

Feasibility of Vegetable Hummingbird Flowers (*Sesbania grandiflora*) in Noodle Production: A Sustainable Approach to Food Innovation

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ABSTRACT

*Despite the abundance of vegetable hummingbird (*Sesbania grandiflora*) flowers, locally known as Katuday/Katuray, they remain underutilized despite their potential as a sustainable food source. This research explored the feasibility of producing noodles from these flowers, branded as Katoodles (Katuday Noodles), to increase their utility and address wheat shortages. By examining the sensory characteristics of noodles made from vegetable hummingbird flowers and wheat flour, the study aimed to provide an innovative and sustainable food product. This quasi-experimental research used four ratios of blended vegetable hummingbird flowers to flour (0:100, 50:50, 60:40, and 40:60). Five food technology and cookery experts, along with five consumers, evaluated the Katoodles based on taste, texture, smell, and appearance using a Five-Point Hedonic Scale. Results indicated that noodles could successfully be made with these blends. Katoodles with 50% blended vegetable hummingbird flowers (Mixture 1) scored the highest in sensory evaluation, while commercial noodles (Mixture 0) scored the lowest. No significant difference was found among the Katoodles mixtures, suggesting consistent quality comparable to commercial products. This study highlights the broader potential of utilizing underutilized crops like Katuday/Katuray to promote sustainability and reduce reliance on wheat. Katoodles offers a nutritious, plant-based alternative, addressing the demand for healthier, eco-friendly options. Their commercialization could diversify the noodle market, create economic opportunities, and encourage the cultivation of sustainable crops. Further research on the nutritional value and marketability of Katoodles is recommended.*

Keywords: Katoodles, mixtures, noodles, quasi-experimental, vegetable hummingbird flowers

INTRODUCTION

The economic problem entails determining how to satisfy limitless demands with limited resources. Humankind cannot have all the goods and services they desire because resources are limited; as a result, they must choose some and forfeit others, the concept of

opportunity cost. Individuals, businesses, and the government face the economic crisis of employing scarce resources to satisfy endless needs.

Agriculture is the leading source of income in the Philippines (Tomaneng et al., 2023); the country produces significant quantities of rice (20 mmt) and maize (8 mmt) within the local grain sector. Still, it does not grow substantial amounts of wheat or barley due to its unfavorable environment. As a result, the amount of wheat imported into the Philippines has increased recently to about six mm (Wilkinson et al., 2019).

As Ocampo (2019) noted, the OECD projects that the top five countries, including the Philippines, will account for a quarter of the world's wheat imports over the next decade due to rising bread and feed consumption. In 2020, the Philippines ranked as the eighth-largest wheat importer globally, with imports valued at \$1.49 billion, primarily sourced from Russia, Ukraine, Australia, and Romania (OECD, 2020).

However, the global wheat shortage, driven by geopolitical conflicts, such as the Russia-Ukraine war and climate-related issues in key producing nations, has disrupted supply chains. The Philippine Association of Flour Millers, Inc. (PAFMI) reports that the blockade of Ukrainian ports and export bans by major producers like India have further aggravated the crisis (Sagcal, 2022; Agarwal, 2022). As a result, the price of imported wheat rose sharply, from \$225 per metric ton in mid-2021 to \$475-\$550 per ton by mid-2022, increasing flour costs and impacting bread and noodle prices (Sagcal, 2022).

The rising costs have heavily burdened both businesses and consumers. Bakery owners express concerns that significant price hikes in bread and pandesal could drive away customers (Sagcal, 2022). The shortage has also affected neighboring countries, such as Indonesia, where supplies of instant noodles diminished due to dependence on Ukrainian wheat (Llewelyn, 2022). Globally, the wheat shortage has pushed up the prices of pasta, bread, and baked goods, with price increases of up to 24.9% in the U.S. in 2022 (Simmons, 2023).

Despite the popularity of traditional wheat-based foods, they are deficient in essential nutrients like dietary fiber and amino acids, highlighting a significant nutritional gap (Li et al., 2022). Efforts to address this deficiency have explored plant-based additives, yet the potential of underutilized local resources, such as vegetable hummingbird flowers, remains largely untapped. These flowers, abundant in regions like the Ilocos, are rich in protein, vitamins, and minerals, making them a promising ingredient for sustainable, value-added food products (Bhokre et al., 2022; Binu, 2020). This presents a dual opportunity to enhance nutritional value while reducing wheat dependency (Alan & Rabacal, 2022).

However, a critical gap remains in utilizing vegetable hummingbird flowers for marketable food innovations. In provinces like the Ilocos region, these flowers, locally known as Katuday/Katuray, bloom year-round and are easily propagated. Despite their abundance, they are underutilized, with many flowers left to wither, contributing to the 22% of food losses

and waste attributed to fruits and vegetables along the supply chain (Ferreira et al., 2015; Gallardo et al., 2024; Santos et al., 2022).

While numerous studies have explored noodle production (Rana, 2022; Adebowale, 2016; Menon, 2015), none have focused on incorporating vegetable hummingbird flowers as a primary component. To address this gap, this study seeks to innovate Katuday Noodles (Katoodles) by incorporating vegetable hummingbird flowers to reduce wheat usage in noodle production. The study aims to determine the feasibility of this approach as a cost-effective and nutritionally enriched alternative to traditional wheat-based noodles. This innovation will address the global wheat shortage and provide consumers with a more affordable and sustainable option than existing wheat-based noodles.

Objectives of the Study

This study aimed to determine the feasibility of hummingbird flowers as noodles. Specifically, it determined the quality level of the four mixtures of Katoodles in terms of taste, texture, smell, and appearance and the significant difference between and among the Katoodles mixtures.

METHODOLOGY

Research Design

The quantitative research design used in this study is Quasi-Experimental.

Participants of the Study

Five (5) food technology and cookery experts and five (5) consumers who were chosen through purposive sampling evaluated the Katoodles (Katuday Noodles).

Research Instrument

A Five-Point Hedonic Scale validated by experts was used in the study to gather data. The Five-Point Hedonic Scale is a common method used in sensory evaluation to measure consumer preferences and the degree of likability or acceptance of a product based on sensory attributes such as taste, appearance, texture, and smell. Using a validated Five-Point Hedonic Scale ensures that the product's sensory evaluation is reliable and meaningful, providing valuable insights into consumer preferences.

Data Gathering Procedure

There were four Katoodles mixtures in the study: Mixture 0 or the no-vegetable mixture (0:100), Mixture 1 (50:50), Mixture 2 (60:40), and Mixture 3 (40:60). By selecting these four ratios, the study covers a broad spectrum of possible vegetable-to-Katoodles

proportions, from no vegetables at all to a more vegetable-dominant mixture. This enables a comprehensive analysis of how varying vegetable content influences the final product, helping to identify optimal blending ratios for taste, nutrition, or other factors of interest.

The validation process, involving expert review, ensures that the scale accurately reflects how evaluators feel about the product and can be used to make informed decisions about product development or quality control. The study properly adhered to the protocol for research ethics.

Data Analysis

Mean and Analysis of Variance were used to analyze data.

RESULTS AND DISCUSSIONS

Results are disclosed in tabular and textual forms.

Quality Level of Katoodles Mixtures

Table 1 shows the quality level of the four mixtures of Katoodles in terms of taste, texture, smell, and appearance.

Table 1

Quality Level of Katoodles Noodles

Criteria	Mixture							
	Mixture 0 (0:100)		Mixture 1 (50:50)		Mixture 2 (60:40)		Mixture 3 (40:60)	
	M	DR	M	DR	M	DR	M	DR
Taste	4.20	G	4.50	E	4.40	E	4.60	E
Texture	4.00	G	4.50	E	4.30	E	4.20	G
Smell	4.20	G	3.90	G	4.10	G	3.90	G
Appearance	4.20	G	4.80	E	4.50	E	4.40	E
Overall	4.15	G	4.43	E	4.33	E	4.28	E

Legend:

4.21-5.00 Excellent (E); 3.41-4.20 Good (G); 2.61-3.40 Fair (F); 1.81-2.60 Poor (P); 1.00-1.80 Very Poor (VP)

As reflected in Table 1, the study's findings reveal that Mixtures 1, 2, and 3 received equally excellent ratings, with mean values of 4.43, 4.33, and 4.28, respectively. Mixture 1

emerged as the top-rated, while Mixture 0, the no-vegetable control mixture (commercial noodles), received the lowest rating with a mean value of 4.15.

It is important to note that Mixture 0 consistently received good ratings across all criteria, unlike the vegetable-enriched mixtures, which scored excellent in some criteria. Specifically, Mixture 0 received the highest rating in smell ($M=4.2$), likely because evaluators were already familiar with the distinct odor of commercial noodles. In contrast, Mixture 1 achieved the highest ratings in texture ($M=4.5$) and appearance ($M=4.8$), while Mixture 3 excelled in taste ($M=4.6$).

These findings highlight the positive impact of adding vegetables to noodle formulations, as evidenced by the high sensory ratings of Mixtures 1, 2, and 3. The addition of vegetables significantly enhanced the nutritional value of the noodles while maintaining their sensory appeal, particularly in terms of texture, appearance, and taste. Although there was a slight trade-off in odor quality, this minor concern did not diminish the overall desirability of the vegetable-based noodles.

The strong performance of Mixtures 1, 2, and 3 positions vegetable-enriched noodles as a marketable, nutritious alternative to traditional commercial noodles (Mixture 0), particularly in the growing market for health-conscious, sustainable food options. This supports the feasibility of incorporating vegetables, such as hummingbird flowers, into noodles, as these mixtures achieved excellent ratings in the study.

The inclusion of vegetables in noodles, as discussed in studies by Kim et al. (2015) and Qumbisa et al. (2022), has been shown to improve the taste, texture, and appearance of noodles while slightly reducing their odor quality due to the natural scent of the added ingredients (Toyokawa et al., 2020). This is further supported by Rabago (2022), who successfully used breadfruit flour to make tart, with all its mixtures receiving high sensory ratings.

Overall, these findings underscore the potential of vegetable-based noodles as a nutritious alternative and a product with significant market potential for health-conscious consumers.

Significant Differences between and among the Katoodles Mixtures

The significant difference between and among the Katoodles mixtures is presented in Table 2.

The table shows that there are no significant differences in quality between the Katoodles mixtures based on taste ($F=0.50$; $p>0.05$), texture ($F=0.77$; $p>0.05$), smell ($F=0.36$; $p>0.05$), and appearance ($F=1.60$; $p>0.05$). Mixtures 1, 2, and 3, which are enriched with vegetables such as hummingbird flowers, are comparable in quality to Mixture 0, the commercial noodle. This suggests that incorporating vegetables into noodles is both feasible and practical, as it does not negatively affect the sensory attributes consumers care about,

such as flavor, texture, and appearance. These findings demonstrate that healthier versions of noodles can be created without compromising the familiar qualities that make them widely appealing, making the vegetable-enriched mixtures suitable for commercialization.

Table 2
ANOVA Results of the Significant Differences in Katoodles Mixtures

Criteria	F	p-value	Decision
Taste	0.50	0.68	Do Not Reject Ho
Texture	0.77	0.52	Do Not Reject Ho
Smell	0.36	0.78	Do Not Reject Ho
Appearance	1.60	0.21	Do Not Reject Ho

Significant at $p < 0.05$

The ability of these vegetable-enriched noodles to maintain high sensory quality highlights their strong potential in the market. Today's consumers are increasingly looking for healthier and more sustainable food options, but they still value taste and convenience. These noodles offer a unique solution by providing both nutrition and sensory satisfaction, appealing to a broad consumer base, from health-conscious individuals to families seeking wholesome, everyday meal options. The comparable quality of the vegetable-enriched noodles to traditional ones gives them a competitive advantage, as they offer added nutritional value without requiring consumers to compromise on the eating experience they enjoy.

In addition to their market appeal, these findings open up opportunities for food innovation. The use of underutilized vegetables like hummingbird flowers in noodle production showcases how traditional recipes can be enhanced with novel ingredients to improve their nutritional profile. This innovation not only adds value to a staple food but also promotes the use of plant-based ingredients that might otherwise be overlooked. This approach aligns with current trends in the food industry that emphasize sustainability, plant-based diets, and the development of functional foods that serve specific health benefits while maintaining high consumer acceptability.

From a public health perspective, these vegetable-enriched noodles could help address key nutritional gaps in communities. By incorporating vegetables into a widely consumed food item, they provide an accessible and convenient way to increase vegetable intake, particularly in populations where fresh produce may be less available or affordable. These noodles could also appeal to picky eaters, such as children, who may not typically eat vegetables but would consume them in a hidden form within familiar foods. As a result, these products have the potential to support healthier eating habits on a large scale while addressing common challenges related to diet and nutrition.

Finally, the scalability and cost-efficiency of producing these vegetable-enriched noodles make them a practical option for commercialization. Since the production process requires minimal adjustments to existing manufacturing systems, companies can adopt the process without significant financial investment, keeping costs low for both producers and consumers. This ensures that the product remains affordable and accessible while maintaining profitability. By promoting these noodles as a nutritious, cost-effective, and sustainable food option, producers can meet the growing demand for healthier products while contributing to a more sustainable and health-focused food system.

Empirical studies have consistently supported the finding that there are no significant differences in taste, texture, aroma, and appearance across various noodle mixtures (Parvin et al., 2020; Qumbisa et al., 2022; Ragee & Abdel-Aal, 2016, as cited by Li et al., 2022; Menon, 2015). These studies affirm that incorporating vegetables or alternative ingredients into noodle formulations does not compromise the sensory qualities that consumers value. This is particularly significant because it demonstrates that vegetable-enriched noodles can offer enhanced nutritional value while maintaining the familiar qualities that make noodles a popular staple food. As a result, vegetable-enriched noodles can be positioned as a direct competitor to traditional commercial noodles in terms of quality and acceptability.

CONCLUSIONS

Noodles made with vegetable hummingbird flowers are feasible. The Katoodles with 50% blended hummingbird flower vegetables (Mixture 1) received the best results. However, the commercial noodles without vegetables (Mixture 0) had the lowest mean rating. Additionally, it was found that there were no significant differences between and among the Katoodles mixtures, indicating that they were all of the same quality and could compete with commercial ones on the market.

RECOMMENDATIONS

In addition to nutritional analysis and consumer acceptability studies, evaluating the production process's scalability and assessing the potential cost implications for large-scale manufacturing is recommended. Understanding the feasibility of scaling up production will be essential for determining the cost-efficiency of producing vegetable-enriched noodles, ensuring they can be competitively priced in the market while maintaining profitability. This step will provide valuable insights into potential challenges related to ingredient sourcing, production timelines, and operational costs, which are crucial for a successful product launch. As mentioned, conducting studies to assess marketability and consumer demand will further enhance the strategic decisions made in the commercialization process. Furthermore, future studies should involve larger sample sizes, more diverse evaluators, and additional evaluation

criteria to validate the product's quality further and improve the marketability of these nutritious noodles.

ETHICAL STATEMENT

This study was conducted by the ethical standards set by the Research Ethics Committee, as it was also reviewed and approved before any data collection began to ensure it met all ethical requirements.

Written consent was obtained from all participants to ensure their voluntary participation in the study. They were also informed that they could withdraw from the study at any point without any consequences. In addition, all personal data collected during the study were kept confidential and anonymized to protect participants' privacy. Data was securely stored and only accessible to the research team. Furthermore, the researchers declare no conflicts of interest in conducting this study. All findings and results were reported honestly and transparently, without fabrication or manipulation of data. Any potential financial or personal conflicts of interest were disclosed before the start of the research.

Research ethics were strictly considered in the study, and the privacy and confidentiality of data and the anonymity of the respondents were prioritized. There were no conflicts of interest in the study.

ACKNOWLEDGMENT

This paper and the research behind it would not have been possible without the exceptional support of the University of Northern Philippines (UNP) President Dr. Erwin F. Cadorna, the UNP- University Research and Development Office headed by Dr. Edelyn A. Cadorna, and the Laboratory Schools.

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