INTERNATIONAL JOURNAL OF HEALTH & MEDICAL RESEARCH

ISSN(print): 2833-213X, ISSN(online): 2833-2148

Volume 04 Issue 11 November 2025

DOI : 10.58806/ijhmr.2025.v4i11n08

Page No. 641 - 646

Development of Biscuits from Winged Bean Seeds (Psophocarpus tetragonolobus L) as a Primary Source for Enhancing Breast Milk Production to Reduce Stunting Rates in Aceh Province, Indonesia

Ampera Miko[1], Rachmawati[2], Andriani. MS[3], Wiqayatun Khazanah[4], Iskandar[5], Abdul Hadi[6]

[1,2,3,4,5,6]Department of Nutrition, Politeknik Kesehatan Kemenkes Aceh, Aceh Besar, Aceh, Indonesia.

ABSTRACT:

Background: Breast milk is the optimal source of nutrition for infants, and adequate maternal nutrition is critical to ensure its quality and volume. Winged bean (Psophocarpus tetragonolobus L.) is a nutrient-rich legume containing up to 46.01% protein and essential amino acids, making it a potential functional ingredient for developing high-protein foods for lactating mothers. This study aimed to evaluate the sensory acceptability and consumption levels of biscuits made with winged bean seed flour among breastfeeding mothers in Aceh Province, Indonesia, a region with persistently high stunting rates despite ongoing nutritional programs.

Methods: The research was conducted in two phases. Phase I involved a true experimental design in a controlled laboratory setting using rabbits (Oryctolagus cuniculus) to evaluate the safety and potential physiological effects of the formulated biscuits. Phase II employed a qualitative organoleptic test to assess sensory attributes (color, taste, aroma, and texture) and residual portions of biscuits consumed by 40 breastfeeding mothers from three villages in the Lampisang Community Health Center area, Aceh Besar District, from 11 to 17 July 2025. Data were analyzed using univariate and bivariate approaches, with Analysis of Variance (ANOVA) applied at a significance level of $\alpha = 0.05$.

Results: The mean sensory scores were 1.93 for color, 2.60 for taste, 2.63 for aroma, and 2.98 for texture (on a 3-point scale), with texture receiving the highest rating, described as “crispy and dry.” Residual biscuit analysis indicated a mean value of 0.325, suggesting minimal leftover portions and high overall consumption. ANOVA results showed no statistically significant differences ($p > 0.05$) between sensory parameters and leftover amounts, indicating consistent acceptability across all attributes.

Conclusion: Biscuits made from winged bean seed flour were well-accepted by breastfeeding mothers and demonstrated potential as a functional food to support maternal nutrition and breast milk production. Further research is recommended to evaluate nutrient bioavailability, long-term effects on lactation outcomes, and strategies to optimize large-scale production.

KEYWORDS: Breastfeeding mothers, Winged bean biscuits, Sensory acceptability, Maternal nutrition, Functional food

INTRODUCTION

Globally, an estimated 150.2 million children under five years of age were affected by stunting in 2024, representing approximately 23.2% of this age group, a decline from 26.3% in 2012. However, the burden remains disproportionately concentrated in Asia (51%) and Africa (43%)(Swinburn et al., 2019; Victora et al., 2016). At the current pace, the global target to reduce the number of stunted children to 90 million by 2030 is unlikely to be achieved, with projections indicating that approximately 46 million children will remain stunted beyond the target year(Andriani et al., 2025; Laksono et al., 2024; Siramaneerat et al., 2024). In Indonesia, substantial progress has been made, with national stunting prevalence declining to 19.8% in 2024 from 21.5% in 2023, marking the first time the rate has fallen below the World Health Organization (WHO) threshold of 20%. Nevertheless, the government aims to further reduce the prevalence to 14.2% by 2029, requiring sustained, evidence-based, and regionally targeted interventions, as several provinces still report alarmingly high prevalence rates exceeding 30%, including Central Papua (39.4%), East Nusa Tenggara (37.9%), Papua Highlands (37.3%), Southwest Papua (31.0%), West Sulawesi (30.3%), and Southeast Sulawesi (30.0%)(Amriviana et al., 2023; Djaiman et al., 2025).

During pregnancy, a woman’s body undergoes profound physiological changes to prepare for lactation, ensuring the production of breast milk, which remains the most optimal and biologically tailored source of nutrition for infants even prior to birth(Beal et al., 2018; Purwanti et al., 2025). One promising strategy to support lactating mothers while addressing stunting—the chronic outcome of prolonged inadequate nutrition and impaired growth—is the utilization of locally available, nutrient-dense plant-based resources

such as winged bean (Psophocarpus tetragonolobus L.), an underutilized tropical legume recognized for its exceptional nutritional profile. Nearly all parts of the plant—leaves, flowers, tubers, and seeds—are edible and rich in nutrients, including protein, vitamins A and C, calcium, and iron. Its seeds contain approximately 35–40% protein and 18% fat, with an amino acid profile notable for high lysine content comparable to soybeans and superior levels of isoleucine, tyrosine, threonine, and valine, though sulfur-containing amino acids such as methionine and cystine are relatively low(Chandran et al., 2023). Protein quality indicators, including a protein efficiency ratio (PER) of around 2.14 and a biological value (BV) of approximately 69.9%, suggest good nutritional potential, though the presence of anti-nutritional factors necessitates appropriate processing to optimize digestibility(Gilani et al., 2012; Kaur Arora, 2023).

Given these attributes, developing biscuits made from winged bean seed flour presents a practical, shelf-stable, and culturally acceptable solution that caters to the dietary needs of lactating mothers, who often require convenient and nutrient-rich foods. This study aims to analyze the effects of incorporating winged bean seed flour into biscuit formulations on sensory acceptance and consumption levels (i.e., leftover rates) among breastfeeding mothers, a key target group for nutritional interventions aimed at improving breast milk quality and quantity. The relevance of such an approach is particularly pronounced in Aceh Province, where, despite a decline in stunting prevalence from 33.2% in 2021 to 28.6% in 2024, the rate remains among the five highest in Indonesia. Multi-sectoral initiatives, such as the BKKBN "Genting" program, which mobilizes over 800 civil servants to provide nutrient-rich ready-to-eat meals worth IDR 15,000 per day for children in their first 1,000 days of life, alongside sanitation improvements, have contributed to recent reductions. However, Aceh's prevalence remains well above both the national target of 14% and the WHO threshold of 20%, underscoring the urgency of complementary, food-based innovations to strengthen maternal and infant nutrition. Integrating winged bean–based biscuits into maternal diets may enhance nutrient intake, support breastfeeding success, reduce food waste, and ultimately contribute to stunting reduction through improved early-life nutrition and maternal health, offering a sustainable, context-specific, and scalable solution within Aceh's broader stunting reduction framework.

RESEARCH DESIGN

This research was conducted through a two-phase design, employing both experimental and qualitative methodologies to ensure comprehensive analysis and reliable results. The first phase, conducted in Year I, utilized a true experimental design to perform clinical trials under controlled laboratory conditions using rabbits (*Oryctolagus cuniculus*) as experimental animals. The objective of this phase was to evaluate the potential physiological effects and safety of the formulated biscuits prior to human acceptability testing. Laboratory procedures adhered to standard experimental protocols, ensuring ethical compliance and reproducibility of results. In the second phase, carried out in Year II, a qualitative acceptability test employing organoleptic evaluation was conducted among breastfeeding mothers. This phase aimed to assess the sensory attributes of the biscuits—including taste, aroma, texture, and overall acceptability—as well as their potential for integration into the mothers' daily diet. The population targeted for this phase consisted of breastfeeding mothers residing within the working area of the Lampisang Community Health Center (Puskesmas), Peukan Bada Subdistrict, Aceh Besar District. Sampling was conducted purposively across three villages: Ajuen, Keuneu Eu, and Payatieng. A total of 40 breastfeeding mothers participated in the study, with data collection scheduled between 11 July and 17 July 2025. All participants were provided with detailed information regarding the study objectives and procedures, and informed consent was obtained prior to data collection. Data analysis for the second phase was performed using both univariate and bivariate approaches. Univariate analysis was applied to describe the distribution of variables, including demographic characteristics and sensory evaluation scores, while bivariate analysis was employed to determine statistical differences across variables. The Analysis of Variance (ANOVA) test was utilized as the primary statistical method, with a significance level set at $\alpha = 0.05$. This approach allowed for the identification of meaningful variations in biscuit acceptability across the study sample, ensuring that conclusions were drawn based on statistically valid evidence.

RESULT

Acceptability Characteristics of Biscuits

The sensory evaluation of biscuits was assessed based on four primary parameters—color, taste, aroma, and texture—along with the residual portion of biscuits consumed by breastfeeding mothers. Descriptive statistics for these parameters are presented in Table 1.

Table 1. Descriptive Statistics of Biscuit Acceptability and Residual Portions

Parameter	Minimum	Maximum	Mean	Standard Deviation
Color	1	3	1.93	0.350

Taste	1	3	2.60	0.709
Aroma	1	3	2.63	0.540
Texture	2	3	2.98	0.158
Residual Biscuit	0	3.0	0.325	0.828

The mean score for color acceptability was 1.93, which corresponds to a yellowish-brown hue, considered visually appealing and indicative of proper baking. Taste received a higher mean score of 2.60, indicating that respondents generally perceived the biscuits to have a sweet and savory flavor. Aroma achieved a comparable mean score of 2.63, further supporting the positive flavor profile. Texture received the highest mean score of 2.98, indicating that respondents rated the biscuits as crispy and dry, a desirable attribute for snack foods. The residual biscuit score, measured using the Comstock method, showed a mean value of 0.325, indicating that, on average, there was no significant leftover biscuit (Code 0). This result reflects high product acceptance, as most participants consumed nearly all of the portions provided.

2. Acceptability by Color

Table 2. Acceptability Categories for Biscuit Color

Category	n	%
Pale Yellow	4	10.0
Yellowish-Brown	35	87.5
Brownish	1	2.5
Total	40	100.0

As presented in Table 2, the majority of respondents (87.5%) rated the biscuit color as yellowish-brown, a hue commonly associated with well-baked products. Only 10.0% perceived the biscuits as pale yellow, while one participant (2.5%) described them as brownish, potentially indicating a darker shade than preferred.

3. Acceptability by Taste

Table 3. Acceptability Categories for Biscuit Taste

Category	n	%
Less Sweet	5	12.5
Sweet	6	15.0
Sweet and Savory	29	72.5
Total	40	100.0

Taste was one of the most positively rated parameters. As shown in Table 3, 72.5% of respondents described the biscuits as sweet and savory, which is an appealing combination for most consumers. A smaller proportion rated the biscuits as sweet (15.0%) or less sweet (12.5%), suggesting minor variations in taste preference among participants.

Table 4. Acceptability Categories for Biscuit Aroma

Category	n	%
No Aroma	1	2.5
Savory Aroma	13	32.5
Savory and Sweet Aroma	26	65.0
Total	40	100.0

Table 4 indicates that the majority of respondents (65.0%) rated the biscuit aroma as savory and sweet, while 32.5% rated it as savory only. A small proportion (2.5%) reported that the biscuits had no aroma.

Table 5. Acceptability Categories for Biscuit Texture

Category	n	%
Not Crispy	9	22.5
Slightly Crispy	12	30.0
Crispy and Dry	19	47.5
Total	40	100.0

Table 5 shows that almost half of the respondents (47.5%) perceived the biscuit texture as crispy and dry, while 30.0% described it as slightly crispy, and 22.5% considered it not crispy.

Visual Comstock Method

The Visual Comstock method is a food consumption survey technique based on visual estimation of leftover food portions. In this study, the method was used to evaluate the amount of biscuit remaining after consumption, where each participant was given two biscuits (10 grams) per serving.

Table 6. Acceptability Categories for Biscuit Residual Portions

Residual Portion Category	n	%
Biscuits Fully Consumed (No Leftover)	34	85.0
1/4 Portion Remaining	1	2.5
1/2 Portion Remaining	3	7.5
3/4 Portion Remaining	2	5.0
Nearly Whole Biscuit Remaining	0	0.0
Whole Biscuit (Not Consumed)	0	0.0
Total	40	100.0

Table 6 demonstrates that the majority of participants (85.0%) consumed all biscuits provided, leaving no leftover portion. Only 2.5% left 1/4 portion, 7.5% left 1/2 portion, and 5.0% left 3/4 portion. No respondents left a nearly whole or completely untouched biscuit.

2. Effect of Acceptability Parameters on Biscuit Residues

The effect of acceptability parameters of winged bean biscuits (color, taste, aroma, and texture) on the amount of biscuit residue was analyzed using ANOVA. The results are presented in the following table:

Table 7. Evaluation of Differences in Calorific Value, Taste, Aroma, and Texture of Biscuit Formulations

Parameter	Sum of Squares	df	Mean Square	F	P value
Calor	0.893	3	0.298	2.759	0.056
Taste	1.169	3	0.390	0.761	0.523
Aroma	0.846	3	0.282	0.964	0.420
Texture	4.216	3	1.405	2.377	0.086

The table above shows the acceptability parameters of breastfeeding mothers toward the remaining biscuits consumed, with significance values (P value) greater than the alpha level of 0.05. This indicates that there are no significant differences in the mothers' assessments regarding the leftover biscuits. It also suggests that the biscuits consumed did not result in varying evaluations concerning the leftovers. Therefore, it can be concluded that biscuits made from winged bean seed flour are relevant and acceptable as an alternative food product to help enhance breast milk production**.**

Trend Analysis of Biscuit Acceptability

The following figure illustrates the trend in acceptability ratings of winged bean biscuits by breastfeeding mothers based on four sensory parameters: color, taste, aroma, and texture. Overall, an upward trend was observed across all parameters, indicating generally positive sensory evaluation. Among these, texture received the highest mean score of 2.98 on a 3-point scale, classified as "crispy and dry," which is considered ideal for biscuit products. This finding highlights that texture plays a critical role in consumer satisfaction, often serving as a key determinant of repeat consumption. Color, taste, and aroma also showed favorable ratings, reflecting that the sensory attributes of the product meet consumer expectations.

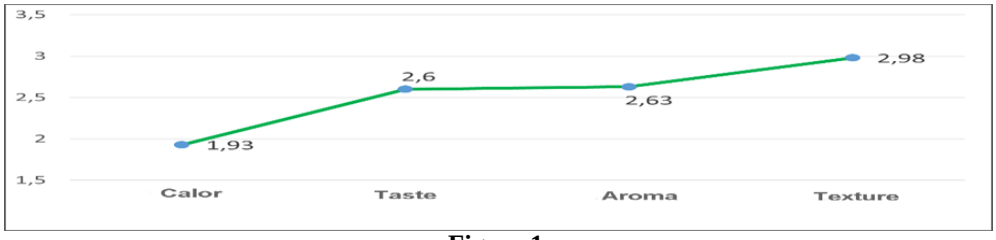

Figure 1.

DISCUSSION

The study examined the acceptability parameters of winged bean biscuits, including color, taste, aroma, and texture, with all parameters showing p-values greater than 0.05, indicating no statistically significant differences in acceptability among breastfeeding mothers. The color parameter ($p = 0.056$) suggests that biscuit color did not significantly affect acceptability, although color is a primary sensory attribute influencing consumer perception and is largely determined by the high protein content (46.01%) of winged bean flour, which undergoes Maillard reactions during baking, producing a characteristic yellowish-brown hue. The taste parameter ($p = 0.523$) revealed no significant difference in acceptability, with the mild nutty flavor and relatively high fat content (26.63%) contributing to a favorable mouthfeel and overall palatability, although cultural and individual taste preferences may still influence real-world acceptance. Aroma ($p = 0.420$) was also not significantly different, with the biscuits exhibiting a mild, non-overpowering legume aroma, supported by processing methods such as soaking and washing to reduce off-flavors, though batch-to-batch variations in production may still pose challenges. The texture parameter ($p = 0.086$) indicated good acceptability, with the biscuits exhibiting desirable crispness and crunchiness supported by their carbohydrate (23.34%), protein, and fat content, although maintaining texture consistency and shelf life under high humidity conditions remains a practical challenge. The findings indicate that winged bean flour biscuits demonstrate good sensory acceptability, highlighting their potential as an alternative food product for breastfeeding mothers. The application of food diversification technology, including fortification with winged bean leaves and seeds, offers a promising strategy for improving maternal nutrition and preventing stunting(Gilani et al., 2012). The high protein content of winged bean seeds (46.01%) can support the nutritional needs of breastfeeding mothers, contributing to the production of high-quality breast milk. Previous studies have shown that protein-rich seeds, such as cowpeas with 24.4 g of protein, can be processed into flour for functional biscuits; thus, winged beans, with even higher protein content, provide an excellent raw material for such products (Miko et al., 2024) that innovative biscuits formulated with chickpea and lentil flours maintained high sensory acceptability despite slight changes in texture and color intensity caused by Maillard reactions, which may also account for the characteristic brownish hue of winged bean biscuits due to their high protein content (46.01%)(Agu et al., 2023; Lazou, 2024). That substituting wheat flour with mung bean and chickpea flours resulted in cookies with improved nutritional composition and favorable sensory evaluations, showing no significant differences in overall acceptability between the two formulations(Felisiak et al., 2024; Topaloğlu Günan et al., 2025). Similarly,(Dilrukshi et al., 2020) found that biscuits fortified with 20% cowpea flour exhibited higher protein, fiber, and mineral content while achieving the best sensory scores, indicating that moderate legume incorporation can enhance both nutritional value and organoleptic quality. Additionally, Michel et al., (2024) emphasized the importance of proper processing techniques—such as soaking, blanching, and controlled baking—in reducing undesirable flavors and ensuring consumer acceptability of legume-based products. Overall, these findings confirm that winged bean flour, with its higher protein content compared to other legumes, is a highly promising raw material for producing functional biscuits that are not only nutritionally rich but also well-accepted sensorially, thereby supporting efforts to improve maternal nutrition and prevent stunting.

CONCLUSION

The winged bean flour-based biscuits demonstrated high acceptability among breastfeeding mothers, as evidenced by positive evaluations of color (87.5% yellowish-brown), taste (72.5% sweet and savory), aroma (65.0% savory and sweet), and texture (47.5% crispy and dry), with the highest mean score of 2.98 on a three-point scale. The Visual Comstock assessment revealed that 85.0% of participants consumed the entire biscuit portion without leftovers, reflecting excellent product acceptance. ANOVA results indicated no significant differences ($P>0.05$) in color, taste, aroma, and texture regarding leftover portions, suggesting consistent consumer assessments. Overall, the biscuits were well-received and hold potential as a nutritious alternative food product to support increased breast milk production among breastfeeding mothers.

REFERENCES

1) Agu, H. O., Ihionu, J. C., & Mba, J. C. (2023). Sensory and physicochemical properties of biscuit produced from blends of whole wheat, soy okara and tigernut residue flours. *Heliyon*, *9*(4). https://doi.org/10.1016/J.HELIYON.2023.E15318

2) Amriviana, M. P., Khairunnisa, C., & Sasongko, T. H. (2023). Parental stature as a risk factor for stunting in Indonesia: A systematic review and meta-analysis. *Narra J*, *3*(2). https://doi.org/10.52225/NARRA.V3I2.144,
3) Andriani, H., Arsyi, M., Sutrisno, A. E., Waits, A., & Rahmawati, N. D. (2025). Projecting the impact of a national strategy to accelerate stunting prevention in East Nusa Tenggara, Indonesia, using the Lives Saved Tool. *Narra J*, *5*(1), 1462. https://doi.org/10.52225/NARRA.V5I1.1462,
4) Beal, T., Tumilowicz, A., Sutrisna, A., Izwardy, D., & Neufeld, L. M. (2018). A review of child stunting determinants in Indonesia. *Maternal and Child Nutrition*, *14*(4). https://doi.org/10.1111/MCN.12617,
5) Chandran, A. S., Suri, S., & Choudhary, P. (2023). Sustainable plant protein: an up-to-date overview of sources, extraction techniques and utilization. *Sustainable Food Technology*, *1*(4), 466–483. https://doi.org/10.1039/D3FB00003F
6) Dilrukshi, N., Torrico, D. D., Brennan, M. A., Brennan, C. S., Brennan@lincoln, M. A., Nz, M. A. B., Brennan@lincoln, C. A., & Nz, C. S. B. (2020). Instrumental and Sensory Properties of Cowpea and Whey Protein Concentrate-Fortified Extruded Rice Snacks. *Proceedings 2021, Vol. 70, Page 95*, *70*(1), 95. https://doi.org/10.3390/FOODS_2020-07704
7) Djaiman, S. P. H., Rizkianti, A., Rachmalina, R., Achjar, K. A. H., Lestari, A. S., & Ruspawan, I. M. (2025). Contextual Risk Factors of Stunting and Severe Stunting among Indonesian Children under 2 Years: Based on Cross-sectional Data from Basic Health Research. *Indian Journal of Public Health*, *69*(1), 50–56. https://doi.org/10.4103/IJPH.IJPH_1276_23,
8) Felisiak, K., Przybylska, S., Tokarczyk, G., Tabaszewska, M., Słupski, J., & Wydurska, J. (2024). Effect of Chickpea (Cicer arietinum L.) Flour Incorporation on Quality, Antioxidant Properties, and Bioactive Compounds of Shortbread Cookies. *Foods*, *13*(15), 2356. https://doi.org/10.3390/FOODS13152356/S1
9) Gilani, G. S., Xiao, C. W., & Cockell, K. A. (2012). Impact of antinutritional factors in food proteins on the digestibility of protein and the bioavailability of amino acids and on protein quality. *British Journal of Nutrition*, *108*(SUPPL. 2). https://doi.org/10.1017/S0007114512002371,
10) Kaur Arora, S. (2023). *An Overview of Importance and Nutritional Evaluation of Food Protein Quality*. https://doi.org/10.31080/ASNH.2023.07.1269
11) Laksono, A. D., Izza, N., Trisnani, T., Paramita, A., Sholikhah, H. H., Andarwati, P., Rosyadi, K., & Wulandari, R. D. (2024). Determination of appropriate policy targets to reduce the prevalence of stunting in children under five years of age in urban-poor communities in Indonesia: a secondary data analysis of the 2022 Indonesian national nutritional status survey. *BMJ Open*, *14*(9). https://doi.org/10.1136/BMJOPEN-2024-089531,
12) Lazou, A. E. (2024). Properties, Structure, and Acceptability of Innovative Legume-Based Biscuits with Alternative Sweeteners. *International Journal of Food Science*, *2024*, 8216796. https://doi.org/10.1155/2024/8216796
13) Michel, M., Eldridge, A. L., Hartmann, C., Klassen, P., Ingram, J., & Meijer, G. W. (2024). Benefits and challenges of food processing in the context of food systems, value chains and sustainable development goals. *Trends in Food Science & Technology*, *153*, 104703. https://doi.org/10.1016/J.TIFS.2024.104703
14) Miko, A., Rachmawati, Andriani, Khazanah, W., Iskandar, & Hadi, A. (2024). Development of Biscuits from Winged Beans (Psophocarpus tetragonolobus L.) as a Primary Source for Milk Production. *South Eastern European Journal of Public Health*, 550–559. https://doi.org/10.70135/SEEJPH.VI.1929
15) Purwanti, E. D., Masitoh, S., & Ronoatmodjo, S. (2025). Association Between Basic Immunization Status and Stunting in Toddlers Aged 12-59 Months in Indonesia. *Journal of Preventive Medicine and Public Health = Yebang Uihakhoe Chi*, *58*(3), 298–306. https://doi.org/10.3961/JPMPH.24.230,
16) Siramaneerat, I., Astutik, E., Agushybana, F., Bhumkittipich, P., & Lamprom, W. (2024). Examining determinants of stunting in Urban and Rural Indonesian: a multilevel analysis using the population-based Indonesian family life survey (IFLS). *BMC Public Health*, *24*(1). https://doi.org/10.1186/S12889-024-18824-Z,
17) Swinburn, B. A., Kraak, V. I., Allender, S., Atkins, V. J., Baker, P. I., Bogard, J. R., Brinsden, H., Calvillo, A., De Schutter, O., Devarajan, R., Ezzati, M., Friel, S., Goenka, S., Hammond, R. A., Hastings, G., Hawkes, C., Herrero, M., Hovmand, P. S., Howden, M., … Dietz, W. H. (2019). The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission report. *The Lancet*, *393*(10173), 791–846. https://doi.org/10.1016/S0140-6736(18)32822-8)
18) Topaloğlu Günan, K., Boğa, T., Çakmak Kavsara, S., Dikeç, İ. E., Yolci Ömeroğlu, P., & Dertli, E. (2025). Gluten-free kömbe made with sprouted flours: nutritional, physicochemical, and sensory evaluation. *CyTA - Journal of Food*, *23*(1), 2527333. https://doi.org/10.1080/19476337.2025.2527333
19) Victora, C. G., Bahl, R., Barros, A. J. D., França, G. V. A., Horton, S., Krasevec, J., Murch, S., Sankar, M. J., Walker, N., & Rollins, N. C. (2016). Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. *The Lancet*, *387*(10017), 475–490. https://doi.org/10.1016/S0140-6736(15)01024-7)