0.002
	Post	13.3	5-28	13.80 ± 6.7			
Control	Pre	20.7	15-55	28.05 ± 19.61	0.388		
	Post	17.1	10-52	20.11 ± 10.8			
Breast milk production (ml)							
Intervention 1	Pre	159	120-297	219.85 ± 11.65	0.000		
	Post	471	405-807	679.40 ± 130.74			
Intervention 2	Pre	103	68-192	155.72 ± 9.88	0.007	0.000	0.005
	Post	396	383-702	593.15 ± 105.83			
Control	Pre	85	63-128	101.98 ± 3.17	0.317		
	Post	101	98-172	157.11± 50.9			

DISCUSSION

In Intervention Group 1, which received 120 g of *Phoenix dactylifera* L. daily, there was a notable reduction in BDI scores from a median of three pre-intervention to 1.5 post-intervention, with a p-value of less than 0.001, indicating a statistically significant improvement in depressive symptoms. The decrease in salivary cortisol levels from 16.1 µg/dL to 11.7 µg/dL (p = 0.001) further supports the notion that nutritional interventions can mitigate stress responses, which are often

exacerbated by postpartum depression. Additionally, the increase in breast milk production from 159 to 471 mL ($p < 0.001$) suggests that the nutritional properties of *Phoenix dactylifera* L. may also enhance lactation, which is crucial for both maternal and infant health.

The relationship between *Phoenix dactylifera* L. consumption, salivary cortisol levels, and breast milk production in postpartum mothers experiencing depression is a multifaceted topic encompassing nutritional, psychological, and physiological dimensions. *Phoenix dactylifera* L. is recognized for its rich nutrient profile, including high levels of sugars, fiber, and essential minerals such as potassium and magnesium.[16] These nutrients are crucial for postpartum recovery and lactation[17], as they can influence both physical health and emotional well-being, which is particularly significant for mothers dealing with postpartum depression.

Research indicates that the consumption of *Phoenix dactylifera* L. may increase breast milk production owing to its natural galactagogue properties. A study demonstrated that *Phoenix dactylifera* L. can significantly increase breast milk production in postpartum mothers.[16,18] The sugars present in *Phoenix dactylifera* L. provide an immediate source of energy, which is essential for lactating mothers who often experience fatigue and low energy levels, especially when coping with depression. Furthermore, the potassium content in *Phoenix dactylifera* L. can help maintain electrolyte balance, which is vital for overall health and can indirectly support lactation.[16]

The nutritional value of *Phoenix dactylifera* L. is significant. They are high in carbohydrates, fiber, and various micronutrients, which can contribute to overall maternal health.[19] The presence of natural sugars in *Phoenix dactylifera* L. provides a quick energy source[20], which is crucial for mothers who may be experiencing fatigue due to the demands of caring for a newborn. Additionally, the high potassium content in *Phoenix dactylifera* L. can help in maintaining electrolyte balance, which is essential for overall health during the postpartum period[16]. The consumption of *Phoenix dactylifera* L. has been linked to improved mood and reduced anxiety[21], which may help lower cortisol levels in postpartum mothers.[22]

In addition to its nutritional benefits, *Phoenix dactylifera* L. may also play a role in modulating stress responses, which is particularly relevant for postpartum mothers experiencing depression. Elevated cortisol levels, which are often associated with stress, can negatively affect lactation. Cortisol is known to inhibit the secretion of prolactin, the hormone responsible for milk production.[23] Therefore, managing stress through dietary interventions, such as the inclusion of *Phoenix dactylifera* L., may help regulate cortisol levels and promote a healthier lactation process. The consumption of *Phoenix dactylifera* L. may provide psychological comfort that can alleviate some symptoms of depression, thereby potentially lowering cortisol levels and enhancing milk production.[16,23]

The nutritional composition of breast milk is influenced by the mother's diet, and a diet rich in fruits can enhance the fatty acid profile and antioxidant content of breast milk.[24] This is particularly important as the quality of breast milk directly impacts infant health and development. The presence of antioxidants in *Phoenix dactylifera* L. may also help in reducing oxidative stress, which can be beneficial for both the mother and the infant.[19]

Moreover, psychological aspects of postpartum recovery cannot be overlooked. Mothers experiencing depression may have altered their feeding practices, which can

further complicate lactation. Positive dietary choices, such as incorporating *Phoenix dactylifera* L. into the diet, can serve as a form of self-care that promotes both physical and mental health. Studies have shown that mothers who engage in healthy eating practices are more likely to experience improved mood and reduced anxiety, which can facilitate better breastfeeding outcomes.[15,23]

To address the potential biological mechanisms through which *Moringa oleifera* and *Phoenix dactylifera L.* exert their effects against postpartum depression (PPD), various pathways can be delineated, primarily focusing on nutritional, hormonal, and anti-inflammatory effects. *Moringa oleifera* is rich in essential vitamins and minerals, which can enhance overall nutritional status and potentially alleviate symptoms of depression associated with nutritional deficiencies. Its leaves boast a high content of vitamins A, C, and E, as well as various important minerals.[25] These micronutrients can play a role in the regulation of neurotransmitters that are crucial for mood stabilization, offering a nutritional mechanism through which Moringa may mitigate depressive symptoms.

On the hormonal side, Moringa oleifera has been associated with the modulation of key hormones that are implicated in lactation and emotion regulation, such as prolactin and oxytocin. Some studies have indicated that Moringa extracts can influence the expression of hormones, which in turn may affect overall hormonal balance and thus impact both mood and lactation processes.[26–28]

Furthermore, the anti-inflammatory properties of *Moringa oleifera* seem to be a significant mechanism contributing to its antidepressant effects. Research has shown its ability to modulate inflammatory cytokines such as Tumor Necrosis Factor-alpha (TNF-α) and Interleukin-6 (IL-6), which are elevated under conditions of stress and depression. The presence of bioactive compounds such as flavonoids and tannins in Moringa is attributed to these anti-inflammatory responses.[26–28] The anti-inflammatory action can potentially alleviate feelings of fatigue and malaise that accompany depression, thus fostering a more conducive environment for breastfeeding due to an improved psychological state.

Studies have suggested that the antioxidant and anti-inflammatory properties of Phoenix dactylifera L. synergistically support mental health. Date palms contain bioactive compounds that may counter oxidative stress, a known contributor to emotional dysregulation.[25] The anti-inflammatory properties observed in the consumption of dates may also help in reducing depressive symptoms, particularly after childbirth, by attenuating the inflammatory responses that are often exacerbated in postpartum women.[29]

Furthermore, the combination of dietary interventions with supportive practices such as oxytocin massage has been shown to increase breast milk production. Oxytocin, often referred to as the "love hormone," plays a critical role in lactation by stimulating milk ejection and promoting maternal bonding with the infant.[30,31] Integrating the consumption of *Phoenix dactylifera* L. with oxytocin-stimulating practices could create a synergistic effect that maximizes breast milk production while also addressing the emotional needs of postpartum mothers. For example, oxytocin massage has been found to effectively increase breast milk volume, particularly when combined with dietary strategies.[30,32]

Intervention Group 2, which consumed 1000 mg of *Moringa oleifera* capsules daily, demonstrated a reduction in BDI scores from 3.2 to 1.7 ($p = 0.003$) and a reduction in cortisol levels from 18.6 μg/dL to 13.3 μg/dL ($p = 0.005$). The significant increase in breast milk production from 103 mL to 396 mL ($p = 0.007$) indicates that *Moringa oleifera*,

known for its high nutritional content and therapeutic properties, may also play a vital role in improving both mental health and lactation outcomes in breastfeeding mothers. The findings from both intervention groups underscore the importance of dietary interventions to address postpartum depression and enhance breastfeeding success.

Moringa oleifera has been identified as a galactagogue that promotes lactation. Research indicates that consumption of *Moringa oleifera* leaf extract can significantly increase breast milk production in postpartum mothers. For example, a study demonstrated that *Moringa oleifera* capsules increased breast milk volume in early postpartum patients, suggesting its efficacy as a natural supplement for lactating mothers.[33] Furthermore, the presence of essential amino acids and minerals in *Moringa oleifera*, such as calcium and iron, plays a crucial role in stimulating the production of prolactin, the hormone responsible for milk synthesis.[34]

Postpartum depression is a significant concern that affects many new mothers, often leading to decreased milk production and adverse effects on maternal-infant bonding. The relationship between stress, cortisol levels, and lactation is well-documented, with elevated cortisol levels being associated with reduced milk supply.[35] *Moringa oleifera's* potential to modulate cortisol levels may provide a dual benefit: alleviating depressive symptoms while simultaneously enhancing lactation. Studies have shown that *Moringa oleifera* supplementation can lead to reductions in cortisol levels, thereby potentially mitigating the stress response that can interfere with milk production.[35,36]

The nutritional benefits of *Moringa oleifera* extend beyond lactation. The leaves are rich in antioxidants and anti-inflammatory compounds, which can help improve the overall maternal health and well-being. For example, *Moringa oleifera* has been shown to possess neuroprotective properties, which may alleviate symptoms of depression through various biochemical pathways, including the modulation of neurotransmitter levels.[36,37]

In addition to its effects on cortisol and lactation, *the role of Moringa oleifera* in improving the quality of breast milk is noteworthy. Research indicates that *Moringa oleifera* supplementation can enhance the nutritional composition of breast milk, particularly in terms of protein and essential fatty acids, which are crucial for infant development.[38] This is particularly important for mothers who may be struggling with nutritional deficiencies during the postpartum period, as adequate nutrition is essential for both maternal recovery and infant growth.

The integration of *Moringa oleifera* leaf capsules into the diet of postpartum mothers could therefore serve as a holistic approach to managing both depression and lactation challenges. By addressing the biochemical and nutritional needs of mothers, *Moringa oleifera* may help create a more conducive environment for breastfeeding, ultimately benefiting both the mother and child. Evidence suggests that *Moringa oleifera* not only supports increased milk production but also contributes to the psychological well-being of mothers, thereby enhancing the overall postpartum experience.

Furthermore, the effects of Moringa on maternal health extend to public health. Given the rising prevalence of postpartum depression and the challenges associated with breastfeeding, incorporating *Moringa oleifera* into maternal health programs could provide a cost-effective and natural solution to improve the outcomes for mothers and their infants. This aligns with the growing interest in plant-based supplements as alternatives to

pharmaceutical interventions, particularly in low-resource settings where access to mental health care may be limited.[39]

RECOMMENDATION

This study showed that nutritional intervention, specifically the consumption of *Phoenix dactylifera* L. and *Moringa oleifera* capsules, had a significant positive impact on the mental and physical health of breastfeeding mothers with postpartum depression. The results from both intervention groups showed a decrease in Beck Depression Inventory (BDI) scores and cortisol levels, as well as a significant increase in breast milk production. In intervention group 1, there was a significant decrease in the BDI scores and salivary cortisol levels, as well as an increase in milk production. Similar results were also seen in intervention group 2, although with slightly lower results than intervention group 1. In contrast, the control group did not show significant changes in the BDI scores, cortisol levels, or milk production. These findings indicate that the intervention is effective in reducing depression and stress levels, as well as increasing milk production in breastfeeding mothers, which has positive implications for maternal and infant health. Further research is required to explore the mechanisms underlying these effects.

AUTHOR CONTRIBUTIONS

MA: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing–original draft, Writing–review & editing; AA: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing–original draft, Writing–review & editing; HY: Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing–review & editing; HR: Conceptualization, Data curation, Investigation, Validation, Writing–original draft; FF: Supervision, Validation, Visualization, Writing–review & editing.

ETHICAL CONSIDERATION

This research has obtained ethical approval from Poltekkes Kemenkes Kendari with the number No.DP.04.03/F.XXXVI.15/004/2024 on may 6.

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CONFLICT OF INTEREST

We declare that we have no conflicts of interest regarding this article

LIMITATION

This study did not register a prior RCT, so we have just registered it and are awaiting the issuance of the RCT number from the WHO. We attach proof of this: ClinicalTrials.gov Protocol Registration and Results System (PRS) Receipt.

RCT IDENTIFIER

This study has received ClinicalTrials.gov Identifier: NCT073375512

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