

The Effect of Walnut Fruit Consumption on Breast Milk Production among Breastfeeding Mothers

Sary Novita Djole^{1*}, Retno Dewi Prisusanti²

^{1,2} Bachelor of Midwifery Program, Faculty of Health Sciences, Institute of Science and Health Technology RS dr. Soepraoen, Malang, Indonesia

*Corresponding Author: retnodewi@itsk-soepraoen.ac.id

Abstract: Background: Breast milk production is a key determinant of successful exclusive breastfeeding. Insufficient milk supply remains one of the major challenges during lactation and is closely associated with inadequate maternal nutritional intake. Canarium indicum (Kenari) is a local functional food rich in protein, unsaturated fatty acids, vitamins, minerals, and antioxidants that may support lactation. However, scientific evidence regarding its effect on breast milk production is still limited. Methods: This quantitative study employed a quasi-experimental approach using a one-group pretest–posttest design. The study was conducted at an Independent Midwifery Practice (PMB X) from January to March 2026 and involved 60 breastfeeding mothers selected through purposive sampling. Participants consumed kenari fruit daily for 14 days. Breast milk production was assessed using validated and reliable observation instruments. Data were analyzed using descriptive statistics and the Paired Sample t-test with a 95% confidence level. Results: The mean breast milk production score increased from 76.42 ± 10.53 before the intervention to 91.85 ± 9.26 after the intervention. Statistical analysis demonstrated a significant difference between pretest and posttest measurements ($p < 0.001$), indicating that kenari fruit consumption significantly improved breast milk production among breastfeeding mothers. Conclusion: Consumption of kenari fruit has the potential to enhance breast milk production by improving maternal nutritional status during lactation. These findings suggest that kenari may serve as a promising local functional food to support exclusive breastfeeding programs. Further studies using randomized controlled trials with larger sample sizes and longer intervention periods are recommended to strengthen the current evidence.

Keywords: Breastfeeding Mothers; Canarium Indicum; Functional Food; Lactation; Milk Production.

1. INTRODUCTION

Breast milk is universally recognized as the optimal source of nutrition for infants during the first six months of life because it provides a complete range of nutrients, immunological components, enzymes, hormones, and numerous bioactive substances that support physical growth, brain development, and protection against infectious diseases. The World Health Organization (WHO) recommends exclusive breastfeeding during the first six months of life, followed by continued breastfeeding alongside appropriate complementary feeding until two years of age or beyond. Despite the well-established health benefits of breastfeeding, the prevalence of exclusive breastfeeding remains below global targets in many regions. One of the major barriers to successful breastfeeding is mothers' perception of insufficient milk supply, which often leads to the premature introduction of infant formula. Consequently, identifying safe, practical, and locally available nutritional interventions to enhance breast milk production has become an important priority for maternal and child health services (World Health Organization [WHO], 2023; Ministry of Health of the Republic of Indonesia, 2023).

Breast milk production is influenced by multiple interrelated factors, including maternal nutritional status, hormonal regulation involving prolactin and oxytocin, breastfeeding frequency, psychological well-being, sleep quality, and adequate intake of energy and essential

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nutrients during lactation. Lactating women require additional calories, protein, essential fatty acids, vitamins, and minerals to sustain milk synthesis. Inadequate nutritional intake may compromise both the quantity and quality of breast milk. Therefore, ensuring sufficient maternal nutrition during the breastfeeding period represents a fundamental strategy for supporting exclusive breastfeeding while improving maternal and infant health outcomes (Victora et al., 2016; Ministry of Health of the Republic of Indonesia, 2020).

Numerous studies have investigated the effectiveness of natural galactagogues in promoting breast milk production. Several indigenous food sources, including *Sauropus androgynus* (katuk leaves), *Moringa oleifera* (moringa leaves), banana blossom, *Coleus amboinicus* (bangun-bangun leaves), and various herbal preparations, have demonstrated potential lactogenic effects through their phytochemical constituents, antioxidant activity, and hormone-stimulating properties that enhance prolactin secretion. Besides being widely accessible, these local food resources are generally considered safer and more economical than synthetic galactagogues. Nevertheless, inconsistent findings across studies indicate that the efficacy of individual food sources remains uncertain, highlighting the need to investigate other nutrient-rich indigenous foods with lactogenic potential (Mortel & Mehta, 2013; Prasetyono, 2019).

One promising indigenous functional food is the walnut fruit (*Canarium indicum* L.), which is abundant in eastern Indonesia but is still predominantly utilized as a snack or food ingredient. The fruit contains substantial amounts of high-quality protein, unsaturated fatty acids, omega-3 and omega-6 fatty acids, vitamin E, magnesium, phosphorus, zinc, and antioxidant compounds that may contribute to maternal health during lactation. Its rich essential fatty acid profile is believed to support cellular metabolism, improve the nutritional quality of breast milk, and provide additional energy required for milk synthesis. These nutritional characteristics suggest that walnut fruit could serve as a valuable locally sourced dietary intervention for enhancing breast milk production (Ministry of Agriculture of the Republic of Indonesia, 2021; Rosnah et al., 2018).

From a physiological perspective, successful lactogenesis depends on adequate energy availability and nutrient supply to support the metabolic activity of mammary alveolar cells. Healthy fats and high-quality proteins are essential for synthesizing the major constituents of breast milk, while minerals such as zinc and magnesium facilitate enzymatic reactions involved in lactation metabolism. Furthermore, the antioxidant compounds present in walnut fruit may reduce oxidative stress commonly experienced during the postpartum period, thereby indirectly supporting maternal physiological conditions favorable for milk production. Although these biological mechanisms appear plausible, scientific evidence regarding the effect of walnut fruit consumption on breast milk production remains limited and warrants further investigation through experimental or quasi-experimental studies (Ballard & Morrow, 2013; Rosnah et al., 2018).

Previous research has primarily focused on the lactogenic effects of katuk leaves, moringa leaves, fenugreek extract, and other herbal products. While these interventions generally demonstrate positive effects on milk production, they differ substantially in nutritional composition and biological mechanisms. In contrast, studies examining walnut fruit as a source of healthy fats and plant-based protein for improving lactation performance remain scarce, particularly among breastfeeding mothers in Indonesia. This lack of evidence limits the development of evidence-based recommendations regarding the use of walnut fruit as a natural galactagogue in maternal and child healthcare services (Mortel & Mehta, 2013; Khasanah et al., 2021).

From a public health perspective, inadequate breast milk production may contribute to unsuccessful exclusive breastfeeding, increased reliance on infant formula, higher susceptibility to infectious diseases among infants, and greater financial burdens on families. Food-based interventions utilizing locally available resources represent a sustainable strategy because they are culturally acceptable, economically affordable, and readily accessible within communities. Promoting walnut fruit as a functional food may not only improve maternal and infant health but also enhance the economic value of local agricultural commodities through product diversification. Consequently, investigating the potential role of walnut fruit in supporting lactation is relevant from both health promotion and local resource development perspectives (WHO, 2023; FAO, 2022).

A review of the existing literature reveals several important research gaps that justify the present study. First, most previous investigations have concentrated on herbal galactagogues, whereas research evaluating indigenous nuts, particularly walnut fruit, remains extremely limited. Second, earlier studies have largely emphasized changes in breast milk volume without examining the contribution of specific nutritional components contained in the intervention foods. Third, relatively few studies have explored locally available functional foods rich in essential fatty acids as nutritional strategies for enhancing lactation. Therefore, this study introduces a novel approach by evaluating walnut fruit as a locally available functional food whose effectiveness in improving breast milk production has not been extensively investigated.

The significance of this research is further reinforced by the increasing need for safe, affordable, accessible, and locally sourced nutritional interventions to support exclusive breastfeeding programs. The findings are expected to provide scientific evidence for developing dietary recommendations for breastfeeding mothers, expand current knowledge regarding the nutritional benefits of walnut fruit, and assist healthcare professionals in delivering evidence-based nutritional counseling during lactation. Furthermore, this research may facilitate the development of walnut-based functional food products as innovative nutritional interventions aimed at improving maternal and infant health in Indonesia.

Accordingly, this study aims to evaluate the effect of walnut fruit consumption on breast milk production among breastfeeding mothers. Specifically, it seeks to assess changes in breast milk production following walnut fruit supplementation and to provide scientific evidence supporting the use of walnut fruit as a locally available functional food for promoting successful exclusive breastfeeding. The findings are expected to contribute to the advancement of midwifery, nutrition, and public health sciences while supporting the development of evidence-based maternal and child health policies.

2. LITERATURE REVIEW

Breast milk production is a complex physiological process regulated by the interaction of hormonal mechanisms, maternal nutritional status, breastfeeding frequency, psychological well-being, and adequate nutrient intake throughout the lactation period. Prolactin is the primary hormone responsible for stimulating milk synthesis within the mammary alveolar cells, whereas oxytocin facilitates milk ejection through the let-down reflex. Optimal lactation depends on sufficient dietary energy, high-quality protein, essential fatty acids, vitamins, and minerals consumed by breastfeeding mothers. Consequently, adequate maternal nutrition plays a pivotal role in maintaining both the quantity and nutritional quality of human milk (Ballard & Morrow, 2013; Victora et al., 2016).

From a nutritional science perspective, the concept of functional foods emphasizes that foods provide not only energy and essential nutrients but also bioactive compounds capable of producing beneficial physiological effects beyond basic nutrition. Walnut fruit (*Canarium indicum* L.) is a locally available food resource rich in protein, unsaturated fatty acids, omega-3 and omega-6 fatty acids, vitamin E, magnesium, phosphorus, zinc, and antioxidant compounds. These nutrients may support maternal metabolism during lactation, supply additional energy required for milk synthesis, and contribute to the formation of breast milk components. Furthermore, the antioxidant properties of walnut fruit may help reduce oxidative stress commonly experienced during the postpartum period, thereby supporting maternal recovery and overall lactation performance (Rosnah et al., 2018).

A growing body of research has investigated the use of natural galactagogues to enhance breast milk production. Consumption of *Sauropus androgynus* (katuk leaves), *Moringa oleifera* (moringa leaves), fenugreek, and various medicinal plants has been reported to improve lactation by stimulating prolactin secretion and enhancing maternal nutritional status. Nevertheless, most existing studies have focused primarily on herbal interventions, while the potential role of indigenous nuts as sources of essential macro- and micronutrients for supporting lactation has received considerably less scientific attention. Moreover, systematic reviews indicate that stronger evidence from well-designed clinical studies is still required to establish the effectiveness of natural galactagogues (Mortel & Mehta, 2013).

Previous nutritional analyses have demonstrated that walnut fruit possesses substantial nutritional value, particularly because of its high content of unsaturated fatty acids, plant protein, essential minerals, and antioxidant compounds that contribute to maintaining normal metabolic function. Despite these favorable nutritional characteristics, research specifically examining the effect of walnut fruit consumption on breast milk production among lactating mothers remains scarce, especially in Indonesia. This limited evidence highlights an important research gap and underscores the need to evaluate walnut fruit as a locally available functional food that may support successful exclusive breastfeeding.

Drawing upon the physiology of lactation, the principles of functional nutrition, and findings from previous studies, it can be hypothesized that walnut fruit consumption may enhance breast milk production by providing additional energy, high-quality protein, essential fatty acids, minerals, and antioxidant compounds that facilitate milk synthesis. Therefore, the present study was undertaken to generate scientific evidence regarding the effect of walnut fruit consumption on breast milk production among breastfeeding mothers. The findings are expected to support the development of evidence-based, locally sourced nutritional interventions for improving maternal and child health services.

3. RESEARCH METHODS

This study employed a quantitative approach using a quasi-experimental design with a one-group pretest–posttest framework. This design was selected to assess changes in breast milk production among breastfeeding mothers before and after the administration of a walnut fruit consumption intervention during the study period. By comparing measurements obtained before and after the intervention, the design enabled the effectiveness of the intervention to be evaluated based on changes in participants' lactation outcomes.

The study population consisted of breastfeeding mothers who met the predefined inclusion criteria, including women who were exclusively breastfeeding, in good general health, willing to participate throughout the study period, and who provided written informed consent. A total of 60 lactating mothers were recruited through purposive sampling, whereby participants were selected according to characteristics relevant to the study objectives. This sample size was considered adequate to evaluate the potential effect of walnut fruit consumption on breast milk production.

Data were collected using a respondent characteristics questionnaire, a breast milk production observation form, and a supplementary questionnaire assessing breastfeeding practices. Breast milk production was evaluated using several indicators, including breastfeeding frequency, infant-based indicators of milk adequacy, and expressed breast milk volume measured with standardized equipment when applicable. Prior to data collection, all research instruments underwent validity and reliability testing. The validity assessment demonstrated that all questionnaire items exceeded the required critical correlation coefficient

($r_{\text{calculated}} > r_{\text{table}}$), while reliability testing yielded a Cronbach's alpha coefficient of 0.87, indicating good internal consistency and confirming the suitability of the instruments for data collection.

Data analysis was conducted in sequential stages, including univariate and bivariate analyses. Univariate analysis was performed to summarize participants' demographic characteristics and describe the distribution of study variables using frequencies, percentages, means, and standard deviations. Before hypothesis testing, data normality was assessed using the Shapiro–Wilk test. For normally distributed data, differences in breast milk production before and after the intervention were analyzed using the paired-samples t-test. When the normality assumption was not satisfied, the Wilcoxon signed-rank test was applied as a non-parametric alternative. All statistical analyses were conducted using a 95% confidence level, with statistical significance defined as $p < 0.05$. The analytical procedures followed the statistical methodologies described by Ghozali (2021) and Sugiyono (2022).

The conceptual framework of this study illustrates the relationship between the independent and dependent variables. Walnut fruit consumption served as the independent variable (X), whereas breast milk production among breastfeeding mothers was designated as the dependent variable (Y). The proposed model assumes that regular consumption of walnut fruit enhances breast milk production, as evaluated through the predefined lactation indicators. This conceptual relationship formed the basis for assessing the effectiveness of the nutritional intervention implemented in the present study.

4. RESULTS AND DISCUSSION

The study was conducted at an independent midwifery practice (PMB X) between January and March 2026. Prior to data collection, ethical approval and research authorization were obtained from the relevant authorities. Participant recruitment was subsequently carried out according to the predefined inclusion and exclusion criteria, resulting in the enrollment of 60 breastfeeding mothers who voluntarily agreed to participate. Before participation, all respondents received a detailed explanation of the study objectives and procedures and provided written informed consent.

Baseline measurements (pretest) of breast milk production were obtained using a validated observation instrument before the intervention was initiated. Participants were then instructed to consume the prescribed dose of walnut fruit daily for 14 consecutive days. Following completion of the intervention period, breast milk production was reassessed (posttest) using the same standardized instrument, allowing objective comparison of lactation outcomes before and after the intervention.

Respondent Characteristics

Table 1. Demographic Characteristics of the Participants

Characteristic	Frequency (n)	Percentage (%)
Age (years)		
<25	15	25.0
25–35	35	58.3
>35	10	16.7
Educational Level		
Junior High School	12	20.0
Senior High School	31	51.7
Higher Education	17	28.3
Parity		
Primiparous	26	43.3
Multiparous	34	56.7

Source: Primary data processed by the researchers (2026).

As presented in Table 1, most participants were between 25 and 35 years of age (58.3%), had completed senior high school education (51.7%), and were multiparous (56.7%). These findings indicate that the majority of respondents were within the optimal reproductive age range and had previous childbirth experience, characteristics that are generally considered favorable for successful breastfeeding and lactation.

Breast Milk Production Before and After the Intervention

Table 2. Mean Breast Milk Production Before and After Walnut Fruit Consumption

Source: Primary data processed by the researchers (2026).

As presented in Table 2, the mean breast milk production score increased from 76.42 prior to the intervention to 91.85 following the 14-day walnut fruit supplementation. The observed mean increase of 15.43 points indicates a substantial improvement in breast milk production after participants received the nutritional intervention, suggesting a favorable effect of walnut fruit consumption on lactation performance.

Hypothesis Testing

Prior to comparative analysis, the distribution of the data was examined using the Shapiro–Wilk normality test. The results indicated that all variables were normally distributed ($p > 0.05$), satisfying the assumptions required for parametric statistical analysis. Accordingly, differences in breast milk production before and after the intervention were evaluated using the paired-samples t-test.

Table 3. Results of the Paired-Samples t-Test for Breast Milk Production

Variable	Mean Difference	<i>t</i>	<i>p</i> -value
Pretest–Posttest	15.43	9.872	<0.001

Source: Primary data processed by the researchers (2026).

The findings of this study demonstrate that daily consumption of walnut fruit significantly increased breast milk production among breastfeeding mothers. The observed improvement may be attributed to the rich nutritional composition of walnut fruit, which includes high-quality protein, unsaturated fatty acids, omega-3 and omega-6 fatty acids,

vitamin E, magnesium, phosphorus, and zinc. These nutrients are essential for meeting the increased metabolic and energy demands of lactation while supporting the biosynthesis of breast milk within the mammary alveolar tissue. Adequate maternal nutrition during the breastfeeding period is widely recognized as a critical determinant of optimal milk production.

The present findings are consistent with the physiological principles of lactation, which emphasize that successful breast milk production depends on both hormonal regulation and sufficient maternal nutrient intake. Adequate energy and essential nutrients facilitate the action of prolactin in stimulating milk synthesis, while oxytocin promotes efficient milk ejection through the let-down reflex. Therefore, walnut fruit, as a nutrient-dense locally available functional food, may improve maternal nutritional status and consequently enhance lactation performance.

The results also align with previous studies investigating natural galactagogues, including *Sauropus androgynus* (katuk leaves), *Moringa oleifera* (moringa leaves), and fenugreek, all of which have been reported to improve breast milk production by enhancing maternal nutritional status and supporting hormonal mechanisms involved in lactation. Although the intervention evaluated in the present study differs from those investigated previously, the collective evidence suggests that natural food-based interventions represent promising non-pharmacological strategies for promoting successful exclusive breastfeeding.

Unlike most previous studies that have primarily investigated herbal galactagogues, the present study introduces walnut fruit as the primary nutritional intervention. This represents an important contribution to the existing literature, as evidence regarding the use of *Canarium indicum* L. as a locally available source of essential fatty acids to support lactation remains limited. Consequently, the findings broaden current scientific knowledge on the role of indigenous Indonesian functional foods in promoting maternal and infant health, particularly in enhancing breast milk production.

Although all participants demonstrated improvements in breast milk production following the intervention, the magnitude of this improvement varied among individuals. These differences are likely attributable to additional factors known to influence lactation outcomes, including breastfeeding frequency, maternal sleep quality, psychological well-being, nutritional status, and the level of family support during the postpartum period. Because lactation is regulated by multiple interacting physiological and behavioral factors, future investigations should consider these variables to better understand their contribution to variations in breastfeeding performance.

Research Implications

From a theoretical perspective, the present findings reinforce the concept that adequate maternal nutrition, achieved through the consumption of locally available functional foods, plays a significant role in optimizing breast milk production. Moreover, this study

provides additional scientific evidence supporting the potential of walnut fruit as a nutrient-rich functional food capable of enhancing lactation among breastfeeding mothers.

From a practical standpoint, these findings may serve as an evidence base for healthcare professionals, particularly midwives and nutritionists, when providing nutritional counseling for lactating women. Walnut fruit may be considered a locally available dietary option to support breastfeeding and improve maternal nutritional intake during the postpartum period. Furthermore, the results may inform the development of exclusive breastfeeding promotion programs and encourage innovation in walnut-based functional food products aimed at improving maternal and infant health outcomes.

Discussion

The findings of the present study demonstrate that walnut fruit consumption significantly enhanced breast milk production among breastfeeding mothers. The increase in the mean breast milk production score following the intervention suggests that improving maternal nutritional intake through locally available functional foods may effectively support the lactation process. Participants who consumed walnut fruit throughout the intervention period exhibited greater milk production than they did before the intervention. These findings underscore the potential value of food-based nutritional interventions as safe, non-pharmacological strategies for promoting successful exclusive breastfeeding and improving maternal nutritional status during lactation (Victora et al., 2016; World Health Organization [WHO], 2023).

From a physiological perspective, the observed improvement in breast milk production can be explained by the mechanisms regulating lactation, which depend on both hormonal activity and adequate maternal nutrient availability. The synthesis and secretion of breast milk are primarily regulated by prolactin and oxytocin, while sufficient dietary intake provides the substrates required for milk production. Walnut fruit is rich in high-quality protein, unsaturated fatty acids, omega-3 and omega-6 fatty acids, vitamin E, magnesium, phosphorus, and zinc, all of which contribute to meeting the increased metabolic and energy demands of lactation. These nutrients support the functional activity of mammary alveolar secretory cells, thereby facilitating more efficient milk synthesis. The combination of essential macronutrients and micronutrients present in walnut fruit may therefore enhance the physiological capacity of lactating mothers to produce breast milk (Ballard & Morrow, 2013; Rosnah et al., 2018).

The present findings are also consistent with the principles of maternal nutrition, which emphasize that both the quality and adequacy of maternal dietary intake are fundamental determinants of successful lactation. Breastfeeding mothers require additional energy, protein, vitamins, and minerals to compensate for nutrients transferred through breast milk. When these nutritional requirements are adequately met, breast milk production is more likely to

increase while maintaining its nutritional quality. Accordingly, walnut fruit may represent a valuable natural food source capable of supporting the nutritional demands of lactating women and contributing to improved breastfeeding outcomes (Ministry of Health of the Republic of Indonesia, 2020; FAO, 2022).

The results are in agreement with previous studies evaluating natural galactagogues, including *Sauropus androgynus* (katuk leaves), *Moringa oleifera* (moringa leaves), and fenugreek, which have been reported to enhance breast milk production through improvements in maternal nutritional status and stimulation of lactation-related hormonal pathways. Although the nutritional intervention evaluated in the present study differs from those examined previously, the collective evidence supports the conclusion that naturally occurring food sources can play an important role in promoting successful breastfeeding. These findings further suggest that improvements in breast milk production are influenced not by a single dietary component, but rather by the capacity of nutrient-rich foods to satisfy maternal nutritional requirements and facilitate the physiological processes underlying lactation (Mortel & Mehta, 2013; Khasanah et al., 2021).

A notable strength of this study lies in its investigation of walnut fruit as the primary intervention. While most previous research has concentrated on herbal galactagogues, relatively few studies have explored the lactation-promoting potential of walnut fruit, particularly among Indonesian breastfeeding mothers. The high concentrations of unsaturated fatty acids, antioxidants, and quality protein found in walnut fruit provide a strong nutritional rationale for its use as a functional food to support lactation. Consequently, this study contributes novel evidence regarding the application of indigenous food resources as sustainable nutritional interventions that align with local agricultural potential and regional food availability (Rosnah et al., 2018; Ministry of Agriculture of the Republic of Indonesia, 2021).

Although breast milk production increased among all participants, the magnitude of improvement varied across individuals. This variability is likely attributable to additional determinants of lactation, including breastfeeding frequency, infant latch quality, maternal psychological well-being, sleep quality, pre-intervention nutritional status, and family support. These factors are well recognized as important contributors to successful breastfeeding and may influence an individual's physiological response to nutritional interventions. Therefore, while walnut fruit consumption appears to be a beneficial adjunct for enhancing lactation, successful breastfeeding should be viewed as a multifactorial process requiring comprehensive support that addresses both nutritional and non-nutritional determinants (Dennis, 2002; WHO, 2023).

From a theoretical perspective, the present study expands the existing evidence supporting the relationship between locally available functional foods and improved breast

milk production. The findings reinforce the concept that food-based nutritional interventions contribute not only to meeting maternal energy requirements but also to optimizing lactation physiology through the provision of essential nutrients. Future research should investigate the optimal dosage and duration of walnut fruit consumption and evaluate its effects on the biochemical composition and nutritional quality of breast milk using more comprehensive laboratory assessments (Ballard & Morrow, 2013; Victora et al., 2016).

From a practical standpoint, these findings provide valuable information for healthcare professionals, particularly midwives, nurses, and nutritionists, who are responsible for providing nutritional counseling to breastfeeding mothers. Walnut fruit may be recommended as a safe, readily available, and nutritionally valuable local food that supports lactation while offering economic benefits to communities where it is cultivated. Integrating education on locally sourced functional foods into maternal and child health programs may contribute to improving exclusive breastfeeding rates while simultaneously promoting the sustainable utilization of indigenous agricultural resources to enhance public health outcomes (Ministry of Health of the Republic of Indonesia, 2023; FAO, 2022).

5. CONCLUSIONS AND SUGGESTIONS

The findings of this study demonstrate that walnut fruit consumption significantly improves breast milk production among breastfeeding mothers. These results suggest that walnut fruit, as a locally available functional food, has considerable potential to support lactation by enhancing maternal nutritional intake during the breastfeeding period. Accordingly, the primary objective of this study—to evaluate the effect of walnut fruit consumption on breast milk production—was successfully achieved. The statistical findings support the acceptance of the research hypothesis, indicating that walnut fruit consumption contributes positively to increased breast milk production. Nevertheless, these findings should be interpreted with caution because they were obtained from a specific study population and research setting. Therefore, further studies involving more diverse populations and broader settings are necessary before the findings can be generalized.

Based on the study outcomes, walnut fruit may be considered a promising locally sourced functional food for inclusion in nutritional education programs targeting breastfeeding mothers. Healthcare professionals, particularly midwives, nurses, and nutritionists, are encouraged to promote adequate maternal nutrition during lactation by incorporating nutrient-rich indigenous food resources into maternal and child health services as part of efforts to improve exclusive breastfeeding practices.

Several limitations should be acknowledged. First, the study employed a quasi-experimental design without a control group, limiting the ability to establish definitive causal relationships. Second, the relatively small sample size and the inclusion of participants from a single study site may restrict the external validity of the findings. In addition, breast milk

production was assessed primarily using clinical and observational indicators rather than objective biochemical biomarkers or laboratory analyses of breast milk composition.

Future studies are therefore recommended to adopt randomized controlled trial designs with larger sample sizes, recruit participants from multiple healthcare facilities, and extend the intervention period to strengthen the evidence regarding the effectiveness of walnut fruit consumption. Further research should also investigate the optimal dosage and duration of walnut supplementation, evaluate changes in the biochemical and nutritional composition of human milk, and examine its long-term effects on infant growth, development, and the success of exclusive breastfeeding. Such investigations would provide stronger scientific evidence supporting the utilization of walnut fruit as a locally available functional food for improving maternal and child health.

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