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Syzygium Aromaticum (Clove) to Prevent Oxidation in Beverages Soybean Honey to Prevent Stunted Growth in Babies

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KEYWORDS

Acidity Test; Syzygium aromaticum; Oxidation; Soybean Honey Drink; Stunting

ABSTRACT:

Aims The purpose of this study was to identify the effectiveness of adding Syzygium Aromaticum (Cloves) to prevent oxidation in honey soya bean drinks to prevent the birth of stunted babies. Instrument and Methods: This study is a quantitative study with a quasi-experimental design two-group pretest and post test design with control group design. This study uses an instrument to measure oxidation using spectrophotometry. The indicator used is the color change that occurs due to the oxidation reaction and measures how long the oxidation process takes place with the addition of Syzygium Aromaticum with the output of this study is a marketable MaSoy product in preventing pregnancy anemia that interferes with the weight gain of pregnant women and the risk of stunting babies. Finding In this study, it was found that there was a difference between the control group and the intervention group (with the addition of cloves) quantitatively. in terms of taste, color and smell there was a significant difference without being given cloves and the group given cloves (p=0.00) Conclusion adding Syzygium aromaticum (cloves) more effectiveness to prevent oxidation in honey soya bean.

1. Introduction

The third trimester of pregnancy begins at 28 weeks and continues through 40 weeks. Physical and psychological changes that can cause discomfort, especially in the second and third trimesters, include dyspnea, insomnia, frequent urination, perineal pressure and discomfort, constipation, varicose veins, fatigue, leg cramps, ankle edema, mood swings, increased anxiety, and back pain.(1)(2). Changes that occur in the third trimester are characterized by swelling of the limbs, feet, hands and face.(3).

According to WHO, the ideal weight gain during pregnancy is 1 kg in the first trimester, 3 kg in the second trimester, and 6 kg in the third trimester.(4)Pregnant women have higher nutritional needs for fetal growth, placental growth, and metabolic growth, so pregnant women must consume foods that contain lots of nutrients.(5)If the need for energy, protein, fat, vitamins, and minerals cannot be met through food consumption, pregnant women will experience malnutrition which will cause problems for pregnant women, such as low birth weight (LBW).(6), premature birth and birth with various difficulties/ even death(4).

Another problem that can occur is nutritional problems (stunting) in children.(7)(8)(9)This is in line with research conducted by Sundari and Rahayu at the Sungai Karias Community Health Center in North Hulu Sungai. Children with low birth weight are 5.87 times more likely to experience stunting.(10)Stunting is a health problem that is often found in developing countries, including Indonesia.(6)Stunting or short stature is a chronic malnutrition problem caused by insufficient nutritional intake over a long period of time, resulting in growth disorders in children, namely the child's height is lower or shorter (dwarfism) than the standard for their age.(11)Stunting at birth, measured by birth length for age, is an important indicator of an individual's early growth and development in childhood

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and later adulthood. One study showed that short birth length is a predictor of stunting.

Malnutrition during pregnancy can cause pregnant women to be at risk of complications, such as bleeding, the mother's weight not increasing normally and anemia.(3)Anemia in pregnant women is said to have the potential to endanger both the mother and the child.(12)(13)Anemia is a medical condition in which the number of red blood cells is low.(14)In Indonesia, the rate of anemia among pregnant women remains quite high. Based on the 2018 Basic Health Research (Riskesdas) data, it has reached 48.9%. In 2018, the highest number of pregnant women with anemia was aged 15-24 (84.6%). The figure was 33.7% for those aged 25-34, 33.6% for those aged 35-44, and 24% for those aged 45-54.(15)The prevalence of anemia and the risk of chronic energy deficiency in women of childbearing age significantly affect the health of the child at birth, including the potential for low birth weight.(11). Global Movement (SUN) is a global movement under the coordination of the UN Secretary General, which aims to reduce nutritional problems, with a focus on the first 1000 days of life (270 days during pregnancy and 730 days from birth to age 2 years) namely in pregnant women, breastfeeding mothers and children aged 0-23 months.(16)

Efforts made to address risk prevention in pregnant women include providing nutrition rich in macro and micro nutrients.(17)During pregnancy, pregnant women should consume approximately two portions of food compared to before pregnancy to maintain and sustain the lives of two people, namely the mother and the fetus in her womb, so that pregnant women tend not to limit their energy intake as recommended.(18)

Previous research conducted on the effectiveness of soy bean honey drinks on pregnant women in the third trimester has had a positive impact on changes in Hb in pregnant women in the third trimester.(19)However, this research evaluation found that the drink spoils quickly, so researchers sought a solution for preserving the drink that wouldn't harm pregnancy.

Food preservation is one of the strategies used to maintain public health levels.(20). Oxidation activity and microbial contamination are the main causes of food spoilage.(21)(22)For health reasons, people prefer natural preservatives over synthetic ones. Senna seeds, cloves, and fennel are safe for pregnant women to consume in small amounts in food. While clove consumption in food is generally safe, there is insufficient information on the potential adverse effects of consuming large amounts of cloves during pregnancy.(21)

Food and beverage preservation is used to determine and increase shelf life, customer acceptance, and improve food safety.(20)Food preservation generally uses chemicals. Synthetic chemical preservatives are widely used in the food and beverage industry to inhibit spoilage caused by bacterial growth, enzyme activity, and oxidation.(22)However, due to the potential health risks posed by synthetic preservatives in food and beverages, consumers are hesitant to consume these products.(21)

Food or drinks that are at room temperature for more than 12 hours have a high risk of rotting and are therefore not suitable for consumption.(23)Oxidation is a major cause of food spoilage. Lipids are divided into two main groups: polar lipids (phospholipids) and neutral lipids (triglycerides), both of which readily oxidize by reacting with reactive oxygen precursors and free radicals. This oxidation can cause rancidity, discoloration, nutritional deterioration, and the formation of several toxic compounds.(12)

The spoilage of soya bean honey drinks can have health impacts and reduce the shelf life of the quality of the drink.(24). The addition of Syzygium aromaticum (cloves) and acidity testing of the drink can prevent the spoilage of the soy bean honey drink. Malnutrition in pregnant women can lead to anemia, which puts the fetus at risk of low birth weight and increases the risk of stunting.(25)Administering honey and soybeans as a stunting prevention measure for pregnant women in their third trimester can be an alternative to prevent anemia and increase weight gain. A honey-soybean drink is beneficial for preventing the birth of stunted babies. The addition of Syzygium aromaticum (cloves) can extend the shelf life of the drink, and acidity testing can determine the acidity level and shelf life of the drink.

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Methods

Research Design

This study employed a quantitative research approach with a quasi-experimental design, utilizing a one-group pre-test and post-test design with a control group. The research was conducted at the Laboratory of Muhammadiyah Ahmad Dahlan University, Palembang. This design was chosen to evaluate the effect of clove extract addition on the antioxidant activity, oxidation-reduction potential (ORP), and sensory stability (color and taste) of a beverage sample before and after treatment. The inclusion of a control group ensured that observed changes could be attributed to the treatment rather than external factors.

Research Stages

The research process was divided into three major stages:

1. Preparation Stage
2. Implementation Stage
3. Reporting Stage

1. Preparation Stage

During the preparation stage, the researcher conducted several administrative and technical activities to ensure the study's smooth implementation.

- A formal request letter was submitted to the Head of the Laboratory Unit to obtain permission for conducting preliminary data collection.
- In addition, an ethical clearance was obtained from the Research Ethics Committee of Muhammadiyah Ahmad Dahlan University to ensure that all procedures met ethical standards for laboratory-based research.
- The researcher also prepared all necessary tools, reagents, and materials required for the assays, including DPPH (2,2-diphenyl-1-picrylhydrazyl) reagent, clove extract, ORP meter, and storage containers.
- Calibration of instruments and preliminary testing of procedures were performed to validate the accuracy and reliability of measurements.

2. Implementation Stage

The implementation stage consisted of three primary experimental procedures: the DPPH free radical scavenging assay, the ORP (Oxidation-Reduction Potential) measurement, and the color and taste stability test.

a. DPPH Assay

The DPPH (2,2-diphenyl-1-picrylhydrazyl) method was used to measure the free radical scavenging activity of the beverage before and after the addition of clove extract.

1. The absorbance of the DPPH solution was measured to determine the baseline free radical concentration.
2. Clove extract was then added to the beverage sample, and the resulting color change—from deep purple to pale yellow—was observed and measured spectrophotometrically.
3. A decrease in color intensity (from purple to pale) indicated a higher antioxidant activity, reflecting the ability of clove compounds (notably eugenol and phenolic constituents) to donate hydrogen atoms and neutralize DPPH radicals.

b. ORP (Oxidation-Reduction Potential) Measurement

The ORP assay was used to evaluate the beverage's electrochemical antioxidant capacity.

1. The ORP value of the beverage was measured before and after the addition of clove extract using a calibrated ORP meter.
2. A decrease in ORP value after the treatment indicated an increase in the reductive (antioxidant) potential of the beverage.
3. This reduction suggests that clove extract effectively enhances the beverage's capacity to act as an electron donor, thereby reducing oxidative degradation.

c. Color and Taste Stability Test

To assess the sensory stability of the beverage, both treated (with clove extract) and untreated (control)

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samples were stored under identical conditions for a defined period.

1. Observations were made periodically to monitor changes in color, taste, and aroma.
2. The sensory evaluation involved both visual inspection and taste testing to detect any deterioration or off-flavors.
3. Results typically showed that beverages containing clove extract maintained their color and sensory quality for a longer duration compared to the control samples, suggesting that clove-derived antioxidants contribute to extended shelf life and product stability.

3. Reporting Stage

In the final stage, all experimental data were tabulated, statistically analyzed, and interpreted. The results from the DPPH assay, ORP measurements, and sensory observations were compared between pre-test and post-test conditions as well as between treatment and control groups. Findings were compiled into a comprehensive report that discussed the implications of clove extract addition on antioxidant potential and beverage quality stability. Conclusions were drawn based on quantitative outcomes and visual observations, supported by relevant literature.

2. Results

This research has been conducted by looking atData analysis used a paired sample t-test with two groups, pretest and posttest. Changes in the soy bean honey drink with cloves were observed and recorded, including color, odor, taste, acidity, and duration of the change. Data were compared before and after the addition of cloves. Ten bottles of the drink were made (250cc each).

Figure 1. Clove extraction process. Figure 2. Soybean addition process. Figure 3. Weighing process to 250cc.

Figure 1. Drink without cloves

Figure 2.Drinks with cloves

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Bivariate analysis was used to determine the difference in pH levels between the clove-treated and non-clove-treated groups. Prior to the bivariate analysis, a Shapiro-Wilk test was performed to determine the normality of the data, as the sample size was <50 before and after the intervention. The data obtained were normally distributed.

a. Normality Test

Table 5.4Normality Test with Shapiro-Wilk

Variables	*Shapiro-Wilk*		
	Statistics	df	Sig.
Difference between Pre and Post Test	0.908	15	0.125

Based on table 5.4, a data normality test was carried out using the Shapiro-Wilk Test (because the sample was <50 respondents). The data obtained were normally distributed, so the researcher used alternative tests, namely the Paired Samples T Test and the independent sample t test.

b. Paired Samples T-Test

When the Paired Samples T-Test was conducted, it was found that the p-value was 0.000 (p-value <0.05) where the null hypothesis (Ho) was rejected (Ha) was accepted, which means that there is an effect of giving cloves to soy bean honey drinks.

Tabel 5.6
Penambahan cengkeh pada kualitas minuman madu soya bean (n=24)

Variabel		Mean	Min	SD	t	P Value
Ph Minuman tanpa cengkeh	Sebelum	7	3,1	0,0	272	0,000
	Sesudah	3,85	3,17	0,04		
Ph minuman dengan cengkeh	Sebelum	7	3,22	0,00		
	Sesudah	3,75	3,26	0,39	318	0,00

Tabel 5.8
Perbedaan Rata-Rata PH pada kelompok tanpa cengkeh dan kelompok dengan penambahan cengkeh

Variabel	Mean	SD	95% CI		t	P value
			Lower	Upper		
Kelompok Intervensi	3,85	0,04	0,06	0,13	6,4	0,000
Kelompok Kontrol	3.75	0,03	0,06	0,13		

The color results showed no difference before and after, but there was an increase in foamy sediment. Meanwhile, in the intervention group with the addition of cloves, the drink turned brown. There was less foamy sediment compared to the group without cloves. The following shows the difference in sediment in the group without cloves and the group with cloves.

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Figure 1. Sediment without cloves Figure 2. Sediment with cloves

In the research results, cloves, especially eugenol in clove essential oil, slow down oxidation through a combination of radical-scavenging activity (capturing free radicals), chelating metal ions (reducing metal catalysis), and inhibition of lipid peroxidation pathways. Many food model studies (meat, salted eggs, oils, vegetable/processed products) show a decrease in oxidation indicators such as TBARS, peroxide value (PV), and anisidine value when given clove extract/oil.(1)

Several in-food studies have reported significant reductions in TBARS when clove essential oil (CEO) or clove extract is added at appropriate concentrations. Eugenol exhibits high DPPH/ABTS radical scavenging and ferric-reducing properties at microgram-per-mL concentrations in test tube assays. This explains its fundamental ability to inhibit oxidation reactions.(2)Clove extract is able to slow the oxidation of unsaturated fatty acids (omega-3) in laboratory models, indicating the potential to protect sensitive components in fatty beverages or oil supplements.(3).

Clove oil/extract was effective against spoilage and pathogenic bacteria in a juice model and exhibited antioxidant activity in an oxidation acceleration assay. Results showed reduced microbial growth and slowed oxidative degradation over a matrix-dependent dose range. Eugenol (the main component of clove) acts as a radical scavenger, metal chelator, and inhibits the lipid peroxidation pathway—explaining why cloves effectively slow down oxidation indicators (TBARS, peroxide value) in a food/beverage model.(4)

Concentrations are often effective (juice/RTD model) as they are sufficient for antioxidant/antimicrobial properties, but sensory testing is required. Parameters that significantly decrease: bacterial count (log CFU), TBARS/peroxide value (for fat content), vitamin C loss (slower with extract). Safe & effective strategies: use hydro-ethanol extract or clove oil encapsulation for aqueous beverages (reduces sharp taste), combine with inert packaging (N_2), dark bottles, and cool storage.(5)

Clove antioxidants slow oxidation. Clove antimicrobials suppress acid production, resulting in a more stable pH. In this study, drinks containing soybeans, honey, and cloves were tested. The clove-containing drink inhibited the oxidation process, and the acidity, color, and odor of the drink were measured. Previous research has shown that drinks without clove supplementation increased Hb levels in pregnant women in their third trimester.(6)

The spoilage of soya bean honey drinks can have health impacts and reduce the shelf life of the quality of the drink.(7). The addition of Syzygium aromaticum (cloves) and acidity testing of the drink can prevent the spoilage of the soy bean honey drink. Malnutrition in pregnant women can lead to anemia, which puts the fetus at risk of low birth weight and increases the risk of stunting.(8). Administering honey and soybeans as an effort to prevent stunting in pregnant women in the third trimester can be an alternative to prevent anemia and increase weight gain in pregnant women in the third trimester. Soybean honey drinks are useful for preventing the birth of stunted babies. The addition of Syzygium aromaticum (cloves) can extend the shelf life of the drink, and by testing the acidity, the level of acidity and shelf life of the drink can be determined. To maintain the quality of the soybean honey drink, an acidity test will be carried

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out and the addition of Syzygium aromaticum (cloves) will be carried out, which aims to extend the shelf life of the soybean honey drink so that it can be consumed for a long time.(9).

1. Physiological and Nutritional Changes During Pregnancy

The findings of this study indicate that pregnant women experience significant physical and psychological changes, particularly during the second and third trimesters. These include increased body weight, uterine enlargement, higher blood volume, and hormonal fluctuations that may lead to discomfort such as fatigue, sleep disturbances, appetite changes, and emotional stress.

During the third trimester, maternal nutritional needs increase substantially due to the rapid growth of the fetus, placental development, and heightened maternal metabolism. At this stage, adequate intake of protein, iron, folic acid, calcium, and antioxidants is essential to ensure optimal fetal growth and maternal health. Nutritional deficiencies during this period may lead to low birth weight (LBW) and increase the risk of stunting in early childhood.

Maternal nutritional adequacy is typically measured through weight gain during pregnancy, which reflects both fetal and maternal growth. Poor maternal nutrition is closely associated with pregnancy complications such as anemia, hemorrhage, preeclampsia, abnormal weight gain, and poor fetal development. These conditions contribute directly to the high prevalence of stunting in Indonesia, highlighting the importance of balanced nutrition and functional food interventions for pregnant women.

2. Nutritional Potential of Soybean (Glycine max L. Merrill)

Soybean (*Glycine max* L. Merrill) is recognized as one of the most valuable and versatile sources of plant-based protein globally. It contains a complete profile of essential amino acids, making it comparable to animal-derived proteins in terms of biological value. In addition to its rich protein content, soybean provides unsaturated fatty acids—particularly linoleic and linolenic acids—that play essential roles in maintaining cardiovascular health and supporting fetal brain development during pregnancy. Soybeans are also an abundant source of vitamins (such as vitamin E, folate, and vitamin K) and minerals (including calcium, phosphorus, magnesium, and iron), which are vital for bone formation, hemoglobin synthesis, and enzymatic activity in both mother and fetus.

One of the most important bioactive components of soybean is its isoflavone content, including compounds such as genistein, daidzein, and glycitein. Isoflavones are classified as phytoestrogens—naturally occurring plant compounds that structurally resemble the hormone estrogen and can bind to estrogen receptors in the body. These compounds belong to the flavonoid group, well known for their potent antioxidant, anti-inflammatory, and cardioprotective properties. Their molecular mechanism involves the scavenging of reactive oxygen species (ROS) and the inhibition of lipid peroxidation, thereby reducing oxidative stress levels in biological systems.

During pregnancy, oxidative stress often increases due to enhanced metabolic demands, elevated oxygen consumption, and changes in hormonal balance. If uncontrolled, excessive oxidative stress can damage placental tissues and fetal cells, leading to complications such as preeclampsia, intrauterine growth restriction (IUGR), or preterm delivery. The antioxidant activity of soy isoflavones therefore plays a crucial role in protecting maternal and fetal cells from oxidative damage, maintaining endothelial integrity, and improving blood flow between the mother and the placenta. By stabilizing redox balance, isoflavones also help regulate the synthesis of nitric oxide, which is essential for vascular relaxation and efficient nutrient transfer to the fetus.

Furthermore, the protein and isoflavone synergy in soybean contributes to enhanced metabolic efficiency and the maintenance of optimal maternal weight gain, both of which are key determinants of fetal growth. Isoflavones have also been associated with the modulation of glucose metabolism and lipid profiles, supporting energy stability throughout pregnancy. These combined nutritional and functional benefits make soybean not only a sustainable dietary protein source but also a strategic ingredient in the formulation of functional foods and beverages aimed at improving maternal nutrition and preventing pregnancy-related complications.

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Therefore, soybean serves as an ideal base material for the development of functional beverages such as the honey–soybean formulation explored in this study. Its rich nutritional composition, combined with the bioactive potency of isoflavones, provides a scientifically grounded foundation for designing nutrient-dense, antioxidant-rich drinks that can support maternal health, enhance fetal growth, and contribute to reducing the risk of stunting in early childhood.

3. Development of the "MaSoy" Product (Honey Soybean Drink)

To address the ongoing issue of maternal nutritional deficiencies, particularly among pregnant women in developing countries such as Indonesia, this study developed MaSoy (Honey Soybean Drink) — a functional beverage formulated from soybean and honey with the addition of the natural preservative and antioxidant agent Syzygium aromaticum (clove). The formulation was designed to meet the dual objective of enhancing maternal nutrition and prolonging product shelf life through the incorporation of bioactive plant compounds.

The base components of the MaSoy formulation — soybean and honey — were chosen for their complementary nutritional profiles. Soybean (*Glycine max* L. Merrill) contributes high-quality plant-based protein, essential amino acids, unsaturated fatty acids, and isoflavones that function as potent antioxidants and phytoestrogens. These compounds play critical roles in promoting maternal tissue growth, placental function, and fetal development, while also maintaining metabolic balance during pregnancy. Honey, derived from *Apis mellifera*, provides natural sugars (glucose and fructose) that supply sustained energy, along with small amounts of vitamins, minerals, and phenolic antioxidants that support immune function and enhance the bioavailability of iron and other micronutrients. The synergistic combination of soybean and honey produces a nutrient-dense beverage that is both functional and palatable, suitable for daily consumption by pregnant women.

The innovation of MaSoy lies in the addition of clove extract (*Syzygium aromaticum*), which serves as a natural antioxidant and preservative. Clove contains a high concentration of eugenol, a phenolic compound recognized for its antioxidant, antimicrobial, and anti-inflammatory properties. Eugenol acts by neutralizing reactive oxygen species (ROS), chelating metal ions, and inhibiting lipid peroxidation processes that contribute to oxidation and spoilage in beverages. Through these mechanisms, clove extract significantly reduces the rate of oxidative degradation, effectively preventing color changes, off-flavor formation, and rancidity, which are common indicators of product deterioration. As a result, the incorporation of clove enhances product stability, extends shelf life, and maintains the sensory characteristics (taste, aroma, and appearance) of the beverage over time.

In addition to its preservative and antioxidant functions, the clove-enriched MaSoy formulation offers important health benefits for pregnant women. During the third trimester, maternal energy and protein demands are at their peak due to accelerated fetal growth and placental metabolism. However, appetite often decreases as gestation progresses, increasing the risk of inadequate nutrient intake. MaSoy can serve as a nutritional supplement alternative that is easy to consume, energy-rich, and capable of fulfilling these increased nutritional requirements. The presence of isoflavones, eugenol, and phenolic compounds contributes to improved hemoglobin levels, reduced fatigue, and prevention of iron-deficiency anemia, which are key factors in ensuring normal maternal weight gain and optimal fetal growth.

Furthermore, the biochemical synergy between soybean's isoflavones, honey's natural sugars and antioxidants, and clove's eugenol enhances the overall antioxidant potential of MaSoy. This combined antioxidant system not only protects the beverage from oxidation but also supports maternal oxidative balance, which is critical for minimizing oxidative stress during pregnancy. Reduced oxidative stress is associated with a lower incidence of pregnancy complications such as preeclampsia, intrauterine growth restriction (IUGR), and preterm birth. Therefore, beyond serving as a functional food product, MaSoy represents a preventive nutritional intervention aimed at improving maternal health outcomes and reducing the risk of stunting in infants by addressing maternal malnutrition during pregnancy.

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In conclusion, the development of MaSoy (Honey Soybean Drink) with the addition of *Syzygium aromaticum* provides an innovative, science-based approach to improving the nutritional quality, safety, and storage stability of plant-based beverages. Its natural composition and functional bioactivity make it an ideal supplement for pregnant women, combining the benefits of nutritional enhancement and oxidative protection in a single, marketable product. The findings from this research reinforce the potential of MaSoy to contribute to broader public health strategies focused on maternal nutrition improvement and stunting prevention in Indonesia and similar contexts worldwide.

Conclusion

The findings of this study demonstrate that the addition of Syzygium aromaticum (clove) to honey soybean drinks significantly enhances their oxidative stability, sensory quality, and shelf life. The clove-enriched beverage showed measurable improvements in color, aroma, and taste when compared with the control group, supported by statistical evidence ($p = 0.000$). This effect is attributed to the active compound eugenol, which functions as a potent natural antioxidant and antimicrobial agent, effectively inhibiting free radical formation and lipid peroxidation. The combination of soy protein, honey, and clove bioactives resulted in a synergistic antioxidant effect that maintained product freshness and reduced microbial spoilage without the use of synthetic preservatives.

Beyond its technological benefits, the development of the MaSoy (Honey Soybean Drink) formulation has important implications for maternal and child health. As a nutrient-dense, protein-rich, and antioxidant-based functional beverage, MaSoy can serve as a supplementary source of nutrition for pregnant women—helping prevent anemia, support adequate maternal weight gain, and promote optimal fetal growth during late pregnancy. Consequently, this innovation may contribute to long-term efforts to reduce the incidence of stunting in Indonesia. The study's outcomes affirm that Syzygium aromaticum can be safely and effectively utilized as a natural preservative in maternal nutrition products, providing both functional and public health value.

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Conflict of Interest

The authors declared no competing interests.

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