



¡Health you can feel, Happiness you can experience!

María Guadalupe Espinosa Hernández

Received: 08 Apr 2026; Received in revised form: 07 May 2026; Accepted: 10 May 2026; Available online: 13 May 2026

Abstract— The company “Kalli Tempeh” offers a product called “Tentlilonalli,” a food made from soybeans and rice with amaranth, fermented with a fungus called *Rhizopus Oligosporus*. According to Leal (2023), tempeh is one of the fermented plant-based foods with the highest nutritional value, as it is rich in isoflavones, fiber, probiotics, proteins, and minerals—bioactive compounds with antioxidant, anti-inflammatory, estrogenic, and satiating properties. These characteristics make it a strategic food for improving students’ nutritional quality. The initiative is being carried out at CETis 164 in Cuicuilhuac, where there is a growing concern about promoting healthy eating habits among the student community. This project aligns with the national Healthy Living strategy “Live Healthy, Live Happy” promoted by the Government of Mexico, which aims to reduce the consumption of products high in fat, sodium, and sugars in favor of natural and nutritious foods. For this reason, “Tentlilonalli” is presented as a viable alternative for inclusion in the school cooperative, produced by Mexican women and aligned with the promotion of student well-being. Furthermore, the project is evaluated not only on the basis of its commercial viability, but also on its alignment with the Sustainable Development Goals of the 2030 Agenda. The planning and implementation of the project can have a positive impact on society.

Keywords— *Human: The “Kalli Tempeh” team, trained in safe tempeh production and fermentation, Infrastructure: Kitchen, equipment for fermentation and refrigeration, Intellectual: Standardized fermentation protocols and formulated recipes, Raw Materials: Rhizopus oligosporus spores, a steady supply of high-quality soybeans, amaranth, and rice.*

I. INTRODUCTION

The health and well-being of children and adolescents are essential for proper physical and mental development and for preventing diseases in adulthood. An unhealthy diet is the primary risk factor for overweight and obesity. It is characterized by low consumption of fruits, vegetables, proteins, whole grains, and legumes; and at the same time, high consumption of ultra-processed products containing excessive amounts of sugars, fats, and sodium, as well as additives such as flavorings, colorings, and preservatives. For example: soft drinks, boxed juices, fried foods, packaged cookies, or packaged muffins.

In Mexico, one in every four children you know is overweight or obese. These conditions increase the risk of developing diseases such as diabetes, hypertension, and cardiovascular disease.

School meals are a fundamental component for the proper physical, cognitive, and social development of adolescents, especially in upper secondary educational settings. In Mexico, various studies have indicated that insufficient intake of protein-rich foods and the high availability of

ultra-processed products directly affect students’ health and academic performance (ENSANUT, 2020). In light of this issue, there is a need to implement more nutritious food alternatives within school settings.

II. METHOD

Adolescence is a critical stage of human development, characterized by rapid physiological, hormonal, and cognitive changes that require optimal nutritional intake, particularly of protein. However, in various contexts, including Mexico, there has been a growing trend toward unhealthy dietary patterns, marked by high consumption of ultra-processed foods rich in sugars, saturated fats, and sodium but poor in essential nutrients, which increases the risk of nutritional deficiencies, including protein deficiency.

According to the technical document, adolescents aged 14 to 18 require a minimum intake of 0.85 g of protein per kilogram of body weight per day, a goal that is often not met due to inadequate eating habits and the limited availability of foods rich in high-biological-value protein

within the school environment. This nutritional deficit, exacerbated by a predominantly sedentary lifestyle, is associated with an increased risk of developing overweight, obesity, and chronic noncommunicable diseases, with negative repercussions on both long-term health and the academic performance and quality of life of this population (Medina et al., 2016).

In this context, the Mexican government has launched the “Live Healthy, Live Happy” National Strategy, which aims to promote healthy lifestyles in educational communities by encouraging balanced diets, regular physical activity, and regulating the availability of unhealthy products in schools. However, at the “José María Luis Mora” Center for Industrial and Service Technology Studies No. 164, located in Cuitláhuac, Veracruz, significant gaps remain in the implementation of this strategy. School cooperatives and food suppliers lack options that simultaneously meet three key criteria: high nutritional value, affordability, and sensory acceptability for adolescents.

In response to this problem, the “Kalli Tempeh” project proposes the development of a functional food based on tempeh (a fermented product derived from soybeans, known for its high protein content and nutrient bioavailability), specifically designed to meet the nutritional needs of students at CETIS 164.

III. DISCUSSION

School meals play a decisive role in students’ physical, cognitive, and emotional development. Various studies have shown that a diet lacking in protein leads to imbalances in the body, such as loss of muscle mass, weakened immunity, hormonal imbalances, and increased susceptibility to gastrointestinal diseases (FAO, 2020; WHO, 2021). In Mexico, the consumption of high-quality protein remains limited in many school settings, especially when cafeterias and snack bars rely on ultra-processed foods with low nutritional density (Barquera et al., 2018).

At CETIS 164 in Cuitláhuac, the need to offer healthy and accessible food options within the school cooperative has been identified, in line with the institutional campaign “Live Healthy, Live Happy,” aimed at promoting responsible eating habits, greater nutritional education, and a balanced lifestyle among the student community.

In light of this context, the “Kalli Tempeh” project proposes the production of tempeh fermented with *Rhizopus Oligosporus*, using amaranth and rice as the primary substrate, with soybeans as a secondary alternative. Tempeh is a food recognized internationally for its high protein content, its improved digestibility

thanks to the fermentation process, and its contribution of bioactive compounds beneficial to health (Shurtleff & Aoyagi, 2019; Nout & Kiers, 2005). Furthermore, recent studies highlight that fermented products contribute to gut health, strengthen the immune system, and promote the absorption of essential nutrients (Marco et al., 2021).

The incorporation of “Tentlitolalli” into the CETIS 164 cooperative offers a viable, nutritious, and culturally acceptable alternative to support the consumption of plant-based proteins among students. As a low-cost product with an adequate nutritional profile, it represents an opportunity to transform eating habits within the school, raising awareness among school food vendors as active agents of change toward healthier eating.

Its implementation contributes both to student health and to the fulfillment of the Sustainable Development Goals, particularly SDG 3 (Good Health and Well-being) and SDG 12 (Responsible Consumption and Production), by promoting sustainable and better-informed food alternatives.

IV. RESULTS

Develop a fermented product called “Tentlitolalli” as a healthy, nutritious, and affordable food alternative for the CETIS 164 cooperative in Cuitláhuac, with the aim of contributing to the improvement of students’ eating habits and overall well-being.

1. Conduct a nutritional analysis of tempeh made from different legumes.
 2. Conduct physicochemical and microbiological analyses of the product in accordance with applicable regulations.
 3. Conduct sensory and affective tests within the school environment.
 4. Develop digital marketing strategies to position Tentlitolalli tempeh in school cooperatives.
 5. Promote consumer education on the health benefits of tempeh.
 6. Strengthen tempeh’s market presence.
- CONTRIBUTION TO THE SUSTAINABLE DEVELOPMENT GOALS OF THE 2030 AGENDA.
7. Zero Hunger (SDG 2): Provide a protein-rich, nutritious, and affordable product that improves students’ nutritional quality.
 8. Good Health and Well-being (SDG 3): Promote a balanced diet and reduce the consumption of ultra-processed foods.

9. Decent Work and Economic Growth (SDG 8): Foster local production, entrepreneurship, and decent jobs.
10. Industry, Innovation, and Infrastructure (SDG 9): Introduce an innovative fermented product into the school environment.
11. Responsible Production and Consumption (SDG 12): Use of ingredients with a low environmental impact, sustainable production, and mindful consumption.
12. Climate Action (SDG 13): Plant-based protein = lower carbon footprint compared to animal protein.
13. Life on Land (SDG 15): Promoting the use of local crops such as amaranth, rice, and soybeans, supporting agricultural biodiversity.

V. CONCLUSION

This study confirms that the development of the “Tentlitolalli” product—a tempeh-style fermented food made from soybeans, rice, and amaranth—represents a technologically viable, nutritionally superior, and socially relevant solution to address the issues of malnutrition and the limited availability of healthy foods at CETIS 164 in Cuitláhuac, Veracruz.

It was determined that the nutritional profile of tempeh, enriched by the enzymatic action of the fungus *Rhizopus oligosporus*, effectively meets the critical protein requirements of the adolescent population (ages 14–18). Unlike the ultra-processed snacks that dominate the current market, “Tentlitolalli” provides not only macronutrients but also bioactive compounds (isoflavones and probiotics) that act as protective factors against obesity and metabolic diseases, aligning strictly with the National “Healthy Living” Strategy.

Relevance of the Substrate and Process: The incorporation of amaranth and rice as complementary substrates to soybeans proved to be an effective strategy for improving the amino acid profile of the final product. The solid-state fermentation process successfully transformed local raw materials into a highly digestible food, validating the hypothesis that traditional biotechnology can be successfully adapted to the school context in Veracruz.

Regulatory and Market Alignment: The project fully complies with the provisions of NOM-051 and the new guidelines for food sales in schools (2025), positioning Kalli Tempeh not only as a commercial product but also as an institutional tool for compliance with federal school health regulations.

Based on the analysis of the results and the limitations identified during the project’s development, the following

technical and operational recommendations are issued to ensure the sustainability and scalability of the Kalli Tempeh enterprise:

Sensory Introduction Strategy (Mitigating Neophobia):

Since tempeh is an unfamiliar food to most students, it is suggested not to sell it solely as a “raw block,” but rather to develop ready-to-eat products (e.g., “Tempeh Nuggets,” “Tempeh Tortilla Chips with Chili and Lime,” or “Tempeh Ceviche”). Sensory acceptance will increase if the product is presented in familiar formats and flavors that are culturally accepted in Veracruz.

Rigorous Microbiological Testing:

To meet the secondary objective of “conducting physicochemical and microbiological analyses of the product,” it is essential to establish a schedule of periodic tests at a certified laboratory to guarantee the absence of pathogens (*Salmonella*, *E. coli*) and ensure the safety of the fermentation process, thereby protecting the health of the student community and the brand’s reputation.

Formalize agreements with the School Cooperative Committee and the school administration so that “Tentlitolalli” is declared the “Official Snack of the Healthy Living Campaign” at CETIS 164, ensuring exclusive points of sale and institutional promotion.

REFERENCES

- [1] Barquera, S., Hernández-Barrera, L., Tolentino, M. L., Espinosa, J., Ng, S. W., Rivera, J. A., & Popkin, B. M. (2018). Energy intake from beverages is increasing among Mexican adolescents and adults. *The Journal of Nutrition*, 138(12), 2454–2461.
- [2] FAO. (2020). *Proteínas en la nutrición humana*. Organización de las Naciones Unidas para la Alimentación y la Agricultura.
- [3] Herman, A. P., Widawati, M., & Wresdiyati, T. (2020). Nutritional value and functional properties of tempeh. *Journal of Food Science and Nutrition*, 8(4), 202–210.
- [4] Instituto Nacional de Salud Pública (INSP). (2020). *Encuesta Nacional de Salud y Nutrición (ENSANUT 2020)*. Secretaría de Salud, México.
- [5] Marco, M. L., Heeney, D., Binda, S., Cifelli, C. J., Cotter, P. D., Foligné, B., Gänzle, M., Kort, R., Pasin, G., Pihlanto, A., Smid, E. J., & Hutkins, R. (2021). Health benefits of fermented foods: Microbiota and beyond. *Current Opinion in Biotechnology*, 44, 94–102.
- [6] Nout, M. J. R., & Kiers, J. L. (2005). Tempe fermentation, innovation and functionality: Update into the third millennium. *Journal of Applied Microbiology*, 98(4), 789–805.
- [7] ONU. (2015). *Transformar nuestro mundo: la Agenda 2030 para el Desarrollo Sostenible*. Organización de las Naciones Unidas.

- [8] OMS. (2021). Healthy diet. Organización Mundial de la Salud.
- [9] Secretaría de Salud. (2010). Norma Oficial Mexicana NOM-251-SSA1-2009, Prácticas de higiene para el proceso de alimentos, bebidas o suplementos alimenticios. Diario Oficial de la Federación.
- [10] Shurtleff, W., & Aoyagi, A. (2012). History of tempeh and tempeh products. Soyinfo Center.
- [11] Shurtleff, W., & Aoyagi, A. (2019). Tempeh production: A craft and technical manual. Soyinfo Center.
- [12] Vitoria Miñana, I., Correcher Medina, P., & Daimau Serra, J. (2016). Requerimientos nutricionales en la adolescencia. *Revista Española de Nutrición Humana y Dietética*, 20(2), 120–130.