Indian Research Journal of Extension Education

RESEARCH ARTICLE

Influence of *Shatavari* (*Asparagus racemosus*) Root Powder in Increasing Mothers Milk Output and Infants Weight Gain

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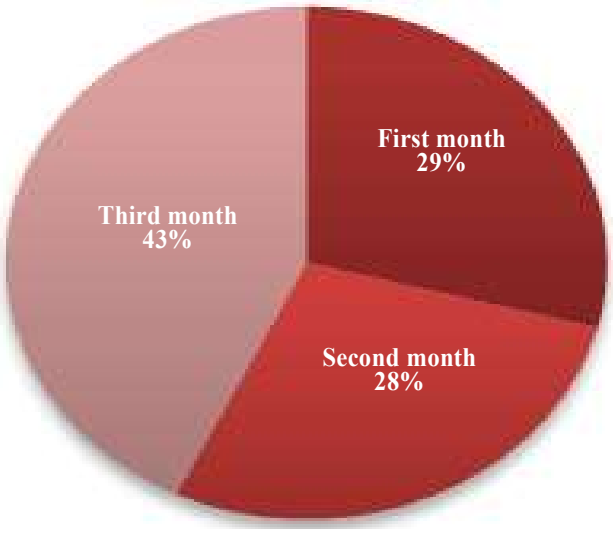
HIGHLIGHTS

- *Shatavari* root powder supplementation enhanced maternal milk output through its influence on prolactin levels, potentially aiding lactating mothers in sustaining adequate breastfeeding.
- Infants receiving breast milk from mothers supplemented with *shatavari* root powder demonstrate improved weight gain, suggesting a positive correlation between milk output and infant growth.
- The inclusion of *shatavari* root powder in the maternal diet presented a natural and potentially effective approach to support both maternal lactation and infant weight gain, offering a holistic solution to address breastfeeding challenges and promote optimal infant nutrition.

GRAPHICAL ABSTRACT

Percentage increase of milk output and infant weight



ARTICLE INFO

Editor:
Dr. Satyapriya

Key words:
Infant weight-gain, Health, Lactation, Milk production, Prolactin, Shatavari root powder

Received : 30.01.2024
Accepted : 25.02.*2024*
Online published : 01.04.2024

doi: 10.54986/irjee/2024/apr_jun/ 42-50

ABSTRACT

Context: Shatavari (*Asparagus racemosus*), has a historical association with promoting lactation and fostering reproductive health in women. Its role in stimulating the production of milk in lactating mothers has been linked to its ability to increase levels of prolactin, a hormone crucial for milk production.

Objective: The present study delved into the effects of administering *shatavari* root powder (SRP) orally on both the lactation process and the infants weight gain.

Method: The study involved a randomized controlled trial of sixty postpartum women, half of them were given 10g of *shatavari* root powder (SRP) every day for duration of three months.

Results and Discussion: The average milk production among women having SRP was found to be 570,690.42 and 756.20ml/day whereas it was 510.7, 620.70 and 645.74ml/day among control group for first, second and third months. The study found a significant positive association (p<0.05) between milk output and infant weight with maternal education and family income. However, no significant association (p<0.05) was observed with mothers' occupation.

Significance: These findings shed light on the promising potential of *shatavari* as a natural supplement to support maternal health and contribute to positive outcomes for newborns, offering a natural and holistic approach to enhance lactation and promote overall maternal and infant well-being. Lactating women found this technology highly effective, low cost and easy to adopt as it can be easily prepared at home.

Breastfeeding plays a pivotal role in promoting the health and well-being of both mothers and infants, has been extensively documented and acknowledged in the medical community (Johnston *et al.,* 2012; WHO, 2003). According to the World Health Organization (WHO), exclusive breastfeeding, with no additional liquids or solids, is recommended for the first six months of an infant's life, followed by a continued period of breastfeeding for at least two years (WHO, 2003). The term "any breastfeeding," refers to the practice of feeding infants with a combination of breast milk and other forms of liquids or solids (Chayal and Dagar, 2017). In the early years, breastfeeding operates within a symbiotic biological system, with the mother's ability to produce and supply sufficient milk contingent upon feedback from the infant, contributing significantly to the child's physical, motor, socio-emotional, and intellectual development (Kent, 2007; Kaur *et al.,* 2016). During the first five years of life, a mother serves as the primary provider of essential care for her child, and her awareness of nutrition plays a pivotal role in the well-being and health of children in the 0-5 age group (Kaur *et al.,* 2015). At this stage, if the child does not receive adequate nutrition, there is a risk of suffering from malnutrition, which can significantly impact the child's physical and cognitive development on later life (Maurya and Maurya, 2005). Successful breastfeeding hinges on maternal mammary tissue integrity, functional nerves and ducts, and a supportive hormonal environment (Kent *et al.,* 2012; Livingstone, 1997; Marasco, 2020), suggesting importance of vegetables in food system (Noopur *et al.*, 2023). Critical factors for successful breastfeeding include proper positioning and attachment of the infant during feeds and fostering a feeding schedule that accommodates day and nighttime breastfeeding (Fooda, 2020). On average, exclusively breastfed infants approximately partake between 750 ml to 900 ml daily, although variations exist, with some thriving infants reported to consume anywhere from 478 ml to 1356 ml (Kent *et al.,* 2006; Nielsen *et al.,* 2011). When breastfeeding progresses smoothly, most infants are likely to regain their birth weight by the time they are 7 days old.

It is not uncommon for women who breastfeed to express concerns about their milk production capability, often leading to premature termination of breastfeeding (Amir, 2006; Brown *et al.,* 2014; Wagner *et al.,* 2013). These worries, however, may sometimes be based on misunderstandings rather than actual insufficiencies (Stuebe *et al.,* 2014). While quantifying the prevalence of inadequate milk production is challenging, it is essential to account for various factors influencing it, such as maternal and neonatal health, effective breastfeeding attachment, feeding frequency, maternal well-being, confidence, support from family and peers, issues like nipple pain, and the use of supplementary bottle feeds (Amir, 2006).

In the current context of modern lifestyles, challenges in lactation are closely linked to factors like sleep deprivation, disrupted hormonal balance and increased stress (Chand *et at.,* 2006). These issues are exacerbated by a lack of nutrition knowledge within affected groups and the widespread unavailability of resources, which collectively serve as the primary contributors to these nutritional deficiencies (Kumari *et at.,* 2016). A recent study postulated that lower insulin sensitivity might lead to the upregulation of a gene responsible for regulating the insulin signalling pathway, consequently contributing to reduced milk production (Lemay *et at.,* 2013). Furthermore, ineffective milk removal by the infant can also contribute to low milk production in the mother, as successful lactation is contingent upon both the quantity of milk extracted and the quality of the suckling stimulation (Geddes *et al.,* 2008; Zhang *et al.,* 2016).

Certainly, in cases of insufficient lactation, lactating mothers are often advised to consider incorporating natural galactagogues, which are herbs known for their potential to stimulate and enhance breast milk production (Gabay, 2002; Penagos *et al.,* 2014). Galactagogues are distinct from essential nutrients crucial for lactation, and while supplementing these nutrients can improve lactation. Mothers who prefer non-pharmacological approaches have access to a wide range of natural galactagogues. Some well-known natural galactagogues include fenugreek, fennel, blessed thistle, torbangun leaves, shatavari, anise, milk thistle, barley, malunggay, and goat's rue. These herbs have been recognized for their potential to enhance lactation and popular choice for mothers seeking to naturally improve milk production (Abascal and Yarnell, 2008; Bingel and Farnsworth, 1994; Bruckner, 1993; Marasco, 2020; Sim *et al.,* 2014). These have been used for generations by women worldwide to boost milk production, especially in traditional cultures where foods and herbs play an integral role in overall health practices. New mothers

are often provided with specific foods or beverages to support ample milk supply for their infants (Jacobson, 2016; Rajith *et al.,* 2010).

Shatavari (Asparagus racemosus), a natural galactagogue herb, has been associated with stimulating milk production in lactating mothers due to its capacity to increase prolactin levels, an essential hormone for milk synthesis (Alok *et al.,* 2013). This effect has been attributed to the presence of bioactive compounds in *shatavari* that act as prolactin promoters, thereby enhancing the overall process of lactation. Estrogens serve as a critical regulator of prolactin production by promoting the expansion of prolactin-producing cells and directly stimulating prolactin synthesis while inhibiting dopamine. *Shatavari* also contains tryptophan, an indispensable amino acid that can potentially stimulate prolactin production, thereby contributing to heightened milk synthesis (Hajela, 2015). *Shatavari* is commercially available in various forms, including powder, sprinkles, granules, capsules and more and can also be grown in kitchen gardening to make it available at household level (Noopur *et al*., 2021). It's worth noting that some of these formulations contain elevated sugar content, often added to conceal the naturally bitter taste of *shatavari*. Furthermore, a majority of these *shatavari* products require mixing with milk, juice, or incorporation in food, underscoring the significance of palatability and taste as important considerations. Given the significance of *shatavari*, the current study was designed to investigate the effects of administering 10g/day of *shatavari* root powder (SRP) orally for a period of three months to experimental group. The research was undertaken to assess the influence of *shatavari* root powder (SRP) intervention on milk production in lactating women and its consequent impact on infant's weight gain. The study included comparisons between control and experimental groups, alongside an analysis of its correlation with a range of dependent and independent variables.

METHODOLOGY

The present study was conducted in collaboration between Chaudhary Charan Singh Haryana Agricultural University and *Vishnu Devi Janana* Hospital in the Hisar district of Haryana state. A group of one hundred pregnant women in their last trimester were screened at the maternity hospital, with sixty of them being randomly selected for voluntary participation in the study. Before enrolling the participants, specific criteria were adhered to. Participants between the ages of 20 and 40 years without chronic illnesses and full-term pregnancy was included, while those who had undergone C-section, had congenital heart disease, or were taking medications were excluded from the study. These sixty women were equally divided into two groups, namely the control and experiment groups. The experiment group was administered 10g of *shatavari* root powder (SRP) daily for duration of 90 days. All the selected lactating women were advised to follow the balanced diet. The study closely monitored the milk output among lactating women and the weight of infants during the first, second, and third month of the lactation period in both the control and experiment groups. Following the intervention period, a detailed comparison was conducted between the control and experiment groups to thoroughly assess the effects of *shatavari* root powder (SRP). The collected data were subjected to rigorous quantitative analysis to derive meaningful insights and conclusions. Statistical analysis of the data was performed using the SPSS software, specifically IBM version 23.0 for Windows, ensuring a systematic and reliable examination of the dataset. During the study, the mean values for milk output and infant weight in the control and experiment groups were compared for the first, second, and third months of the lactation period using a two-sample t-test. Statistical significance was attributed to *p*-values less than 0.05. Before the commencement of the study, written consent was acquired from all chosen participants to ensure their voluntary engagement in the research inquiry.

For the experimental groups, fresh *shatavari* roots were procured from the Medicinal, Aromatic, and Underutilized Plants Section of the Department of Genetics and Plant Breeding at CCS Haryana

Fig.1 Location of current research

Agricultural University in Hisar (29°08'58.7"N 75°041'39.1"E).

Prior to distribution, these *shatavari* roots underwent a thorough cleaning process using running water to eliminate any dirt or impurities. To mitigate their natural bitterness, the roots were blanched at 80°C for 3 minutes and subsequently dried in an oven at 60±5^{O}C until they reached an adequately dried state. The dried *shatavari* roots were then finely ground into a powder and sifted through a 60-mesh sieve to ensure uniform texture. The resulting SRP was carefully packaged in 250-gram quantities in low-density polyethylene (LDPE) bags, labelled and distributed to the lactating women participating in the experimental group. This procedure was implemented to enhance the palatability and ease of use for the recipients.

To assess milk output, a comprehensive measurement process was conducted over three consecutive days during the first, second, and third months of lactation. This involved recording the infant's weight before and after feeding, as well as the hand expression of milk from each breast. Hand expression was performed by gently applying rhythmic pressure on the nerve, while holding the nipple between the thumb and forefinger. The milk was collected in a sterilized bowl and subsequently measured using a 100ml capacity measuring cylinder. This meticulous methodology ensured accurate and consistent data collection for the evaluation of milk production among the participating lactating women. Throughout the study, the weight of the infants was measured periodically to track their growth milestones. These measurements were taken immediately after birth and then continued during the first, second and third months of the lactation period. The weight measurements were recorded using a reliable Crown analogue personal baby weighing scale, ensuring accurate and consistent data collection.

RESULTS

The average milk output of lactating women during three months of intervention period is outlined in Table 1. The present research revealed that the control group of lactating women recorded an average daily milk output of 510.7ml during the first month of lactation, which increased to 620.70ml in the second month and further to 645.74ml per day. Similarly, the experiment group also showed a similar trend, with their daily milk output significantly (p<0.05) increasing from 570.0ml in the first month to 690.42ml in the second month and further to 756.20ml during the third month of lactation (Table 1; Fig.2) consumed SRP10 gram daily for three months.

Table 1. Milk output during first three months of lactation period

Duration	Milk output (ml/day)		t-value
	Control group (n=30)	Experiment group (n=30)	
First Month	510.7±16.83	570.0±13.15*	2.59
Second Month	620.70±14.84	690.42±24.28*	4.18
Third Month	645.74±16.18	756.20±29.43*	6.71

Values are mean ±SD * Significant at 5% Level

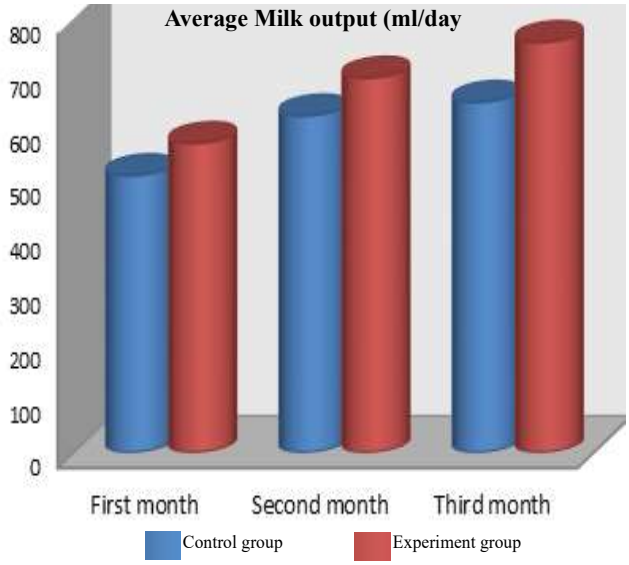


Fig. 2 Average milk output (ml/day) for three month

Throughout the study, both the control and experiment groups consistently observed an escalation in milk output over the three-month period. Notably, the group receiving 10g of *shatavari* root powder (SRP) daily experienced a substantially greater percentage increase in milk production, recording values of 11.6 per cent, 11.2 per cent and 17.1 per cent during the first three months in comparison to the control group (Fig.1). This effect can be attributed to *shatavari's* known ability to stimulate the secretion of the hormone prolactin. Prolactin is essential for initiating and sustaining lactation in breastfeeding mothers. By enhancing the release of prolactin, *shatavari* contributes to heightened breast milk production, providing valuable support for lactating women throughout their breastfeeding journey.

Table 2 depicts the results of the mean infant weight in both the control and experiment groups. The analysis

did not reveal any significant (p<0.05) difference in infant birth weight between the control and experiment groups. The initial mean infant birth weight was 2.69 kg in the control group and 2.68 kg in the experiment group. The present results are in accordance with the study by Joshi (2018), which indicated that a significant proportion of infants fell within the birth weight range of 2.5 to 3 kg, with additional clusters observed below 2.5 kg, between 3.1 and 4 kg, and above 4 kg. Over the three-month intervention period, both groups noted an increase in infant weight, with a more pronounced increase seen in the experiment group where lactating women were administered 10g of *shatavari* root powder daily. Specifically, the infant birth weight in the control group increased from 2.69 kg to 4.33 kg during the first three months of lactation. In the experiment group, the infant birth weight increased from 2.68 kg to 4.98 kg over the subsequent three months of lactation as detailed in Table 2.

The consumption of *shatavari* root powder (SRP) has been associated with a notable increase in milk output, which subsequently contributes to an augmentation in the weight of the infants, thereby supporting their overall health and development. This improvement in infant health can lead to enhanced immunity, better growth and development, and reduced susceptibility to various ailments, establishing a strong foundation for their well-being in the long run.

Table 2. Infant mean weight during first three months of lactation

Average child weight (kg)	Control group (n=30)	Experiment group (n=30)	t-value
Birth weight	2.69±.29	2.68±.23	0.24
First Month	3.31±.35	3.62±.38*	3.02
Second Month	3.83±.37	4.27±.52*	4.46
Third Month	4.33±.47	4.98±.57*	4.77

Values are mean ±SD * Significant at 5% Level

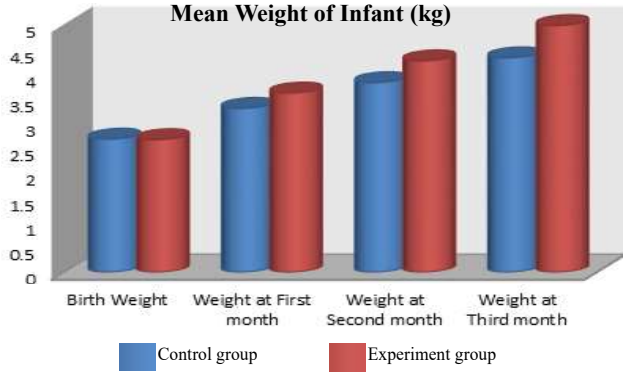


Fig. 3 Mean weight of infant (kg) for three month

Moreover, infants in the experiment group revealed weight gains of 9.4 per cent, 11.5 per cent, and 15.0 per cent during the first, second, and third month, respectively, compared to the control group (Fig.3). The results are consistent with the earlier investigation by Gupta and Shaw (2011), which demonstrated the notable impact of *shatavari* root powder on the escalation of infant weight (16.13±3.65) over a 30-day period of consumption than control (5.68±2.57) group. Additionally, the research by Alok *et al.,* (2013) corroborates the findings of the current study.

The data in Table 3 demonstrated the relationship between dependent and independent variables, revealing a positive correlation between milk production, infant weight, and prolactin levels in lactating women with their energy, protein and fat intake, as well as consumption of galactagogue foods. Additionally, it was observed that the independent variables i.e. educational level and family income of lactating women were positively (p<0.05) associated to both infant weight and milk production. This positive correlation suggests that as the educational attainment and income level of mother's increase, both milk production and infant weight gain tend to rise as well (Kaur *et al.,* 2014). The education level of mothers can significantly impact on infants' weight and overall health. It influences nutrition awareness and healthy practices, leading to improved lifestyle choices. Moreover, higher education can provide better access to healthcare resources (Singh *et al.,* 2015) and a supportive environment for a child's well-being (Liu *et al.,* 2008). This highlights the substantial influence of socio-economic aspects in fostering positive breastfeeding outcomes and promoting infant development.

Several factors, including infant suckling and demand, hormonal regulation, and physical well-

Table 3. Coefficient of correlation between dependent and independent variables

Variables	Milk output	Infant weight	Prolactin level
Energy	0.51*	0.45*	0.23*
Protein	0.48*	0.51*	0.28*
Fat	0.61*	0.36*	0.21*
Galactogogues Food	0.72*	0.45*	0.34*
Lactating women's Education	0.33*	0.41*	0.10^{NS}
Lactating women's Occupation	-0.29	0.11^{NS}	0.08^{NS}
Family Income	0.31*	0.21*	0.12^{NS}
Lactating women's sleeping hours	0.42*	0.46*	0.34*

*Significant at 5% level, NS-Non-Significant

being, can impact prolactin levels, while independent variables do not appear to have a significant (p<0.05) correlated with prolactin levels. Additionally, a negative association was noted between milk output and the occupation of lactating women. The duration of sleep among lactating women during their lactation period significantly (p<0.05) influences both milk production and infant weight. A longer duration of sleep for lactating women's is correlated with higher prolactin levels and increased milk output, resulting in greater infant weight gain. These findings align with the study by Glasier *et al.,* (1984), which also indicates a correlation between a mother's sleep duration and her serum prolactin levels. This connection is particularly important as prolactin levels are naturally higher during the night, making night-time breastfeeding beneficial for sustaining milk supply.

The recent study highlighted the potential of *shatavari* root powder (SRP) in accelerating the onset of breast fullness, thus facilitating early lactation. This is particularly significant for infant health, as they benefit from receiving rich and nutritious milk supply during this critical period of development. This effect can reduce the necessity for supplementary water or top feeds, benefiting both mothers and infants. The study's key strength lies in its incorporation of serum prolactin level measurements, which offered valuable insights supporting the clinical observations concerning milk production and infant weight gain. By fostering connections between different age groups within the social system, we can further tap into the richness of traditional knowledge and promote its use (Dudi and Singh, 2007).

DISCUSSION

Maternal milk output: The current study's findings regarding maternal milk output are consistent with previous research conducted by *Birla et al.* in 2022. Birla et al. found that oral supplementation of *Shavari* Bar, a product containing *shatavari,* during the initial five days postpartum resulted in a significantly higher average total milk output of 64.74 ml compared to the placebo group, which had an average output of 49.69 ml (p=0.008). Moreover, the results of the present study are supported by the research conducted by Ikhlasiah *et al.* in 2020. This suggests a consistent trend across studies, indicating that *shatavari* supplementation may indeed positively impact maternal milk output during the early postpartum period. Such findings could have important implications for maternal and infant health, highlighting the potential benefits of *shatavari* supplementation in lactating women. The trend identified in the present findings is also corroborated by Gupta and Shaw (2011). The findings of the current study align with those of Bumrungpert *et al.,* (2018), who conducted a double-blind randomized trial consuming natural galactagogues (fenugreek, ginger and turmeric) in the form of three capsules three times daily for four weeks to postpartum mothers. Their study demonstrated a significant (p<0.05) 49 per cent increase in milk volume at week two and a substantial 103 per cent increase at week four, as compared to the placebo group and further reinforces the potential efficacy of natural galactagogues in increasing milk volume among postpartum mothers, suggesting a promising avenue for supporting breastfeeding mothers in enhancing their milk supply. Similarly, Espinosa (2005) provides further support for the current findings, highlighting that the average breast milk significantly increased (p<0.05) from 18 ml (23%) on day 3 postpartum to 245 ml (162%) on day 10 postpartum in those who consumed malunggay (Prolacta) leaves through a commercial capsule preparation of 350 mg, taken as two capsules once daily. Nordin *et al.,* (2019) found that the consumption of lactogenic properties of banana flower (*Musa x paradisiaca*) in the form of biscuits (50:50:: banana flower: wheat flour) had positive effects on lactating women. Although the intervention did not significantly affect the mothers' BMI, the BMI for age index among the infants showed a notable difference after the intervention, indicating that the lactogenic biscuits contributed to the infants' growth status (p<0.05). This indicates a potential correlation between the intervention and reduction in child malnutrition. The research conducted by King *et al*., (2013) consistent with the current findings, demonstrating that the intake of galactagogue herb moringa capsules led to a substantial increase in milk production. Specifically, there was a noteworthy increase of 23.09 ml, 31.78 ml, and 123.87 ml observed on the 4th, 5th and 7th day of lactation in comparison to the placebo group. Furthermore, the results indicated a significant (p<0.05) enhancement in infant weight attributed to the consumption of moringa capsules, while no statistically significant impact was observed on maternal weight.

Infant weight gain: The results regarding infant's

weight gain are consistent with the earlier investigation by Gupta and Shaw (2011), which demonstrated the notable impact of *shatavari* root powder on the escalation of infant weight (16.13±3.65) over a 30-day period of consumption than control (5.68±2.57) group. Additionally, the research by Alok *et al.,* (2013) corroborates the findings of the current study. The study conducted by Ravi and Joseph (2020) showcased that the administration of 7.5g of fenugreek, soaked overnight, resulted in a significant increase in infant weight, with recorded values of 2.2kg, 2.3kg, 2.6kg, and 2.8kg on the first, third, fifth, and seventh day of postpartum, respectively. These results were compared to the corresponding infant weights in the control group, which were observed to be 2.7kg, 2.6kg, 2.5kg, and 2.5kg on the same respective days. Therefore, the researchers concluded that galactagogues are effective in promoting and enhancing breast milk production and infant weight, with no adverse effects observed during the lactation period.

Coefficient of correlation between dependent and independent variables: Infant weight and health is strongly linked to the energy and protein intake of the mother during pregnancy and lactation. Adequate protein intake supports the development of the infant's musculature, tissues, and organs, promoting healthy growth and overall development. Additionally, maternal protein consumption can influence the quality and quantity of breast milk, providing essential nutrients necessary for the infant's optimal health (Giyawati *et al.,* 2021). Moreover, Nilsson *et al.,* (2009) corroborate the current findings by establishing a connection between maternal dietary protein intake and serum prolactin levels. Prolactin, during lactation, is known to inhibit the production of fat cells and glucose absorption, facilitating the transfer of energy sources to the mammary gland for enhanced milk production. The findings of the current research are consistent with those of prior studies conducted by Bantuchai *et al.,* (2017), which indicated a significant association ($p< 0.05$) between the intake of specific traditional galactagogues and human milk volume. Notably, the consumption of certain items such as banana flower, lemon basil, Thai basil, bottle gourd, and pumpkin demonstrated a positive correlation with the increase in milk output. Prolactin also promotes relaxation and better sleeps quality for breastfeeding mothers, even if they nurse during the night. Through the regulation of milk production and breastfeeding patterns, prolactin indirectly contributes to the infant's overall health and development, supporting various aspects such as immune function, growth, and cognitive development (Huang and Chih, 2020). The mechanisms regulating prolactin secretion at night and in response to suckling are relatively distinct. Ruan *et al.,* (2022) also corroborate the current findings.

CONCLUSION

Perceived inadequacy of breast milk often leads to actual insufficiency, setting off a detrimental cycle of supplementary feeding, reduced suckling, and decreased milk synthesis. This cycle may have long-term consequences for the physical and mental health of children in their later life. Over the course of a comprehensive three-month investigation, the daily consumption of 10g of *shatavari* root powder (SRP) led to a noteworthy and statistically significant ($p<0.05$) improvement in milk output among the lactating women. This increase was consistently progressive throughout the duration of the study. Moreover, infants whose mothers received SRP showed a considerable weight gain over the same three-month period, highlighting the potential advantages of *shatavari* for both lactating mothers and their infants. The research findings strongly support the safety and efficacy of *shatavari* root powder (SRP) in augmenting breast milk production, highlighting its potential as a natural and beneficial intervention for lactating mothers. Furthermore, the utilization of SRP has demonstrated encouraging effects on both maternal and infant health, promoting the weight gain of infants and contributing to their overall nourishment. These findings emphasize the importance of *shatavari* as a reliable and safe option for enhancing the health and development of infants during their crucial early stages.

Funding: No funding source for conducting the research.

Declaration of competing interest: The author declares no conflict of interests with respect to the article.

Data Availability: Data would be available on request.

Appendix: Supplementary data, including tables and graphs, in JPEG format are provided as an appendix for online visibility to the readers.

Author's contribution: The study's conceptualization and operationalization were a joint effort between the first and second authors, encompassing design, analysis, data collection, and writing. The third author contributed to editing and reviewing the results.

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