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MICROBIOLOGICAL, MINERALS AND VITAMINS EVALUATIONS OF *ARACHIS HYPOGAEA* BURGER SOLD IN ASABA, DELTA STATE

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ABSTRACT :

Arachis hypogaea (peanut or groundnut), is an important foodstuff in the world taking advantage of its high nutritional content especially in protein and micronutrient-stricken areas. This paper explored the microorganisms, vitamin and mineral contents of a locally manufactured peanut-based product, peanut burger with emphasis on the role it can play in micronutrient intake. The peanuts burgers obtained in the super-market sales outlet in Asaba, Delta State were packaged in plastic bottles and were ready to be consumed. Microbial cultivation of the samples was done by pour-plate technique. The total bacteria result given by Nutrient Agar is among 5.83 x 10^3CFU/g to 6.0 x 10^3CFU/g as the averages. Coliform found in the MacConkey Agar varies between a mean of 1.3 x 10^3CFU/g to 6.75 x 10^3CFU/g and fungal obtained at Sabourand Dextrose Agar has a variety of 7.0 x 103 to 3.75 x 104 CFU/g. The microbial contaminants present in the burger of the peanut sold in Asaba are bacteria such as *Bacillus* sp, *Enterococcus* sp, *Staphylococcus* sp, *Escherichia coli* and *Enterobacter* sp. Whereas, there are *Saccharomyces* sp, *Penicillium notatum*, *Mucor* sp and *Penicillium caseigenum* as the fungal isolates. Atomic Absorption Spectrometry (AAS) was adopted to determine the mineral content and vitamin content was determined by High Performance Liquid Chromatography (HPLC). The results found large amounts of edible minerals: potassium (1423.59mg/100g), phosphorus (549.03mg/100g), sodium (226.36mg/100g), magnesium (224.68mg/100g), calcium (223.49mg/100g), iron (5.30mg/100g), zinc (3.20mg/100g), and copper (0.7mg/100g). Vitamin evaluation showed that the levels of vitamin B3 (9.93mg/100 g), vitamin C (7.82mg/100 g), and vitamin A (5.43mg/100 g) were all within the recommended permissible limits set by the World Health Organization (WHO). It was discovered that combining eggs and flour during the preparation process improved the micronutrient content, especially raising the levels of calcium, magnesium, and phosphorus—all of which are essential for maintaining the peanut burgers' microbial community. The manufacturers must adhere to strict microbiological safety guidelines during production and packaging, these findings highlight the nutritional potential of peanut burgers as a functional food that can augment essential vitamins and minerals in regular diets, particularly in environments with limited resources. This product is one of the tools to achieve the Sustainable Development Goal (SDG) 1 and 2 of Zero hunger; Good Health and Well-being respectively.

Keywords: *Pea nut burgers, Microorganisms, Micronutrients, Vitamins, Minerals, Asaba.*

Introduction

The leguminous crop that is highly preferred by Nigerians because of its high protein and lipids is the *Arachis hypogaea*, also referred to as peanut or groundnut (Ogunbanwo *et al*., 2022). Classified as Fabaceae family, ground nut is a large annual oilseed crop and a potential nutritious protein source due to its high content of lysine, and it can supplement cereal-based food products (Eke-Ejiofor *et al*., 2012; Okaka, 2005). It can be processed as ready-to-eat individually or processed with other local materials to form a composite this product holds more than just the potential as a protein supplement but also a means of delivering micronutrients as well. Nevertheless, the vitamin and mineral profiles of this indigenous snack, especially the processed product, have featured very little in the scientific literature, even though it is an attractive food in terms of nutrition.

The widespread consumption of the pea nut burgers as a ready-to-eat snack that is largely used in Nigeria and most parts of the world since it is convenient to consume, palatable and affordable.

The rising food culture of Ready-To-Eat (RTE) food and eating habits like *Arachis hypogaea* (groundnut) burgers in the urban centers in Nigeria signifies a change in dieting dimensions due to urbanisation, economic alterations, and living habits that emphasize on comfortability.

Commonly called peanut in Nigeria, peanut burger is a famous and adored Nigerian snack that is famous due to the crumby structure and the scrumptious flavour (Igbo, 2024). It is a convenient, feel-good snack that everyone loves to eat. It is made by dipping peanuts into a batter that consists of corn flour, sugar, and eggs and deep-frying it till a golden color. Peanut burgers are a healthy snack option because peanuts are a good source of fiber, protein, and good fats.

Additionally, it is crucial that locally made fast foods like peanut burgers should be microbiologically safe. These foods are susceptible to microbial contamination because they are frequently handled and prepared in less-than-ideal hygienic conditions. Common foodborne pathogens include *Salmonella* species and *Escherichia coli*, *Bacillus cereus* and *Staphylococcus aureus* are commonly linked to RTE food contamination as a result of improper

handling, processing, and storage (Adeniran *et al*., 2021 and Ogbozor *et al*., 2023). Particularly in people with weakened immune systems, eating food tainted with harmful bacteria, fungi, or poisons can cause anything from minor gastroenteritis to serious systemic infections.

Aim and Objectives

This study is aimed at evaluating the microbiological quality, mineral content, and vitamin composition of *Arachis hypogaea* burgers sold in Asaba, Delta State.

Specifically, it seeks to:

Determine the presence and load of microbial contaminants in the peanut burger samples;

Quantify essential minerals such as calcium, magnesium, potassium, and iron;

Analyze the levels of vitamins A, C, and B3.

Materials and Methods

Study Design

A cross-sectional descriptive research design was used in this study to evaluate the microbiological quality of ready-to-eat (RTE) peanut burgers that were offered for sale in different retail locations throughout Asaba, Delta State. Without changing any variables, the study's cross-sectional design allowed for a quick assessment of the peanut burgers' microbiological conditions at a particular moment in time. This design works well for figuring out how common microbial contamination is and identifying the vitamins and minerals that are associated with the products. In July 2025, a total of twelve Peanut Burger samples were gathered and sent to the Anthony Van Leeuwenhoek Research Centre in Owerri, Imo State, Nigeria, for examination.

Study Area, Collection and preparation of sample, preparation of media and diluent

The research was carried out in Asaba, the capital city of Delta State, the South-South geopolitical zone of Nigeria. Asaba is located on the west bank of River Niger directly opposite Onitsha in the Anambra State. According to The Editors of Encyclopaedia Britannica 2025, Geographically, Asaba is located at 6°11′N latitude and 6°45′E longitude, with an altitude of some 84 meters (276 feet) above sea. It has a tropical monsoon-type climate with a distinct wet and a dry season whereby the rainy season occurs in the months of March to October after which the dry season then follows in the months of November to February (Asaba.com, 2025). Warm weather dominates with average annual temperature of 24°C to 32°C, and this generates humid conditions that could facilitate microbial growth in foods especially ready-to-eat (RTE) products like pea nut burgers.

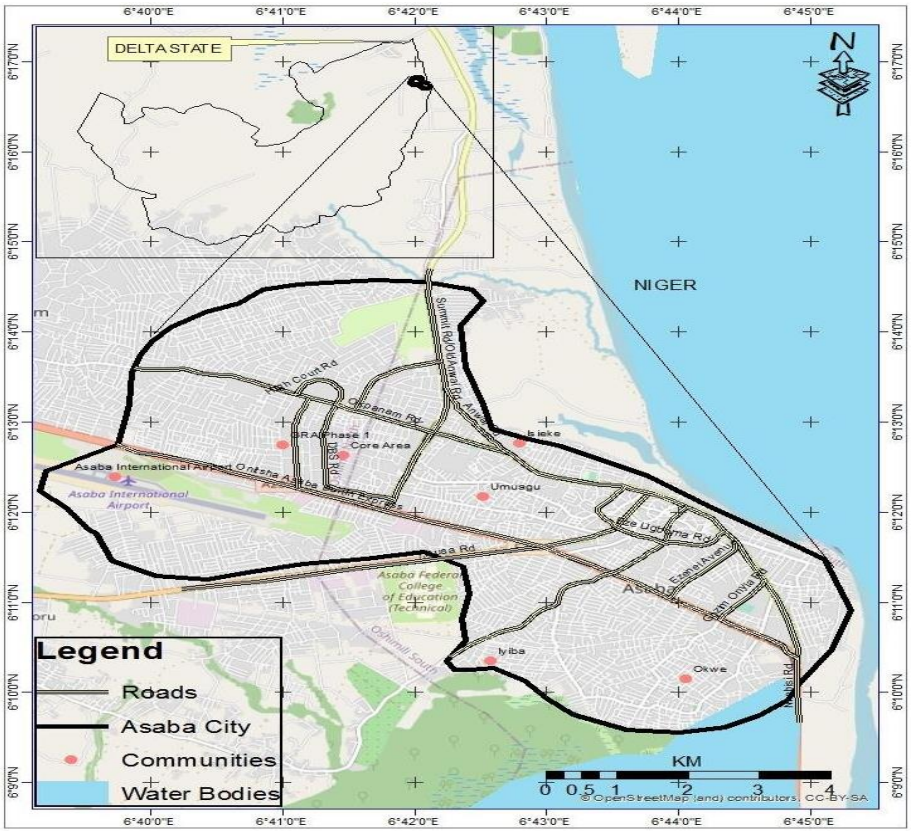

Figure 1: Map of Delta State showing Asaba region (Source: Modified after Delta State Ministry of Lands, Surveys and Urban Development, 2010).

Asaba is an expansive town and business center that is fast developing in population density, urbanization and food delivery activities. The city has diverse food sellers such as the road side stalls, mobile food vendors, restaurants, food stores, mini markets and the institutional canteens. The city of Asaba has been a busy hub of transportation connection between the eastern regions and western regions of Nigeria, hence the traffic of commuters and inhabitants of the rest of the city which leads to the vast popularity of convenient and easy to-go meals such as meat pies.

The production of Peanut Burger

Making Peanut burgers, as expounded by Igbo 2024 included:
Ingredients: Raw groundnuts (peanuts), flour, eggs, sugar, nutmeg (optional), baking powder, salt, vegetable oil and optionally, powdered milk and vanilla flavor are the ingredients.
Preparation: The preparation procedure takes place when we coat the peanuts in a mixture of egg batter and flour, and the coating should be accepted even and consistent. This is then proceeded by frying, cooling and storage. The frying process becomes completed as the peanuts are covered with the coatings, and then these coated peanuts undergo deep-frying in hot oil until reaching the golden color and hopefully crispy. Once fried, the peanut burgers are cooled down and kept in air tight containers to snack.
The peanut burgers are provided with a great crunch through the deep-frying process. The peanuts mixed with the batter have a good and nutty taste. Peanut burgers can be commercially manufactured and the size and packaging varies.
It is a common snack, which can be spotted in the market, supermarkets, and online stores in Nigeria.
The peanut burgers can be taken throughout the day and they make a very good snack among friends and family. During social and wedding ceremonies, pea nuts burgers are generally employed in entertaining guests in ceremonial occasions.

Sample Collection

Twelve (12) supper-markets and shops in Asaba were used in buying pea nut burgers.
The preparation of media and diluents was done in a standard way (Cheesbrough, 2000). The following culture media Nutrient Agar (NA), MacConkey Agar (MCA), Salmonella Shigella Agar (SSA) and Sabouraud Dextrose Agar (SDA) were prepared to inoculate the microorganisms found in peanuts.
The peanuts were diluted using distilled water (DW) in the form of aliquot volume.

Microbiological Analysis

The 10 grams (10 g) of the peanut was weighed into DW (90 ml) and decimally diluted in a sterile distilled (DW). A one-tenth (0.1 ml) of representative dilutions was used to inoculate a variety of media that was spread and incubated according to appropriates.
Identification of bacteria: colonies were identified colonially/culturally, microscopically and biochemically as per standard methods detailed by Cheesbrough (2000) and Sharma (2009). Identification of the isolates was done with the help of standard identification manuals (Buchanan and Gibbons, 2000).
Detection of Fungi: In characterization and identification of moulds by way of colonies, use was made of mycelia, sporulation and pigmentation. In microscopic identification of yeasts, Gram staining method was applied. Differentiation and identification of moulds were done using the wet mount techniques.

Minerals and Vitamin Analysis

An analysis of minerals using Atomic Absorption Spectrometry (AAS), was carried out on Potassium, Phosphorus, Sodium, Magnesium, Calcium, Iron, Zinc and Copper.
Vitamin B3, Vitamin C and Vitamin A were determined by High Performance Liquid Chromatography (HPLC).

Results

Results of Microbiological Analysis

Table 1: Total Counts and colonial Characteristics of Bacteria isolated on Nutrient Agar

Sample code	Total Counts (CFU/g) Mean	Colony Types	Colonial Characteristics	Most Probable Identity
A	5.83 X 10^3	Ax	Large smooth dull a and dry white-cream colonies	*Bacillus* sp
		Ay	Small circular moist and shiny cream colonies	*Enterococcus* sp
		Az	Smooth moist and shiny golden yellow colonies	*Staphylococcus* sp
B	6.0 X 10^3	Bx	Large smooth dull a and dry white-cream colonies	*Bacillus* sp

Table 2: Total counts and colonial Characteristics of Bacteria isolated on MacConkey Agar

Sample code	Total Counts (CFU/g)	Colony Types	Colonial Characteristics	Most Probable Identity
A	1.3 X 10^3	Aa	Small smooth moist and shiny pink colonies	*Escherichia coli*
B	6.75 X 10^3	Ba	large smooth moist and pink colonies	*Enterobacter* sp

Table 3: Total counts and colonial Characteristics of Fungi isolated on Saboraud Dextrose Agar

Sample code	Total Counts (CFU/g) Mean	Colony Types	Colonial Characteristics	Microscopic Characteristics	Most Probable Identity
A	7.0 X 10^3	Au	Small circular moist and shiny mucoid cream colonies	Large Gram positive spherical to oval budding cells	*Saccharomyces* sp
		Av	Dirty green spores enclosed in a white hyphae	Hyphae septate. Conidia arranged like mob head	*Penicillium notatum*
		Aw	Short white filamentous hyphae	Hyphae non septate. Spores arranged in a sporangium	*Mucor* sp
B	3.75 X 10^4	Bu	Small circular moist and shiny mucoid cream colonies	Large Gram positive spherical to oval budding cells	*Saccharomyces* sp
		Av	Thick green spores enclosed in a white hyphae	Hyphae septate. Conidia arranged like mob head	*Penicillium caseigenum*
		Aw	Short white filamentous hyphae	Hyphae non septate. Spores arranged in a sporangium	*Mucor* sp

Table 4: Microscopic and Biochemical Characteristics of Bacteria isolated from Peanuts

Colonial morphology	Gram	Mot	Spo	Cat	In	Coag	L	S	G	M	Mn	Identity of isolates
Golden yellow colonies on NA	+S	-	-	+	-	+	+	+	+	+	+	*Staphylococcus* sp
Dull and dry flat serrated cream colonies on NA	+R	+	+	+	-	-	-	-	+	-	-	*Bacillus* sp
Small smooth moist and shiny colonies on NA	+S	-	-	-	-	-	+	+	+	+	+	*Enterococcus* sp
Small circular moist and shiny pink colonies on MCA agar	-R	-	-	+	-	-	+	+	+	+	-	*Enterobacter* sp
Small smooth moist and shiny pink colonies on MCA	-R	+	-	+	+	-	+	+	+	-	+	*Escherichia coli*

Mineral Composition of Pea Nut Burger

Table 5 shows the mineral content of the locally made *Arachis hypogaea* burger. The findings show significant concentrations of vital macro- and microminerals.

Table 5: Mineral Composition of *Arachis hypogaea* Burger (mg/100 g)

S/N	Mineral	Concentration (mg/100 g)
1	Phosphorus	549.03 ± 4.32
2	Sodium	26.36 ± 1.10
3	Iron	5.03 ± 0.21
4	Potassium	1423.59 ± 6.50

5	Zinc	3.82 ± 0.04
6	Magnesium	224.68 ± 5.39
7	Calcium	223.49 ± 4.90
8	Copper	0.74 ± 2.10

Values are means ± Standard deviation of triplicate determination values are significant at (P<0.05).

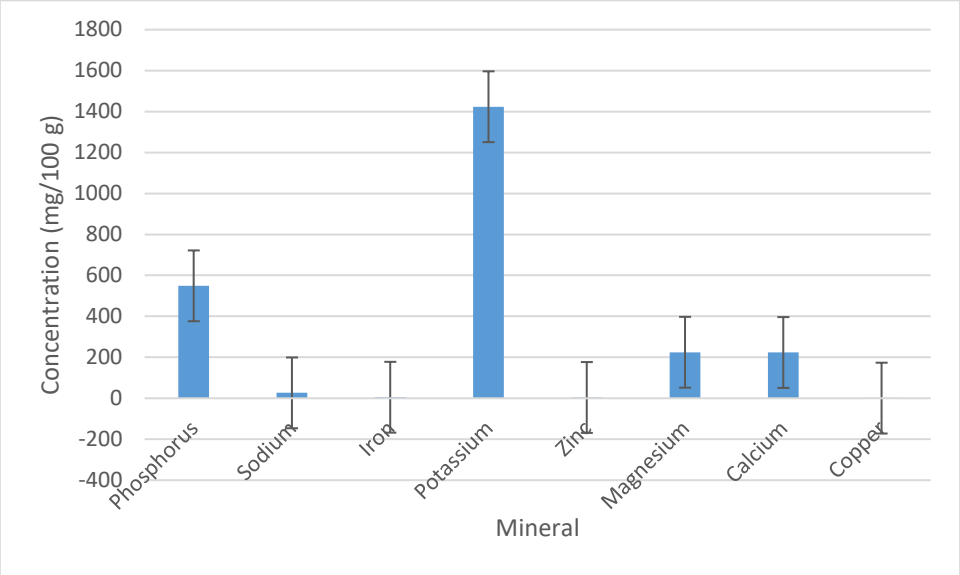

Figure 2: A graphical representation of the Mineral contents of Peanut Burgers

Vitamin Content of Pea Nut Burger

Table 6: Vitamin Composition of *Arachis hypogaea* Burger (mg/100 g)

Vitamin	Concentration (mg/100g)
Vitamin A	5.43± 0.13
Vitamin C	7.82± 0.05
Vitamin B3 (Niacin)	9.93± 3.90

Values are means ± Standard deviation of triplicate determination values are significant at (P<0.05).

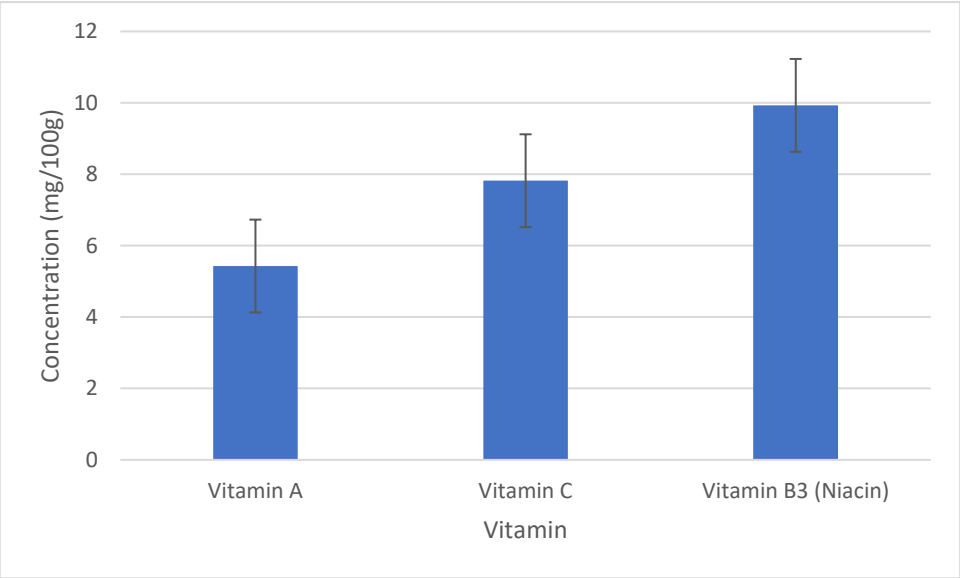

Figure 3: A graphical representation of the Vitamins contents of Peanut Burgers.

DISCUSSION

The microbiological quality of peanut burgers sold in Asaba, Delta State, Nigeria showed a collection of bacteria that alludes to *Bacillus* sp, *Enterococcus* sp, *Staphylococcus* sp, *Escherichia coli* and *Enterobacter* sp. As well as fungi that comprises *Saccharomyces* sp, *Penicillium notantum*, *Mucor* sp and *Penicillium caseigenum*. The total bacterial counts determined using Nutrient Agar varies between the average range of 5.83 x 10^3 CFU/g and 6.0 x 10^3CFU/g. Coliform derived in MacConkey Agar varies with the mean values of 1.3 x10^3 CFU/g and 6.75 x10^3CFU/g on one hand, and fungal isolates derived in Sabourand Dextrose Agar varies with the means of 7.0 x10^3 and 3.75 x10^4CFU/g on the other. This microbial level falls under the satisfactory and/or borderlines criteria of microbiology in Ready-To-Eat foods because the microbial load is equal or less to 10^4CFU/g (Centre for Food Safety, 2014). The results of this study were aligned with that of Mengistu *et al*., (2022). They reported a predominance of well-known bacterial pathogens in Ready-To-Eat foods including; *Staphylococcus aureus*, E. *coli*, *Shigella*, *Bacillus cereus*, and species of *Salmonella*. However, the microbial presence may indicate no significant health hazard, but its importance is related to food safety since certain organisms were involved in food degradation and food related illnesses (Hungaro *et al*., 2014). These microbiological contaminations are explainable in terms of multiple volumes such as the raw peanuts, processing procedure and storage conditions.

Peanut Burger revealed good concentration of potassium which is one of the major electrolytes that maintain the cellular fluid balance and neuromuscular activity. The fact that calcium and magnesium are included in minerals obtained emphasizes the role of the product in maintaining the skeletal integrity and activation of enzymes (Goodman and Quarles, 2008; Bertinato *et al*., 2015). The presence of iron, which is required in the formation of hemoglobin and the process of oxidative phosphorylation, was moderate, supporting the evidence proving the snack effective in alleviating anemia-due iron deficiency (Li *et al*., 2020). Other important aspects such as zinc which is essential in immune response, neuro-behavioural functions were also identified in significant amounts (Gaur and Agnihotri, 2017). The fact that it contains copper, albeit in minute proportions may act as an enhancer of antioxidant enzyme activity.

Based on the results, it can be concluded that *Arachis hypogaea* burgers or Peanuts burgers despite its traditional position as a fast-food product can be consumed due to its potential nutritional implications. In addition to this, protein fortification with rich treats like eggs proved to be able to increase the level of minerals making it an even more valuable functional food product (Fasogbon *et al*., 2017). In the analysis, the good concentrations of Vitamin B3 (Niacin) and vitamin C (Ascorbic acid) and vitamin A (Retinol) were identified. Niacin plays a vital role in oxidative metabolism and the prevention of Pellagra and Vitamin C facilitates the immune system and its a strong antioxidant. Vitamin A is vital in visual acuity, epithelium integrity, immune modulation. Against the reality that the fast foods lack any micronutrient content, this study highlights that the Peanut burgers have vital micronutrients, which can form the Recommended Dietary Allowance (RDA) of the consumer population particularly within poor urban environments such as Asaba. This research touched on the Zero Hunger and Good Health and Well-being as Sustainable Development Goal 2 and 3.

Conclusion

This is to confirm our findings that there are high levels of nutritious minerals and vitamins in locally processed *Arachis hypogaea* (Ground nut or Pea nut) burgers sold in Asaba have the potential of providing dietary nutrients when taken in moderation.

These burgers can be used as cheap, nutritionally viable street food in both urban and rural Nigeria because this microbial level falls within the satisfactory and borderline range of microbiological criteria of Ready-To-Eat foods with additional microbiological safety thereby making this product accessible to all people regardless of their social status.

Recommendations

To raise the standard of manufacturing peanut burgers in Asaba, Delta State capital, there is need to enhance the quality of peanut burgers manufactured by small scale manufacturers. To ensure this is done the following should be considered: stress must be put on informing and training producers of the long-term advantages of good manufacturing and hygiene practices that must be integrated in the production system. Producers could also be sensitized to appreciate the fact that high quality products would enhance their turn- over and generate more profits for their business. Sanitization of the production equipment, sufficient storage quality system and processing of raw materials might be identified as the quality improvement approaches. Further maintenance of effective atmospheric packaging material is needed in order not to contaminate the finished product after production. Finally, this is wakeup call for extreme adherence to minimum basic quality control and specification of global standard of production and delivery of wholesome product to meets consumers acceptance.

DECLARATION OF CONFLICT OF INTEREST

The author declares no conflict of interest. Funding for this research was provided by the researcher.

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