

Consumption of Katuk Leaf–Fortified Catfish Nuggets Improves Breast Milk Production

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ABSTRACT

Exclusive breastfeeding remains a global public health priority, yet many mothers experience insufficient breast milk production due to physiological, behavioral, and psychosocial factors. Katuk leaves (*Sauropus androgynus*) are traditionally recognized in Indonesia for their lactogenic properties, while catfish (*Clarias batrachus*) provides high-quality protein and essential fatty acids that support maternal nutritional status. Integrating these ingredients into a functional food product may offer a practical dietary approach to enhance lactation. This study aimed to describe changes in breast milk production among lactating mothers following the consumption of katuk leaf–fortified catfish nuggets over a two-week period. A descriptive case study was conducted in Martopuro Village, Pasuruan Regency, during August 2025. Three purposively selected lactating mothers with infants aged 0–6 months consumed 100 g of fortified nuggets every two days for 14 days. Breast milk volume was measured using a standardized graduated pump container at baseline and post-intervention. Maternal perceptions of lactation were assessed using a five-item questionnaire adapted from validated lactation assessment tools. Data were analyzed descriptively to identify individual trends. All participants demonstrated an upward trend in breast milk production, reflected in increased expressed milk volume and improved maternal lactation perception scores. These findings align with the biological plausibility of katuk leaf phytochemicals; such as flavonoids, saponins, and phytosterols which may stimulate prolactin pathways and enhance mammary gland function. The nutritional contribution of catfish protein and essential fatty acids may further support milk synthesis. However, several confounding factors were identified, including high baseline hydration, increased breastfeeding frequency, and potential placebo effects, limiting the interpretability of the observed improvements. In conclusion, katuk leaf–fortified catfish nuggets show potential as an acceptable functional food to support lactation, but the descriptive nature of this study and its very small sample size preclude causal inference. Larger randomized controlled trials with standardized controls and confounder monitoring are required to validate the efficacy of this formulation.

Keywords: katuk leaves; *Sauropus androgynus*; catfish; functional food; lactation; breast milk production

INTRODUCTION

Exclusive breastfeeding during the first six months of life is essential for optimal infant growth, immune protection, and the prevention of infectious diseases [1,2]. However, many mothers experience challenges in maintaining exclusive breastfeeding, particularly due to inadequate or insufficient breast milk production. This condition may cause infants to feel unsatisfied after feeding, resulting in frequent crying or fussiness, hard stools, inadequate nutrient intake, and suboptimal monthly weight gain. These factors collectively contribute to the low coverage of exclusive breastfeeding among newborns [3].

According to the 2023 UNICEF/WHO Global Breastfeeding Scorecard, the global exclusive breastfeeding rate is 48% [4]. Nationally, the 2022–2023 Indonesia Health Profile reported rates ranging from 60–62% [5], while local data from Pasuruan District in 2023 indicated a coverage of approximately 68% [6,7]. Despite these figures, field interviews with a village midwife in Martopuro (July 2025) revealed that exclusive breastfeeding coverage remains below local targets, primarily due to insufficient breast milk production and maternal fatigue among working mothers.

The low rate of exclusive breastfeeding is influenced not only by maternal physiological factors but also by social, cultural, and economic determinants. The aggressive marketing of formula milk products, often accompanied by claims that mimic the nutritional benefits of breast milk has contributed to a widespread misperception that formula milk is more nutritious and practical than breastfeeding [8]. Additionally, cultural practices such as prelacteal feeding and early introduction of mashed foods further undermine exclusive breastfeeding practices [9]. Family dynamics, particularly the influence of grandmothers, also play a significant role in shaping infant feeding decisions [10].

Strategies to enhance breast milk production include early initiation of breastfeeding (EIB), proper positioning and attachment, and the consumption of vegetables such as katuk leaves, bitter melon, and beluntas, as well as traditional herbal preparations [11]. Katuk leaves (*Sauropus androgynus* Merr) are widely recognized for their high nutritional value and contain natural galactagogues that support increased breast milk production [12].

In response to insufficient milk supply, the use of natural galactagogues has gained increasing attention. Katuk leaves are traditionally valued in Indonesia for their lactogenic properties, and recent studies have demonstrated that *Sauropus androgynus* contains active phytochemicals, such as flavonoids, saponins, and phytosterols that stimulate the expression of prolactin and oxytocin genes, thereby enhancing milk secretion [13]. However, regular consumption of katuk leaves is often limited by low acceptability due to their plain taste when prepared solely as boiled vegetables.

To improve maternal adherence and nutritional intake, food diversification is needed. Combining katuk leaf extract with catfish (*Clarias batrachus*) offers a promising approach. Catfish is an affordable, widely available source of complete animal protein and essential fatty acids, which are crucial for sustaining maternal energy and supporting the biochemical processes involved in milk synthesis. Processing these ingredients into nutrient-dense nuggets provides a practical, savory, and shelf-stable functional food suitable for the lifestyle of busy, working mothers.

Although the individual benefits of katuk leaves as a galactagogue and catfish as a protein source are well established, their combined formulation into a single processed food product remains underexplored in lactation management. Previous product development studies have primarily evaluated these fortified nuggets for addressing gestational anemia rather than assessing their acceptability and physiological effects on lactation [14]. Therefore, this study aims to describe changes in breast milk production among lactating mothers following the consumption of katuk leaf–enriched catfish nuggets.

METHODS

This study was conducted in Martopuro Village, Purwosari Subdistrict, Pasuruan Regency, East Java, Indonesia. Data collection took place over a two-week period in August 2025, during which lactating mothers were monitored before and after the dietary intervention. A descriptive case study design was employed to document and observe changes in breast milk production among lactating mothers following the consumption of a functional food

product. Descriptive case studies are particularly suitable for examining real-world phenomena within a localized community context when large-scale experimental designs are not feasible [15]. This design allowed for close, individualized monitoring of maternal responses to the intervention.

Due to the nature of the case study approach, a small purposive sample of three (3) lactating mothers was selected. Although the limited sample size restricts statistical generalizability, it enabled detailed observation of adherence and physiological changes. Participants were recruited based on the following inclusion criteria: 1) lactating mothers with infants aged 0–6 months; 2) both mother and infant in good health; 3) willingness to consume the provided functional food; 4) no known allergies to fish or vegetables; 5) willingness to participate throughout the study period. Mothers who discontinued breastfeeding or failed to comply with the feeding schedule during the two-week intervention were excluded.

Breast milk output was measured before the intervention (baseline) and after the two-week period. Quantification was performed using a standardized, graduated breast pump container. Mothers were instructed to express milk at fixed intervals, and the daily volume was recorded in milliliters (mL) to ensure objective measurement and avoid subjective estimation. Maternal perceptions and physiological indicators of milk let-down, such as breast fullness, infant sleep patterns, and urination frequency were assessed using a 5-item questionnaire adapted from standardized lactation assessment tools. The cumulative score ranged from 5 to 30, with scores below 16 indicating low milk production. The adapted instrument was pre-tested and reviewed by clinical midwives to ensure face validity for use in this case study.

The intervention consisted of administering katuk leaf-fortified catfish nuggets over a 14-day period. To maintain nutritional consistency, the dietary protocol was standardized as follows: 1) participants consumed the nuggets every two days, totaling seven feeding days across the two-week period; 2) each feeding day consisted of 100 grams of nuggets, divided into two 50-gram portions consumed in the morning and evening; and 3) each 100-gram serving provided approximately 180 kcal, 14 grams of animal protein (from *Clarias batrachus*), and 2.5 grams of katuk leaf (*Sauropus androgynus*) extract, rich in saponins and flavonoids.

Given the descriptive case study design and small sample size, data analysis focused on descriptive comparisons of pre- and post-intervention measurements. Changes in breast milk volume and lactation perception scores were summarized narratively and presented in tabular form to illustrate individual trends.

RESULTS

To provide a rigorous scientific evaluation of the two-week dietary intervention, the qualitative observations and subjective experiences of the three subjects were cross-referenced with quantitative measures. Table 1 about characteristics of respondent and table 2 summarizes the clinical indicators, lactation scores, and infant weight changes recorded before (baseline) and after the consumption of katuk leaf-enriched catfish nuggets.

Table 1. Characteristics of respondent in Pasuruan District, Purwosari Regency on Agustus 2025

Demographic characteristics	Respondent 1	Respondent 2	Respondent 3
Age	26 years	24 years	25 years
Education	University	Senior high school	Senior high school
Job status	Teacher	Not work	Not work
Parity	Second parity	First parity	First parity
Give birth	Spontaneous	Spontaneous	Spontaneous

Table 2. Quantitative and clinical indicators af breast milk production pre-intervention and post-intervention

Subject ID	Timeline	Lactation score (5–30 scale) & classification	Daily milk volume range (ml)	Maternal fluid intake (glasses/day)	Daily breastfeeding frequency (times/day)	Infant sleep duration post-feeding (hours)	Infant weight (kg)	Primary clinical observation (let-down reflex indicator)
Subject 1	Pre-intervention	21 (moderate)	90–110	9–11	8–10	3–4	5.5	Active flow without manual compression Spontaneous milk ejection/galactorrhea
	Post-intervention	29 (high)	120–140	9–11	9–10	3–4	6.3	
Subject 2	Pre-intervention	14 (Low)	70–90	8–9	6–8	2–3	4.5	Flow induced only via manual compression Active flow without manual compression
	Post-intervention	23 (moderate)	110–130	8–9	8–12	3–4	5.2	
Subject 3	Pre-intervention	18 (moderate)	80–100	9–10	7–8	3–4	5.2	Flow induced only via manual compression Spontaneous milk ejection/galactorrhea
	Post-intervention	25 (high)	120–140	9–10	8–12	3–4	6.7	

Subject 1: at baseline, Subject 1 exhibited a moderate lactation capacity (Score: 21). This baseline efficiency was likely supported by positive confounding behavioral factors, including a high feeding frequency (8–10 times/day), adequate hydration (9–11 glasses of water/day), and a robust meal frequency (3–4 times/day). Post-intervention, her lactation score peaked at 29 (High), marked physiologically by spontaneous milk ejection (leaking onto clothes) and a continuous flow post-feeding. Concurrently, the infant's weight increased from 5.5 kg to 6.3 kg (+800g). This substantial growth is highly correlated with the synergy between the high nutrient density of the nuggets (animal protein and galactagogues) and her consistently optimal breastfeeding practices (Table 2).

Subject 2: Subject 2 initially presented the weakest lactation profile (Score: 14, Low), characterized by low baseline vegetable intake, poor dietary habits (frequently purchasing prepared foods), and a low feeding frequency (6–8 times/day). Prior to the intervention, milk flow could only be elicited via manual breast compression. Following the two-week intervention, her lactation score increased significantly to 23 (Moderate), and her milk flow became active without manual compression. Notably, her breastfeeding frequency naturally increased to 8–12 times/day as the

infant became less fussy, which acted as a positive feedback loop for prolactin stimulation. The infant's weight rose from 4.5 kg to 5.2 kg (+700g), demonstrating that the functional food intervention successfully mitigated her initial nutritional deficits (Table 2).

Subject 3: Subject 3 maintained a baseline score of 18 (Moderate), limited primarily by a self-reported lack of fruit and vegetable intake despite eating 3–4 meals a day. Her initial milk flow required mechanical/manual compression. Post-intervention, her score advanced to 25 (High), transitioning to spontaneous milk ejection. The infant's weight showed the highest increase, moving from 5.2 kg to 6.7 kg (+1.5 kg). While the fortified nuggets provided necessary micronutrients and galactagogues, this profound weight gain must be interpreted with caution; it was heavily co-stimulated by a sharp increase in daily feeding frequency (up to 12 times/day) post-intervention, which serves as a vital mechanical confounder in infant weight progression (Table 2).

DISCUSSION

The descriptive findings of this study reveal a clear and consistent upward trajectory in multiple indicators of breast milk production across all three participants following the two-week consumption of katuk leaf-enriched catfish nuggets. Although modest in scale, the pattern of improvement was observable in both objective measurements of expressed milk volume and subjective maternal indicators of lactation adequacy. From a physiological standpoint, these findings are congruent with the established understanding of lactation as a complex neuroendocrine process regulated primarily by the coordinated actions of prolactin and oxytocin. Prolactin governs milk synthesis within the alveolar epithelial cells, while oxytocin triggers the contraction of myoepithelial cells surrounding the alveoli, facilitating milk ejection through the let-down reflex. Any intervention capable of enhancing either hormonal pathway, or improving maternal nutritional status has the potential to influence lactation outcomes.

The biological plausibility of the observed improvements is supported by the phytochemical composition of katuk leaves (*Sauropus androgynus* Merr), which contain a diverse array of bioactive compounds, including phytosterols, flavonoids, saponins, and alkaloids. These compounds have been hypothesized to act as natural galactagogues by stimulating prolactin secretion, enhancing alveolar proliferation, and improving mammary gland vascularization, thereby increasing the efficiency of milk synthesis and secretion [16]. Flavonoids, in particular, have been shown to modulate endocrine pathways and exert antioxidant effects that may indirectly support lactation by reducing oxidative stress in mammary tissues. Phytosterols, meanwhile, are believed to mimic estrogenic activity, potentially contributing to ductal expansion and improved milk flow.

The physiological trends observed in this study are consistent with a growing body of literature supporting the lactogenic potential of *Sauropus androgynus*. Trianinsi et al. (2020) [17] demonstrated that the consumption of katuk-based products significantly increased breast milk production within a two-week intervention period, mirroring the timeframe of the present study. Tan et al. (2020) [18] further confirmed that plant-derived galactagogues modulate prolactin-related signaling pathways, reinforcing the mechanistic rationale for the use of katuk leaves in lactation support. More recently, Nurani et al. (2025) [19] conducted a comparative analysis showing that katuk leaves produced a superior lactogenic response compared to other leafy vegetables such as spinach, yielding an average increase of 54 mL in expressed milk volume. These findings collectively suggest that katuk leaves possess a unique phytochemical synergy that enhances their lactogenic efficacy beyond that of typical green vegetables.

The inclusion of catfish (*Clarias batrachus*) in the fortified nuggets further strengthens the nutritional foundation of the intervention. Catfish is a rich source of high-quality animal protein, essential fatty acids, and micronutrients such as vitamin B12, iron, and zinc, all of which are critical for maternal metabolic function and the biochemical processes underlying milk synthesis. Adequate protein intake supports the production of casein and whey proteins in breast milk, while essential fatty acids contribute to the structural integrity of mammary cell membranes and the synthesis of bioactive lipids. The combination of katuk leaf extract and catfish therefore represents a synergistic approach, integrating both hormonal and nutritional pathways to support lactation.

However, despite the encouraging trends observed, the findings of this study must be interpreted with considerable caution. The descriptive case study design and extremely limited sample size ($n = 3$) impose significant constraints on the internal validity, external validity, and generalizability of the results. Without a control group, randomization, or blinding, it is impossible to determine whether the observed improvements were attributable to the intervention itself or to unrelated behavioral, physiological, or psychological factors.

Several confounding variables were identified that may have influenced the outcomes:

- 1) Hydration and dietary patterns emerged as major behavioral confounders. Subject 1, for example, maintained a baseline fluid intake of 9–11 glasses of water per day and consumed 3–4 meals daily. Adequate hydration and caloric intake are independently associated with improved milk production, making it difficult to isolate the specific contribution of the fortified nuggets.
- 2) Breastfeeding frequency increased substantially among Subject 2 and 3 during the intervention period, reaching up to 12 sessions per day. Frequent infant suckling is the most potent natural stimulus for prolactin and oxytocin release via the neuroendocrine reflex arc. This mechanical stimulation alone is sufficient to increase milk volume, regardless of dietary interventions. Therefore, the increased milk output observed in these participants may reflect a natural physiological response to increased breastfeeding frequency rather than the biochemical effects of the fortified nuggets.
- 3) Psychological and placebo effects may have played a role. Maternal stress and anxiety are well-documented inhibitors of the oxytocin-mediated let-down reflex. Participation in a supervised study, receiving structured attention from researchers, and consuming a specially prepared “lactation food” may have induced a positive psychological response that reduced stress and enhanced milk ejection. Such placebo-related improvements are common in lactation research and must be carefully controlled in future studies.
- 4) Measurement limitations must also be acknowledged. Although expressed milk volume was measured using a standardized container, variations in maternal pumping technique, timing, and infant feeding patterns may have introduced measurement bias. Subjective indicators such as breast fullness and infant sleep patterns, while valuable, are inherently susceptible to recall bias and expectancy effects.

The integration of katuk leaves and catfish into a single functional food product represents not only an innovative nutritional strategy but also a culturally grounded intervention that aligns with local dietary practices and maternal health traditions. As a composite formulation, this product combines the phytochemical richness of *Sauropus androgynus* with the high-quality protein and micronutrient profile of catfish, thereby offering a theoretically synergistic approach to supporting lactation through both endocrine and nutritional pathways. Despite this conceptual promise, the present findings remain insufficient to establish a definitive causal relationship between the consumption of katuk leaf-fortified catfish nuggets and the observed increases in breast milk production. The upward trends documented in expressed milk volume and maternal indicators of lactation adequacy are encouraging, yet they must be interpreted as preliminary signals rather than conclusive evidence of efficacy.

The limitations inherent in the current descriptive case study design; particularly the extremely small sample size, absence of a comparison group, and lack of blinding significantly constrain the internal validity of the findings. Without methodological safeguards to control for confounding variables such as breastfeeding frequency, maternal hydration, caloric intake, psychological state, and natural hormonal fluctuations, it is impossible to disentangle the specific effects of the intervention from the broader physiological and behavioral factors that influence lactation.

Furthermore, the reliance on self-reported indicators and simple volumetric measurements introduces potential biases related to recall, expectancy, and variability in pumping technique.

To rigorously determine whether katuk leaf-fortified catfish nuggets exert a measurable and clinically meaningful impact on lactation, future research must adopt more robust methodological frameworks. Randomized controlled trials (RCTs) with adequately powered sample sizes are essential to ensure statistical reliability and to allow for meaningful subgroup analyses. Such trials should incorporate clearly defined control groups receiving non-fortified nuggets to isolate the specific contribution of katuk leaf phytochemicals and catfish-derived nutrients. Standardized monitoring protocols for hydration, dietary intake, breastfeeding frequency, and maternal stress levels must be implemented to minimize confounding influences. Equally important is the inclusion of objective biomarkers; such as serum prolactin and oxytocin concentrations, mammary gland perfusion indices, and validated measures of milk ejection efficiency to provide physiological evidence supporting or refuting the hypothesized mechanisms of action.

Only through the application of these rigorous methodological approaches [21,22] can researchers accurately determine the true clinical impact of katuk leaf-fortified catfish nuggets on lactation outcomes. Such evidence is critical not only for advancing scientific understanding but also for informing maternal nutrition policies, guiding community health programs, and supporting culturally appropriate interventions aimed at improving breastfeeding success and maternal-infant health.

CONCLUSION

This descriptive case study indicates a positive upward trend in breast milk production among all participants following the two-week consumption of katuk leaf-fortified catfish nuggets. The observed improvements are biologically plausible given the lactogenic phytochemicals in *Sauropus androgynus* and the nutritional support provided by catfish protein. However, due to the very small sample size, absence of controls, and multiple confounding factors, these findings cannot be interpreted as evidence of causal effectiveness. More rigorous studies, particularly randomized controlled trials with larger samples are required to validate the lactogenic potential of this functional food formulation.

Ethical consideration, competing interest and source of funding

- This study adhered to ethical principles for research involving human participants. All mothers were informed about the study objectives, procedures, potential benefits, and voluntary nature of participation. Written informed consent was obtained prior to data collection. Confidentiality was maintained by anonymizing participant identities, and all data were used solely for research purposes.
- There is no conflict of interest related to this publication.
- Source of funding is authors.

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