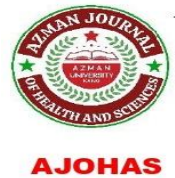




AZMAN JOURNAL OF HEALTH AND SCIENCES (AJOHAS)



Volume 1, Issue 1, June, 2026

www.ajohas.azmanuniversity.edu.ng

Antioxidant Properties of Indigenous-Based Small-Quantity Lipid-Based Nutrient Supplements for the Management of Moderate Acute Malnutrition in Katsina State, Nigeria

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Abstract

Malnutrition remains a significant public health challenge in Northern Nigeria, particularly among children under five years of age. This study formulated small-quantity lipid-based nutrient supplements (SQ-LNS) using locally available indigenous ingredients and evaluated their antioxidant properties for potential use in managing moderate acute malnutrition (MAM) in Katsina State, Nigeria. SQ-LNS blends were developed from millet, groundnut, soybean, baobab pulp, and red palm oil. Antioxidant activity was assessed using DPPH radical scavenging activity, ferric reducing antioxidant power (FRAP), and total phenolic content (TPC). The antioxidant properties of the formulations were compared with 100% pearl millet flour and a standard UNICEF therapeutic food. Total phenolic content ranged from 150.2 to 180.6 mg GAE/100 g among the formulated samples. DPPH inhibition reached up to 72.1%, while FRAP values ranged from 320.5 to 350.8 $\mu\text{mol Fe}^{2+}/\text{g}$. The UNICEF therapeutic food exhibited slightly higher antioxidant values, whereas pearl millet flour showed the lowest activity. These findings indicate that locally formulated SQ-LNS possess significant antioxidant potential capable of reducing oxidative stress and supporting nutritional recovery. The use of affordable and culturally acceptable ingredients enhances feasibility, sustainability, and scalability in community-based interventions for MAM.

Keywords: Antioxidants; SQ-LNS; Indigenous ingredients; Moderate Acute Malnutrition; Katsina State; Nigeria

INTRODUCTION

Malnutrition remains a leading cause of morbidity and mortality among children under five years of age, particularly in low- and middle-income countries. In Northern Nigeria, food insecurity, poverty, infectious diseases, and poor infant and young child feeding practices contribute significantly to the high prevalence of moderate acute malnutrition (MAM). Addressing this problem requires context-specific, affordable, and sustainable interventions that are culturally acceptable and nutritionally effective (Black et al., 2013; World Health Organization [WHO], 2023).

Small-Quantity Lipid-Based Nutrient Supplements (SQ-LNS) are specialized food products designed

to prevent and manage undernutrition in vulnerable populations. Unlike large-quantity therapeutic foods, SQ-LNS are provided in daily doses of 20 g or less and are intended to complement, rather than replace, the regular diet. These supplements are energy-dense, micronutrient-rich pastes typically composed of vegetable oil, groundnut paste, milk powder, sugar, and a vitamin–mineral premix (Dewey & Arimond, 2012; Adu-Afarwuah et al., 2017).

Beyond macronutrients and micronutrients, SQ-LNS formulations can be enriched with bioactive compounds such as antioxidants. Oxidative stress is commonly observed in malnourished children

due to inflammation, infections, and micronutrient deficiencies, and it may impair immune function and tissue repair. Antioxidant-rich foods may therefore contribute to improved nutritional recovery and immune function among children with acute malnutrition (Bhutta et al., 2017; Attia et al., 2017).

Recent research emphasizes the development of SQ-LNS using locally sourced indigenous ingredients to improve sustainability, reduce cost, and enhance community acceptance while maintaining nutritional adequacy. Local production and utilization of culturally acceptable ingredients have been shown to improve accessibility and long-term program sustainability (Segrè et al., 2017; Dewey et al., 2021).

This study therefore formulated SQ-LNS from millet, groundnut, soybean, baobab pulp, and red palm oil and evaluated their antioxidant properties using standard laboratory assays.

Materials and Methods

Study Area

The study was conducted in Katsina State, Northwestern Nigeria, where malnutrition among children under five is highly prevalent. The state experiences high rates of food insecurity, poverty, and childhood undernutrition, making it an appropriate setting for investigating locally

produced nutritional interventions (National Population Commission & ICF, 2019; WHO, 2023).

Ingredient Selection and Formulation

Groundnuts, millet, soybeans, baobab pulp, and red palm oil were selected based on their nutritional value, availability, and cultural acceptance. The ingredients were cleaned, processed (including roasting and milling where appropriate), and blended in predetermined ratios. The mixtures were homogenized to obtain paste-like SQ-LNS formulations in line with international recommendations for lipid-based nutrient supplements (Dewey & Arimond, 2012; Adu-Afarwuah *et al.*, 2017).

Antioxidant Analysis

Antioxidant properties were determined using Total Phenolic Content (TPC), expressed as mg gallic acid equivalents (GAE)/100 g; DPPH radical scavenging activity (% inhibition); and Ferric Reducing Antioxidant Power (FRAP), expressed as $\mu\text{mol Fe}^{2+}/\text{g}$. These methods are widely used and validated for evaluating the antioxidant potential of food products and functional nutritional formulations (Prior *et al.*, 2005; Thaipong *et al.*, 2006). All analyses were conducted in triplicate, and results are presented as mean $\pm$ standard deviation.

Results and Discussion

Table 1: Antioxidant Properties of SQ-LNS Formulations and Control Samples

Sample Formulation Description		TPC (mg GAE/100 g)	DPPH (%)	FRAP ($\mu\text{mol Fe}^{2+}/\text{g}$)
F1	Millet + Groundnut	150.2 $\pm$ 2.1	68.4 $\pm$ 1.5	320.5 $\pm$ 4.3
F2	Soybean + Baobab	180.6 $\pm$ 3.2	72.1 $\pm$ 2.0	350.8 $\pm$ 5.1
F3	Millet + Groundnut + Baobab + Soybean	175.4 $\pm$ 2.8	70.3 $\pm$ 1.8	340.2 $\pm$ 4.7
PMF	100% Pearl Millet Flour	98.7 $\pm$ 1.6	52.5 $\pm$ 1.2	210.4 $\pm$ 3.9
CTL	UNICEF Therapeutic Food	185.0 $\pm$ 3.0	73.0 $\pm$ 1.6	360.0 $\pm$ 4.5

The formulated SQ-LNS demonstrated significantly higher antioxidant activity than plain pearl millet flour. Formulation F2 (Soybean + Baobab) exhibited the highest antioxidant capacity among locally prepared blends. The inclusion of baobab pulp and red palm oil likely contributed to elevated phenolic content and reducing power.

The antioxidant values were comparable to the UNICEF therapeutic food, suggesting that locally formulated SQ-LNS can provide both nutritional and functional benefits. Given that oxidative stress contributes to impaired immune function and delayed recovery in malnourished children, these antioxidant-rich formulations may enhance nutritional rehabilitation outcomes.

5.0 Conclusion and Recommendations

5.1 Conclusion

Locally formulated SQ-LNS developed from millet, groundnut, soybean, baobab pulp, and red palm oil demonstrated substantial antioxidant potential. These formulations may contribute to reducing oxidative stress while providing essential nutrients for managing moderate acute malnutrition. The use of indigenous ingredients enhances sustainability, affordability, and cultural acceptance.

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