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Sensory Evaluation and Nutritional Composition of Waffle with Chaya Leaf (*Cnidoscolus aconitifolius*) Substitution as an Alternative Snacks for Adolescent Girls' Anemia

Evaluasi Sensori dan Komposisi Gizi Wafel Substitusi Daun Pepaya Jepang (Cnidoscolus aconitifolius) sebagai Camilan Alternatif untuk Remaja Putri Anemia

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ABSTRACT

Background: Waffle is sweet food like cake but cooked differently, are a beloved snack for teenagers. Chaya is a leafy vegetable that is often consumed because it has a nutritional content that is beneficial for health and can be made into snacks such as waffles.
Objectives: This study aimed to evaluate the nutritional and cyanide content of Chaya Leaf waffles using a selected formula as a potential solution for iron deficiency anemia in adolescents girls.
Methods: Experimental research with a randomized complete design was conducted, varying the amount of Chaya Leaf are 0g, 25g, 50g, and 75g in waffle formulations. Sensory analysis is based on hedonic test results which are evaluated using SPSS version 25 analyzed using one-way ANOVA followed by DMRT (Duncan's Multiple Range Test) analysis, while proximate analysis was conducted following SNI 4305:2018 guidelines. Iron content was measured using atomic absorption spectrophotometry (SNI 01-2896-1998) and cyanide content using the acid titration method and the wet titration method based on SNI 4305:2018.
Results: A hedonic test involving 30 semi-trained panelists favored formula F4, containing 75 g of Chaya Leaf, for its color (p-value<0.001), taste (p-value=0.001), and texture (p-value=0.019). In 100 g of waffle, water content was 54.15%, ash content was 2.06%, protein was 20.90%, fat was 12.16%, and carbohydrates were 63.67%. The iron content was 0.43 mg, and cyanide levels were found to be 0.919 mg/g.
Conclusions: Formula F4 was preferred by panelists for its high iron content and safe cyanide levels, suggesting the potential of Chaya Leaf waffles as a nutritious snack for teenagers.

INTRODUCTION

Adolescent health plays a crucial role in overall health development, as this age marks the transition into productivity. The World Health Organization (WHO) defines the productive age group as individuals between 15 and 49 years old. The prevalence of anemia among women in this productive age group in Indonesia has been steadily increasing over the years. According to the Global Health Observatory data from 2017, the prevalence of anemia was 29.6%, which rose to 30.4% in 2018 and 31.2% in 2019. This data suggests that anemia affects approximately one out of every three women in their reproductive years. According to the Basic Health Research (Riskesdas), the incidence of anemia rose from 37.1% in 2013 to 48.9% in 2018, with the highest rates found among individuals aged 15-24 years and 25-34 years. Neglected anemia can set off a chain reaction in global nutrition, triggering problems like stunted growth, wasting, low birth weight, and obesity. These issues arise from dwindling energy levels, making physical activity a challenge, as outlined by the World Health Organization. Additionally, untreated anemia can lead to lower learning performance and reduced productivity at work, while also weakening the body's ability to fight off infections[1].

Changes in dietary habits and physical activity are among the factors that contribute to the occurrence of anemia. As indicated by the UNICEF baseline survey in 2017, a significant portion of teenagers spend their free time being inactive. Additionally, about one-third of teenagers opt for artificial snacks or processed foods, while another one-third regularly indulge in moist cakes, soft bread, fried foods, and crackers. The evolution of lifestyle, including increased internet connectivity among teenagers, has empowered them to make more

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independent choices. However, these choices often lack appropriateness, indirectly leading to nutritional problems. Iron deficiency anemia is one of the most common forms of anemia, and it can easily occur due to changes in dietary patterns that lack balanced nutrition, especially a sufficient intake of iron-rich foods. A deficiency in iron intake can result from an inadequate intake of iron-rich foods, and the status of anemia directly correlates with the adequacy of iron intake levels.

Green-colored vegetables are known to be rich sources of iron, and one such vegetable with high iron content is Chaya Leaf (*Cnidoscolus aconitifolius).* According to previous research, 100 g of Chaya Leaf contain approximately 85 ml of water, 5.7 g of protein, 11.4 mg of iron, 39 mg of phosphorus, 199 mg of calcium, 217 mg of potassium, and 165 mg of vitamin C. Remarkably, the iron content in Chaya Leaf exceeds that of spinach, containing only 5.7 mg of iron per 100 g, by more than twofold. Moreover, Chaya Leaf boast higher levels of vitamin C compared to spinach[2,3]. However, the benefits of Chaya Leaf are not widely known among the general public, and some people use them as feed for cattle instead.

Waffles, a beloved Belgian treat, have found their way into the hearts and palates of Indonesians, becoming a popular food item available in various establishments such as street vendors, cafes, and restaurants. Enjoyed by individuals of all ages, from children to adults, waffles are cherished for their delectable savory-sweet flavor profile and distinctive texture reminiscent of a honeycomb[4,5]. The presentation of waffles varies widely depending on the producer, with an array of flavors and toppings to choose from. Despite the creative variations, the main ingredient in waffle batter remains wheat flour, not sourced locally in Indonesia. Despite this, the culinary innovation surrounding waffles continues to evolve, with the incorporation of nutritious ingredients such as Chaya Leaf into some products, contributing to the diversity of flavors and nutritional offerings available to consumers.

Although waffles made with added catfish bones and mushrooms were previously developed by researchers, they were not well-received in taste tests, despite the increased calcium content in the waffles[6]. Based on the description above, the author is interested in conducting a study to utilize Chaya Leaf in waffle making. The aim is to contribute to nutrition by providing a source of iron, particularly targeting teenagers and productive-aged women to increase their iron intake. Therefore, the goal of this study is to analyze the nutritional content, including iron content and cyanide levels, in Chaya Leaf waffles for addressing iron deficiency anemia.

METHODS

Design, Place, and Time of Research

The study was conducted from March to October 2022. The production of the product took place at the Nutrition and Food Laboratory, Nutrition Science Study Program, Faculty of Public Health, Andalas University, Padang. Proximate analysis, as well as the determination of iron and cyanide levels in the product, was carried out at the Padang Standardization and Industrial Services Laboratory (BSPJI). Additionally, a hedonic test involving 30 panelists was conducted at the Nutrition and Food Laboratory, Nutrition Science Study Program, Faculty of Public Health, Andalas University, Padang. Ethical approval was obtained from Faculty of Public Health, Universitas Andalas No: 10/UN16.12/KEP-FKM/2022 on 24 June 2022.

This study utilized a randomized complete block design, with a single factorial design involving three different formulas of Chaya Leaf puree added to waffles. Each formula was replicated or prepared once. Formula 1 represented waffles without the addition of Chaya Leaf. Formula 2 included 25 g Chaya Leaf in the waffle mixture, while Formula 3 included 50 g of Chaya Leaf. The additional ingredients used in the waffles included 100 g flour, 30 g of granulated sugar, 5 g of instant yeast, 1 egg, and 5 g of salt.

Material and Tools

The ingredients utilized for waffle making consist of Chaya Leaf puree, wheat flour, instant yeast, sugar, eggs, salt, and butter. The equipment employed for waffle preparation includes digital scales, mixers, waffle molds, blenders (for blending Chaya Leaf), spoons, bowls, measuring cups, stoves (for cooking waffles), and pans. For the sensory evaluation, the tools utilized include attendance lists, plastic cups and spoons, chairs, hedonic test forms, and pens.

Waffle Making Process

The waffle-making process starts by separating the Chaya Leaf from the stems and washing them thoroughly. The Leaf are then blanched in hot water for 4-5 minutes before being finely blended to create Chaya Leaf puree. Next, mixing all-purpose flour, salt, instant yeast, and sugar until well combined, creating the dry mixture. The wet mixture is prepared by beating the eggs, coconut milk, and butter until smooth. The dry and wet mixtures are then combined and stirred thoroughly to form the batter. Afterward, Chaya leaf puree is added to the batter according to the desired formulation of 25 g (F1), 50 g (F2), or 75 g (F3). Once the batter is ready, the waffle mold is heated and greased with butter. Finally, the batter is poured into the mold and baked until the waffles are fully cooked (Figure 1).

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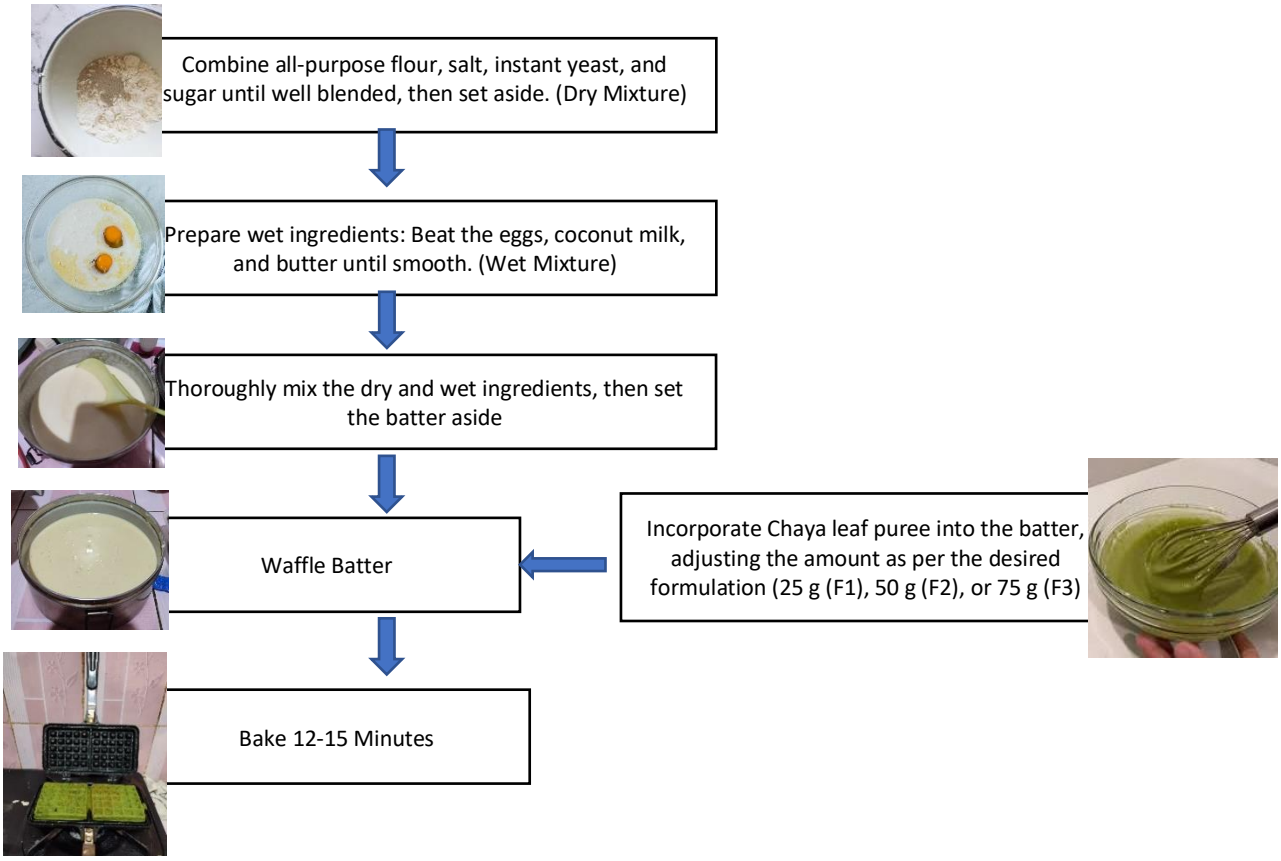

Figure 1. The waffle-making process

Table 1. Waffle formula ingredients Chaya Leaf

Formulas	Chaya Leaf (g)	Wheat Flour (g)	Sugar (g)	Instant yeast (g)	Eggs (grains)	Butter (g)	Salt (g)
F1	0	100	30	5	1	30	5
F2	25	100	30	5	1	30	5
F3	50	100	30	5	1	30	5
F4	75	100	30	5	1	30	5

Acceptance Level Test Procedure

The acceptance level test was conducted using the hedonic method with 30 semi-trained panelists, who were students of the Nutrition Science program at the Faculty of Public Health, Andalas University, Padang. The test commenced with the panelists filling in an attendance list upon arrival. They were then seated at approximately 2 meters apart from each other. Each panelist was provided with a hedonic test form, a pen, and samples of the four waffle formulas (placed in plastic mica containers and accompanied by spoons). Additionally, neutral mineral water was provided to cleanse the palate between tastings of different formulas. The panelists were instructed to rate their hedonic response on a scale from 1 to 9, where 1 indicated "very, very disliked," and 9 indicated "really liked." The evaluation focused on four attributes: color, aroma, taste, and texture. The tested formulas included four variations, consisting of the addition of Chaya Leaf in quantities of 0 g, 25 g, 50 g, and 75 g.

Procedure Analysis of Substance Levels Iron and Cyanide

The proximate tests and analysis of cyanide content were conducted at the Center for Standardization and Industrial Services using the acid titration method and the wet titration method based on SNI 4305:2018. The testing for iron content was performed using an atomic absorption spectrophotometer according to the analysis method outlined in SNI 01-2896-1998.

Proximate Test Procedure

Selected seruit products by panelists derived from organoleptic test results were then subjected to proximate analysis (water, ash, fat, protein, and carbohydrates), and Aw value. Analysis of water content (thermogravi method), ash content (dry ashing method), fat content (Soxhlet method) was carried out in accordance with SNI 01-2891-1992 (SNI 1992), protein content (micro Kjedahl method) was carried out in accordance with AOAC 960.52-1961 (AOAC, 2005), and carbohydrates (by different), Aw value (isothermic sorption method).

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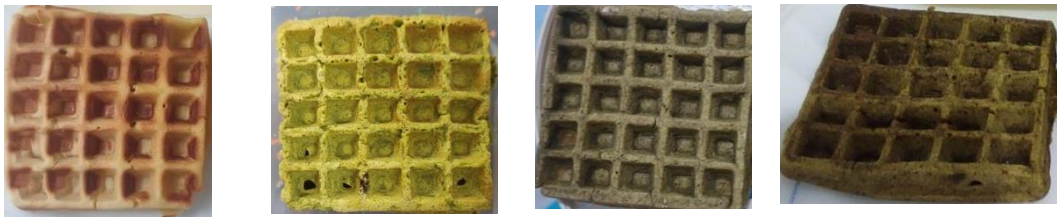
Statistical Analysis

The collected data in the research includes acceptance level test data, results of the analysis of iron content, and results of the analysis of cyanide content. The acceptance level test data was analyzed using SPSS software version 22, beginning with a normality test using the Shapiro-Wilk test. To assess differences between formulas, an ANOVA test was conducted. If a significant difference was found, the Duncan's multiple range test (DMRT) was employed for post-hoc analysis.

RESULTS AND DISCUSSIONS

Level of Preference of Waffle

The waffle was made from Wheat flour (WF) and Chaya Leaf Pure (CLP) with four formulas, i.e., 100 WF (F0, Formula 0), 100 g WF and 25 g CLP (F1), 100 g WF and 50 g CLP (F2) and 100 g WF and 75 g CLP (F3) (Figure 2). The level of preference was analyzed by the hedonic method to analyze the level of preferences of the panelists on the appearance, smell, taste, and texture attributes of waffle with four different formulas. The formulation of chaya leaf waffles is based on the iron content found in the Leaf. According to Arza (2023), the iron content of chaya Leaf after boiling for 5 minutes is 9.34 mg/kg[7]. Utilizing these Leaf as the main ingredient aims to create a functional food product with high nutritional value, particularly iron, offering both health benefits and good taste. With the right formulation, this waffle is expected to serve as a nutritious and practical food option for a wide range of consumers. The results of the analysis using the Friedman test (Table 2) showed that most panelists preferred the waffle formula incorporating Chaya Leaf puree. Formula F4, which contains a mixture of 75g of Chaya Leaf puree, was identified as the top choice based on the power test results. Organoleptic analysis indicated significant differences in the color, taste, and texture of the waffle (p-value<0.05), highlighting the positive impact of the Chaya Leaf puree addition on these aspects. However, there was no significant difference observed in the aroma of the waffle (p-value>0.05). The results of waffle are shown in Figure 2.



F1 F2 F3 F4

Figure 2. Waffles with Four different formula

Table 2. Evaluation of organoleptic properties

Indicators	Formulas				p-value
	F1	F2	F3	F4	
Color	8.03 [a]	6.93 [c]	7.40 [b]	8.10 [a]	<0.001
Aroma	7.67 [b]	7.53 [b]	7.33 [b]	7.43 [a]	0.110
Flavor	7.23 [a]	6.63 [b]	7.10 [a]	7.33 [a]	<0.001
Texture	7.20 [a]	6.87 [b]	7.00 [a, b]	7.27 [a]	0.019

Numbers to follow with different letters on the same line show exists difference real

Formulas F2 and F3 did not exhibit a significant difference in color compared with Formula F1; however, they also did not differ significantly from Formula F4. The color of the waffle was evidently influenced by the quantity of Chaya Leaf added. Previous research has suggested that incorporating at least 15–20 g of Chaya Leaf into food products can yield a stable color and achieve satisfactory acceptance among panelists[6]. The green color of the chaya Leaf was influenced by the content of phenolic and amino acids. The dark green color is influenced by high concentrations of amino acids such as leucine, lysine, and phenylalanine[8]. Therefore, it can be concluded that Chaya Leaf can be effectively utilized as a natural dye ingredient in products such as waffles.

Aroma attributes indicate that formulas F2 and F3 do not differ from F1 formula however different from formula F4. Previous studies have shown that giving Chaya Leaf at least 15-20 g in the food product can provide a stable and distinctive aroma Power accept the good panelist[6]. The aroma of the waffles was affected by the compounds found in the ingredients used. The folate present in Chaya Leaf, specifically in the form of an aldehyde known as 3-methylbutanal, contributes to a distinct aroma resembling that of malt. This unique aroma adds to the sensory experience of waffle products[9]. Moreover, the phenol content in chaya Leaf also influences the aroma of the waffles added to each formula produced[2,10].

The attributes of the F2 formula differ significantly from those of the F1 formula, but no significant differences are observed between formulas F3 and F4. Previous research indicates that incorporating at least 15-20g of Chaya Leaf into food products can impart a sense of stability and contribute to positive acceptance among panelists[6]. A study conducted by Jaroennon and Manakla (2021) indicates that incorporating Chaya Leaf at a concentration of at least 50% leads to significantly

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higher acceptance rates among panelists[11]. Therefore, in the F4 formula, where 75% concentration of Chaya Leaf is utilized, it still maintains high acceptance among panelists. Chaya Leaf are rich in umami taste, which adds a savory flavor to food products, making them suitable for incorporation into waffle recipes. Chaya Leaf contain various umami substances, such as sour quinate, trigonelline, alanyl-tyrosine, leucil-glycyl-proline, l-glutamic acid, acid pyroglutamate, and 5'-adenosine monophosphate, which contribute to their robust umami profile[12].

Waffles with excellent stability and texture have minimal stickiness, which is why it is crucial to select appropriate dough ingredients. In the case of formulas F3 and F4, their texture does not significantly differ from that of the F1 formula or from formula F2. The quality of waffle texture is affected by dough parameters, where a positive correlation exists between the pH value, density, and viscosity. Conversely, pH and water activity (aw) are negatively correlated with waffle texture characteristics[13].

Proximate, Iron and Cyanide Content

Chaya is a leafy vegetable that is often consumed because it has a nutritional content that is beneficial for health because it contains protein and bioactive compounds[11,12,14,15]. Laboratory analysis results indicate that per 100g of waffles in the selected formula (F4), the nutritional content includes 54.15% water content, 2.06% ash, 20.90% protein, 12.16% fat, and 63.67% carbohydrates. Compared with SNI 01-4309-1996, our products do not meet the quality standards for wet cakes, where our products still have a higher water and fat content, but the ash content meets the standards[16]. These findings align with previous studies suggesting that snacks enriched with Chaya Leaf contain approximately 80% of macronutrient content, which is not significantly different[17]. Incorporating Chaya Leaf into the formula at a rate of 20% has been shown to result in a high protein content, ranging from 9.21% to 10.10% [18]. Therefore, Chaya Leaf hold the potential to serve as an alternative food source due to their low cost and underutilization. Additionally, their rich nutritional content makes them suitable for the development of functional food products aimed at addressing nutritional deficiencies in society[14].

Table 3. Content selected nutritional waffle formula per 100 g

Parameter	Content	SNI 01-4309- 1996
Water Content	54.15%	40%
Ash Content	2.06%	3.0%
Proteins	20.90%	-
Fat	12.16%	3.0%
Carbohydrate	63.67%	-
Substance Levels Iron	0.437 mg/g	-
Cyanide Levels	0.919 mg/g	-

Nutritional analysis of the product was solely conducted on the selected formula, Formula 4, which received the highest marks in acceptance tests for color, aroma, taste, and texture categories. The iron content in waffles with Formula 4 was measured at 0.43 mg per 100 g of waffle. It's noteworthy that the iron content in 100 g of fresh Chaya Leaf, as indicated in previous studies, is 1.02 mg. Therefore, incorporating Chaya Leaf into the waffle mix significantly increases the iron content[19] According to the Food and Agriculture Organization (FAO), the safe limit for cyanide consumption is equal to or less than 10 ppm (parts per million)[20].

Contribution of Waffles to The Iron Adequate Intake (AI) for Young Women according to The Indonesian Ministry of Health's 2018 Recommendations (AKG 2018)

The iron content analysis of Formula 4 waffles can be compared to the Adequate Intake (AI) for iron recommended by the Indonesian Ministry of Health in 2018 (AKG 2018). This comparison helps determine if the iron content in the waffles meets or exceeds the recommended daily intake levels set by the authorities. The AKG used for this comparison is for teenage daughters aged 13-15 years and 16-18 years, with both age groups having the same recommended iron intake of 15 mg per day. The percentage contribution of iron from waffles to the AKG for teenage daughters is calculated by comparing the iron content in the waffles to the recommended intake. This percentage is then multiplied by 100% to obtain the result in percentage terms. The contribution of iron from waffles to the AKG for teenage daughters aged 13-15 years and 16-18 years is calculated to be 2.9%. Consequently, a composite waffle product containing Chaya Leaf has the potential to serve as an alternative snack food and dietary addition to address anemia issues in adolescent daughters.

Cyanide is a highly poisonous substance, and its ingestion through food can pose serious health risks to the human body[21]. Therefore, comprehending the toxicity level of cyanide in food is crucial to guarantee the safety of food products for consumer consumption[22]. The safety standard for cyanide levels in waffles is set at 9.19 ppm. Recent research indicates that Chaya Leaf contain approximately 102.00 mg of cyanide per 100 g[23]. Blanching Chaya Leaf is a recommended method for making them safe to eat by reducing cyanide levels. Boiling them for more than five minutes in hot water can significantly lower the remaining cyanide content, making the Leaf safe for consumption. This treatment process is highly recommended to ensure the safety of Chaya Leaf for consumption[24]. The FAO establishes the safe consumption limit for sour cyanide at or below 10 ppm[20]. This aligns with previous studies indicating that the safe consumption level of cyanide is ≤ 10 ppm[25].

The strength of this study is that there has been no research on making waffles from Japanese papaya Leaf, which are popular among teenagers. However, this study has a limitation: some people are unfamiliar with

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Japanese papaya Leaf and have not been optimally utilized. Therefore, it is necessary to develop new food products that are combined with using Chaya leaves.

CONCLUSIONS

The addition of Chaya Leaf to waffle formulation has been found to significantly impact the color, taste, and texture of the cookies. According to organoleptic tests, panelists preferred the cookies made with the F4 formula, which included 75g of Chaya Leaf, citing superior color, aroma, taste, and texture. Proximate testing revealed that the F4 waffle formula contained adequate levels of carbohydrates, protein, and fat, making it an excellent choice as a snack for teenagers. So, according to researchers, the F4 formula is recommended as an alternative snack for female adolescents with anemia. Furthermore, this waffle formulation also provides sufficient iron content and maintains a safe cyanide level for consumption by teenagers. It is suggested that Chaya Leaf waffles have great potential as an alternative snack high in iron content for teenagers, warranting further development and exploration as a product.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

PAA: Shaping the research concept, Executing, and collecting the study; AEY: analyzing data, writing and editor manuscript.

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